PROGRAM

40th IEEE PHOTOVOLTAIC SPECIALISTS CONFERENCE

Colorado Convention Center
Denver, Colorado

June 8-13, 2014

IEEE

ELECTRON DEVICES SOCIETY®

IEEE photonics SOCIETY
formerly LEOS

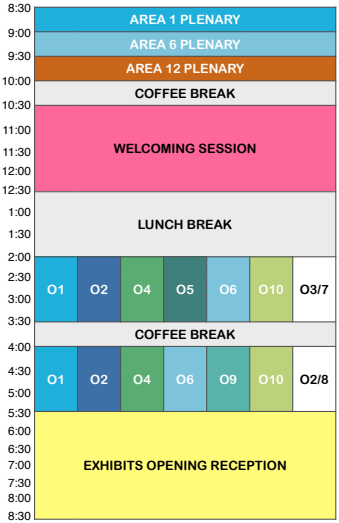
IEEE PES
Power & Energy Society®

ReliabilitySociety

IEEE★USA

PROGRAM AT-A-GLANCE

MONDAY



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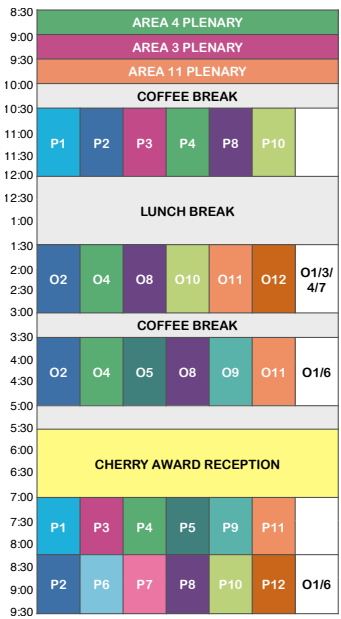

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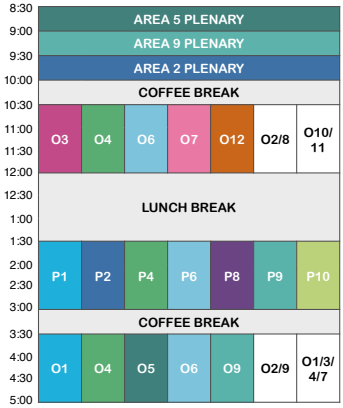

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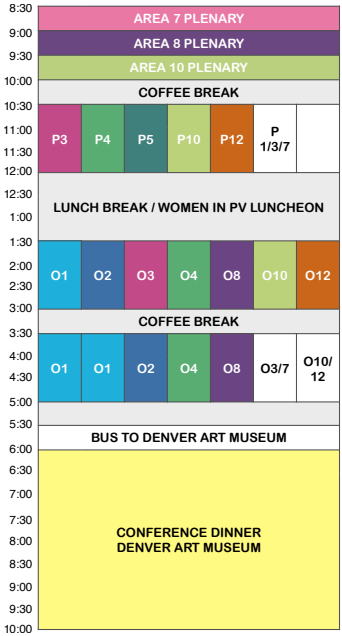
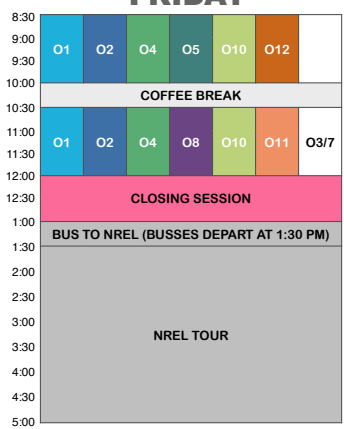


FRIDAY



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40th IEEE PHOTOVOLTAIC SPECIALISTS CONFERENCE

Sponsored by the Electron Devices Society of the Institute of Electrical and Electronics Engineers

CHAIRMAN'S MESSAGE

It is my great pleasure to welcome you to the 40th IEEE Photovoltaic Specialists Conference! The PVSC-40 takes place June 8-13, 2014, at the Colorado Convention Center in mile-high Denver, Colorado. Denver is a beautiful city with sunny days for most of the year, and one of strong solar importance, with many PV companies and the National Renewable Energy Laboratory located nearby.

We are in the midst of a crucial time for energy management on our planet. Environmental, climate change, and energy security concerns are among the most pressing issues we face today. Clearly, photovoltaics can be part of the solution. Public awareness is growing that photovoltaics can shape energy use patterns for future generations - much as the automobile transformed transportation within a time span of 50 years - as evidenced by the exponential rise in photovoltaic production over the last decade. Science and technology developments in PV over the next several years, and their influence on the economics of PV installations, are likely to establish which energy technologies become dominant for decades to come.

The purpose of our conference and our efforts to bring the world's brightest PV minds together is essentially an educational mission. Our conference is here to exchange information on the fundamental principles, materials science, fabrication, characterization, and application of solar cells. In this modest way, we strive to create a forum which encourages discovery, advances understanding of all aspects of photovoltaics, and hastens the widespread availability of solar electricity and its multiple environmental, economic, and political benefits for humankind. The chance to share and discuss these crucial PV technologies, and what they mean for accelerating PV deployment, is what the PVSC is all about. Thank you for joining us in continuing the PVSC's tradition as the preeminent conference dedicated to the science and technology of photovoltaics!

The Technical Program is divided into 12 areas covering the range of important developments in PV, from fundamentals, materials science, devices, systems and reliability, through policy and PV deployment acceleration. In the PVSC's oral and poster presentations, you'll be able to hear the latest advances and breakthroughs in our field of photovoltaics. Our Technical Program Committee members come from all over the globe, and we are excited about making the PVSC an ever more international conference, with major contributions from all the continents of the world.

The Tutorials and Short Courses program, taught by renowned experts in PV, is a great way to learn about a fascinating area of PV that may be new to you, or strengthen your foundation in a PV area you've been in for many years. The PVSC-40 hosts a dynamic Exhibition for companies and research labs to showcase their latest PV characterization, research, and manufacturing advances, bringing scientists and technologists together with leading PV industries and organizations. We are resuming our popular Solar Day in 2014, with many organizations showing how they are making solar electricity a reality in Colorado, and providing a model of PV acceleration for other communities.

We will have some fun too. We'll have Evening Poster Sessions for the first time at the conference on Tuesday night, with a reception-style dinner so you can feed mind and body at the same time. The Social Program has organized trips to see some of the best that Denver and nearby areas of Colorado have to offer for both attendees and companions, including touring Red Rocks, the chance to paint your own canvas, and hikes in the Rocky Mountains of Colorado. The Conference Dinner will be held in the breathtaking architectural space of the Hamilton Building of the Denver Art Museum. This event promises to be an evening of good art, music, food, and friends. I hope to see you there!

On behalf of the Organizing, Cherry, and International Committees, welcome to Denver and the 40th IEEE PVSC!

Richard R. King
PVSC-40 General Chair

GENERAL INFORMATION

DATES

The 40th IEEE Photovoltaic Specialists Conference begins Sunday, June 8th, with a day of tutorials. The technical program begins Monday, June 9th, and concludes Friday, June 13th, 2014.

CONFERENCE VENUE

Colorado Convention Center
700 14th Street
Denver, Colorado 80202

Phone: (303) 228-8000
Fax: (303) 228-8103
Email: info@denverconvention.com
Website: www.denverconvention.com

REGISTRATION INFORMATION

Name badges and final programs will be distributed at the Registration Desk which is located Concourse E of the Colorado Convention Center. The Registration Desk will be open during the following hours:

Saturday	4:00 PM - 8:00 PM
Sunday	7:30 AM - 8:00 PM
Monday	7:30 AM - 7:00 PM
Tuesday	7:30 AM - 6:00 PM
Wednesday	7:30 AM - 5:00 PM
Thursday	7:30 AM - 5:00 PM
Friday	7:30 AM - 1:00 PM

INSTRUCTIONS TO ORAL PRESENTERS

The speaker ready room will be available to all oral presenters for required previewing and optional editing of your presentation(s). The speaker ready room in MR 612 will be open during the following hours:

Sunday-Thursday	7:00 AM - 5:00 PM
Friday	7:00 AM - 10:00 AM

Please be sure to visit the speaker ready room and drop-off a copy of your presentation at least 24 hours prior to your scheduled presentation time. Even if you upload your presentation prior to the conference, you must check that it uploaded correctly by reviewing it in the Speaker Ready Room at the conference.

Please arrive at your session at least 15 minutes before the scheduled start to coordinate with the session chairs, check that the presentation will display properly, and become familiar with the audio-visual equipment in your room.

INSTRUCTIONS TO POSTER PRESENTERS

Poster boards will be available when the Posters/Exhibits Hall opens on Monday, June 9th, 2014, prior to the first poster sessions, which begins on Monday afternoon. All posters should be mounted by the end of the day on Monday, June 9th, 2014. The posters will remain on display through the morning poster sessions on Thursday. Posters must be

removed from the poster boards by 3:00 PM on Thursday, June 12th, 2014. Any posters not removed on time will be removed and discarded. Please be sure to present your poster in person at the designed time. Poster boards will be arranged with letters designating each aisle and numbered poster position on each aisle.

Poster Check-in: You are required to check-in at the poster registration desk before your poster session time. The poster registration desk will be located in the exhibit hall near the front of the poster area and will be open for registration 30 minutes before every session. If you do not check in, your poster will be recorded as not presented and your manuscript will not be published.

INTERNET ACCESS

Free Wifi access is available in the exhibit/poster hall. WiFi access is generously sponsored by Oriel Instruments.

NO PHOTOGRAPHY POLICY

Attendees may not take pictures of oral or poster presentations. Only official conference photographers are allowed to take such pictures.

COFFEE BREAKS

Coffee and soda breaks will be available each morning and afternoon. Please see below for locations:

EXHIBITS

The exhibit hall is located on the 3rd floor of the Convention Center in the East Hall and will be open during the following hours:

Monday	5:30 PM - 8:30 PM
Tuesday	10:00 AM - 6:00 PM
Wednesday	10:00 AM - 3:30 PM

ONLINE/MOBILE CONFERENCE PROGRAM

PVSC attendees may access the online conference in multiple formats including the full-text of each abstract submission.

Web-Based App
http://mobile.ieee-pvsc.org

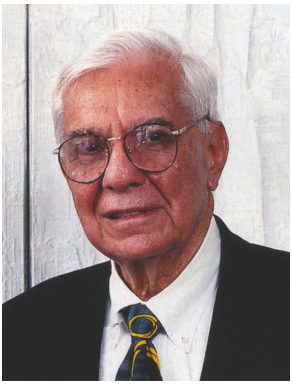
iOS/Android App
STEP 1: Download the MA eProgram App from either the iOS App Store or Google Play.

STEP 2: Use the scan event QR code feature and the following activation code:

Or enter “pvsc40” as the username and password

RECOGNITION OF DR. MORTON B. PRINCE

(Bell Labs Pioneer and PV Leader)



The confluence of the 40th IEEE PVSC and the 60th Anniversary of the Bell Telephone Laboratories discovery of the modern solar cell provides us with a unique opportunity to recognize one of our most distinguished members of the world PV community. As a MIT graduate student, Dr. Morton Prince was recruited by William Shockley to join Bell Labs and their development of the relatively new "transistor". While Mort was involved with the investigation of minority-carrier properties in these devices, he was approached by fellow group member, Gerald Pearson, about some incredible progress he was leading with this other new Bell device opportunity — the solar cell. In the late fall of 1953, Mort joined Pearson with responsibilities for characterization and device applications — and a seminal publication about the performance potential of the Si solar cell. History and Mort's contributions to photovoltaics thereafter speak for themselves! He left Bell Labs in 1956 to become Director of R&D at Hoffman Electronics (Semiconductor Division), leading the efforts to establish PV as the "power of choice" for space applications with the first solar power satellite, Vanguard, in 1958. Mort Prince has had an incredible career in semiconductor electronics — and led the growth of PV as the ERDA and DOE manager for this technology from 1975 to 1993. In 1994, he was recognized with the European Becquerel Prize for Outstanding Merits in Photovoltaics. The world PV community owes a lot to Mort. This year, the IEEE PVSC is especially proud to have this special recognition of Dr. Morton B. Prince for his leadership and his pioneering and outstanding contributions to our PV technology.

WILLIAM R. CHERRY AWARD

This award is named in honor of William R. Cherry, a founder of the photovoltaic community. In the 1950's, he was instrumental in establishing solar cells as the ideal power source for space satellites and for recognizing, advocating, and nurturing the use of photovoltaic systems for terrestrial applications. The William R. Cherry award was instituted in 1980, shortly after his death. The purpose of the award is to recognize an individual engineer or scientist who devoted a part of his/her professional life to the advancement of the science and technology of photovoltaic energy conversion. The nominee must have made significant contributions to the science and/or technology of PV energy conversion, with dissemination by substantial publications and presentations. Professional society activities, promotional and/or organizational efforts, and achievements are not considerations in the election for the award.

This award is presented at each IEEE Photovoltaic Specialists Conference. The recipient is selected by the William R. Cherry Committee, which is composed of past PVSC conference chairpersons and past recipients of the award. Those nominated for the award do not participate in the process.

To be eligible for the award, the nominee must currently be active in the science and technology of PV conversion. He/she must have been active in the field for an extended period with the expectation of continued activity. Short-term activities in the field, and/or single outstanding contributions are not sufficient to make a person eligible for the award.

To make a nomination, please submit a completed electronic nomination form and accompanying materials at: http://www.ieee-pvsc.org/ePVSC/cherry/form.php. The information required on the electronic form is summarized below:

1. Nominator's name, address, phone, and email
2. Nominee's name, present position, company, address, phone, and email
3. List of Nominee's key activities in the field
4. Nominee's current CV
5. Nominee's photograph
6. Citation: less than 40 words that reflect specific achievements
7. Rationale: less than 150-word summary of nominee's contribution to the advancement of the PV field

The deadline for Cherry Award nominations to be considered for the next IEEE PVSC is January 10 of each year.

Previous Cherry Award Recipients

Dr. Paul Rappaport	1980
Dr. Joseph L. Loferski	1981
Prof. Martin Wolf	1982
Dr. Henry W. Brandhorst	1984
Mr. Eugene L. Ralph	1985
Dr. Charles E. Backus	1987
Dr. David E. Carlson	1988
Dr. Martin A. Green	1990
Mr. Peter A. Iles	1991
Dr. Lawrence L. Kazmerski	1993
Prof. Yoshihiro Hamakawa	1994
Dr. Allen M. Barnett	1996
Dr. Adolf Goetzberger	1997
Dr. Richard J. Schwartz	1998
Dr. Christopher R. Wronski	2000
Dr. Richard M. Swanson	2002
Dr. Ajeet Rohatgi	2003
Dr. Timothy J. Coutts	2005
Dr. Antonio Luque	2006
Dr. Masafumi Yamaguchi	2008
Dr. Stuart Wenham	2009
Dr. Richard R. King	2010
Dr. Jerry M. Olson	2011
Dr. Sarah Kurtz	2012
Mr. Keith Emery	2013

THIS YEAR THE WILLIAM R. CHERRY AWARD WILL BE PRESENTED TO:

DR. RONALD A. SINTON

Ronald A. Sinton is founder and president of Sinton Instruments, based in Boulder, Colorado. Ron received his PhD in Applied Physics from Stanford University in 1987, following a B.S. in Engineering Physics from the University of Colorado in 1981. His studies at Stanford University included the demonstration of 28%-efficient silicon concentrator solar cells, the physics of high-injection solar cells, detailed device modeling, measurements of Auger recombination, and the test and measurement of concentrator solar cells. As a Research Associate at Stanford, Ron developed simplified versions of the sophisticated point-contact solar cell designs that could maintain the high efficiency while minimizing the process complexity. He continued this work during the early years of SunPower Corporation, focusing on solar cell designs and manufacturing processes potentially suitable for commercialization.

Dr. Sinton founded Sinton Consulting in 1992. The company soon focused on the development of novel test and measurement instruments. This work resulted in many fruitful, and very international, collaborations and research papers. Innovations from Sinton Instruments that have become standard within the R&D community and the silicon manufacturing industry include the QSSPC lifetime technique, Suns-Voc measurements, and novel methodologies for measuring the efficiency of high-efficiency solar cells and modules.

Dr. Sinton has maintained his special interest in the device physics of silicon solar cells. Running a metrology company has proven to be an effective way to be at the center of both of the R&D and manufacturing communities, offering opportunities to contribute at the most technical academic level as well as providing instrumentation to support tens of GWs of silicon solar cell and module production.

Ron received the R&D 500 award in 2005 for developing instruments for measuring bulk lifetime in silicon ingots and bricks. He is well published and has coauthored 4 book chapters. He is an associate editor of the IEEE Journal of Photovoltaics and has frequently presented tutorials on silicon solar cells and device physics at the IEEE PVSC conferences, first in 1988 and as recently as 2013. Ron is a frequent contributor to conference program committees; especially the IEEE PVSC, the NREL Silicon Workshop, and the SiliconPV conference.

Congratulations, Dr. Sinton!

IEEE PVSC YOUNG PROFESSIONAL AWARD

The organizing committee of the PVSC is excited to introduce a new award beginning this year at PVSC 40. The Young Professional Award is designed to recognize outstanding young professionals in our community who have made significant contributions to the science and technology of PV energy conversion, including work on PV materials, devices, modules, and/or systems. The award recipient must also show significant promise as a leader in the field.

In showing our commitment to encourage outstanding work by individuals at all stages of their career, we are proud to add the Young Professional Award to our conference awards program, which includes the Best Student Paper Award, the Best Poster Award, and the Cherry Award.

We encourage all of our attendees to begin thinking about nominating a colleague for the Young Professional Award in 2015, at PVSC 42. Award nominations will be due January 31, 2015. Complete criteria and eligibility requirements for this award can be found on our website at: http://www.ieee-pvsc.org/PVSC40/pages/communities-young-investigator.php.

THIS YEAR THE IEEE PVSC YOUNG PROFESSIONAL AWARD WILL BE PRESENTED TO:

DR. OLIVER SCHULTZ-WITTMANN

On behalf of the organizing and program committees of the 40th IEEE PVSC, I am delighted to announce the recipient of this year's award—Dr. Oliver Schultz-Wittmann. He is recognized for his outstanding achievements in the development of silicon solar cells, including the current world-record multicrystalline cell (20.4%) and high-efficiency, low-cost crystalline cells developed for commercialization by a recently-acquired start-up company.

Dr. Oliver Schultz-Wittmann started his work in the PV field in 1998 helping with rooftop installations while studying Physics at the University of Hamburg, Germany, where he received his diploma in Physics in 2001. His graduate thesis topic was the manufacturing and characterization of selective emitter structures on crystalline silicon solar cells in cooperation with the Fraunhofer Institute for Solar Energy Systems ISE in Freiburg, Germany. In 2002, he began his doctoral thesis on high-efficiency multicrystalline silicon solar cells at Fraunhofer ISE. The highlight of his work was demonstrating cells made from this material with conversion efficiencies greater than 20%, a record that still stands today. Oliver worked with industrial partners on several high-efficiency concepts, including laser-grooved buried contact cells and interdigitated back contact structures, before leading the high-efficiency cell group from 2007-2008. In 2009, Oliver co-founded the Silicon Valley start-up company TetraSun which was acquired by First Solar in 2013 for their launch of crystalline silicon solar cell production. He has five issued patents and is an active peer-reviewer for several journal publications and the IEEE Photovoltaic Specialists Conference. Oliver received the Solar World Junior Einstein Award in 2006 and is a co-awardee of the R&D 100 award of 2013.

Attendees of PVSC 40 - Be sure to check out a special talk by Dr. Schultz-Wittman taking place in the Area 4 oral session on Tuesday, June 10, at 1:30pm in Ballroom 1EF.

Congratulations, Dr. Schultz-Wittmann!

Kyle Montgomery
Awards Chair, PVSC-40
University of California, Davis

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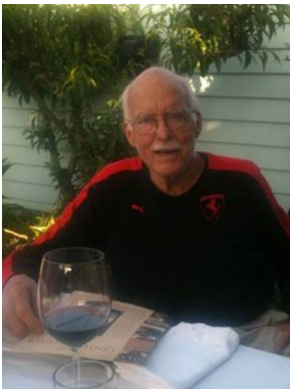
IN MEMORIAM



John “Bill” Yerkes, a solar pioneer considered the “father of terrestrial PV”, died on January 29, 2014 in Santa Barbara from an adenocarcinoma. He was 79.

Yerkes was an innovator and entrepreneur in PV for his entire life. He got his solar start as designer/manager of the Boeing Spacecraft test facility in Kent, WA. His supplier of sun-simulators, Spectrolab, hired him as General Manager to further develop flashers and search lights. As President, he led the development of solar arrays for Apollo 11 and his signature – among other key contributors’ - is still on the moon. When he left Spectrolab, Yerkes looked for ways to use solar energy on earth and founded Solar Technology International in 1973, where he scaled up low-cost processes such as POCl diffusion and screen printing. The purchase by oil giant Atlantic Richfield in 1979 allowed Yerkes’ company to become the world’s #1 cell and module producer out of Chatsworth and Camarillo, CA, where today’s essential solar module components were born. Markets included an alternative to thermoelectric power for telecom, aids to navigation, cathodic protection, vaccine refrigeration, water pumping and lighting in developing countries. Charlie Gay, who was VP of R&D under Yerkes and later ARCO Solar’s President recalls “Bill was magical. His raw, positive enthusiasm was contagious.” ARCO Solar’s ownership transitioned over the years to Siemens, Shell and 10 years ago to German giant SolarWorld, who still runs the largest solar cell and panel production in the USA out of Hillsboro, OR.

In the early 90’s, Yerkes returned to Seattle to build Boeing’s High Tech Center and later to lead the power systems division of Teledesic’s ambitious broadband satellite constellation program. More recently, Yerkes co-founded Solaicx to develop novel continuous-growth Czochralski pullers delivering record productivity, and its ingot production operation in Portland, OR, is still growing today under Sun Edison’s ownership.

Yerkes’ passion beyond solar included wine and great food, art, Formula 1 and his family. His natural hands-on skills and just-do-it attitude inspired many people to become passionate about solar and launch careers in photovoltaics. Richard Swanson, SunPower Corp.’s founder and long-time friend says “Bill had a unique ability to form lifelong friendships with his former employees and partners.”

Yerkes is survived by his wife Sara, his daughter Kari Hummel and three grandchildren.

PV JOBS WEBSITE PORTAL

As a continuous service to our PV community, the PV Jobs Portal can be accessed through our website (www.ieee-pvsc.org). Through this portal, you may post your resume to be viewed by potential employers. If you have a position to fill, you may post job postings at no charge to be viewed by the entire PV community. Check the PV Jobs Website Portal during the conference to see the latest job and resume postings.

PV Jobs at the Conference

The PV Jobs service offers the following during the conference:

- Scrolling job announcements. Active job postings will be scrolled on the oral presentation room screens during breaks
- Job Fair. We will be holding our third annual PV Jobs Fair during the conference to bring together potential employers with employees. The Fair will occur Tuesday, June 10 from 7:00 - 9:00 pm in the Poster Area during the evening poster sessions.
- A private room will be available during the conference that employers can reserve for candidate interviews.

HIGH SCHOOL PHOTOVOLTAIC DESIGN COMPETITION

The annual High School Photovoltaic Design Competition will be held as part of PVSC during Denver Solar Day on Sunday June 8th, 2014. The High School Photovoltaic Design Competition has been held in conjunction with the IEEE PVSC for over 20 years. This venue provides participating high school students with direct interactions with world-famous photovoltaic technologists and businesses. Denver Solar Day expects to attract up to 2000 people from the Denver community including PV installers, PV buyers, students, utilities, and the general public who are interested in including solar power in the daily lives. There is no charge for the general public to attend Denver Solar Day events.

SOCIAL PROGRAM

My name is Hala King and I am delighted to be your Social Program Chair for the 40th PVSC to be held in Denver, Colorado. With so much to do in Denver, it's hard to choose where to start. From the natural beauty of Red Rocks to the striking modern architecture of the Denver Art Museum, there is something for everyone in this vibrant Mile-High City.

We are pleased to offer four organized companion tours through Operation Altitude: the US Mint and Botanical Gardens tour, Red Rocks and Coors Brewery tour, Butterfly Pavilion and Pearl Street tour, and a unique painting experience to bring out the inner artist in you. There will also be hiking excursions lead by the fearless and hospitable NREL naturalists (who also do research on the side). Additional information about each tour offering is available online at http://www.ieee-pvsc.org under "Events".

In addition to the Companions' Program, we will be holding our traditional Conference Dinner and Cherry Award Reception. The Conference Dinner will be held at the Denver Art Museum. Do not miss this incredible opportunity to enjoy fabulous food catered by world-renowned Kevin Taylor, while being captivated by the art around you and by the entertainment chosen for the evening. This year's Cherry Award Reception will take place on the balcony area of the Colorado Convention Center right before the evening poster session, a new event at this conference.

As has been the practice over the past few conferences, we are asking all the companions to register for the conference. This will make signing up for the various activities easier, ensure that you will receive email regarding any changes and other special events/opportunities, and will provide you with access to the companions' room at the Hyatt Regency Denver (which includes complimentary continental breakfast each morning).

We look forward to seeing you in the Queen City of the Plains!

Hala K. King
PVSC-40 Social Chair

Fun facts: The number 40 is the atomic number of zirconium; negative 40 is the unique temperature at which the Fahrenheit and Celsius scale correspond; the Tessarakonteres, or 40, was the largest ship of antiquity, constructed by Ptolemy IV; "40" is the title of songs by U2, Franz Ferdinand, and the Dave Matthews Band; forty is the number of spaces in a standard Monopoly game board; 40 is the code for direct dial international phone calls to Romania; 40 was the first jersey number to be retired by the Denver Nuggets, in honor of Byron Beck; and oh yeah, is the number of your favorite conference this year ☺☺.

COMPANION ROOM

Because we are special, we have a dedicated space at the hotel to rendezvous, socialize, and be merry. Start each morning here with a complimentary continental breakfast. Companions are encouraged to make full use of this room. PLEASE NOTE that only companions with badges will be allowed in the companion's room for our continental breakfasts.

All tours will depart from the Hyatt Regency Denver porte-cochere.

Monday - Thursday 7:00 am - 9:00 am
Hyatt Regency Denver, Mineral Hall FG (Third Level)

SATURDAY, JUNE 7TH

PVSC HIKE
7:30 AM (Hyatt Lobby)

Chief mountain 5.8 miles round trip with 3 miles on a dirt road. The summit elevation is 11,709 ft. (3569 m) with 1000 ft. elevation from trial head. The trail gradually winds up through pleasant forest for half the hike up into alpine-like surroundings above tree line. As the trail comes out of the trees, the views of the surrounding mountains to the north and west appear. At the summit are huge granite outcroppings that you can climb for a spectacular 360 degree view of the foothills, valleys, and Rockies to the west. http://www.summitpost.org/chief-mountain/153817

If interested, please contact keith.emery@nrel.gov

SUNDAY, JUNE 8TH

IEEE EDS YOUNG PROFESSIONAL MIXER
6:00 - 8:00 PM
MR 607

Are you a student or recent graduate attending the PVSC? If so, come to the PVSC Student Mixer sponsored by the Electron Devices Society GOLD (Graduates of the Last Decade) Committee. Join us for an informal reception with a brief presentation about EDS, followed by a mixer with free food. It is a great opportunity to get to know fellow students and recent PV graduates just as the conference kicks off. See you there!

MONDAY, JUNE 9TH

EXHIBITORS' RECEPTION
5:30 - 7:30 PM (Exhibit Hall D)
The Exhibitors' Reception is open to all attendees.

TUESDAY, JUNE 10TH

CHERRY AWARD RECEPTION
5:30 - 7:00 PM (Exhibit Hall D Pre-Function and Terrace)

PV JOBS FAIR
7:00 - 9:00 PM (Exhibit Hall D)

EVENING POSTER RECEPTION
7:00 - 9:30 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11TH

SUN RUN
6:15 AM

What is 3.1 miles long and 1 mile high? The 26th IEEE PVSC Sun Run in the Mile High City of Denver! The run (our first was in 1980!) is scheduled for 6:15 am on Wednesday, June 11, 2014, to ensure everyone will be back in time for the presenters' breakfast and the sessions! The course will be run along historic Cherry Creek, in which gold was first discovered in Colorado in 1858. The Cherry Creek Trail is directly behind the Denver Convention Center-so no busing! Runners (both competitive and less so!) can register on line or at the meeting. The registration fee covers a special T-shirt, refreshments, recognitions for outstanding performance- and some commemorative materials of great worth. Awards will be made in several age categories for our men and women competitors. Again we will have the Corporate Cup Competition for teams (3 or more runners) for which the times are handicapped by both age and gender using the long-tested (since 1984!) "Modified Arvizu-Kazmerski Adjustment System" (we should get both of them to run this year?). For details and information, please contact L.L. Kazmerski (solarpvkaz@gmail.com).

THURSDAY, JUNE 12TH

CONFERENCE DINNER
6:00 - 10:00 PM (Buses begin staging at 5:30 pm.)
Denver Art Museum (Ticket Required)

Please come join us in the amazing architectural space of the Hamilton Building of the Denver Art Museum, for the PVSC-40 Conference Dinner! A gourmet reception-style dinner will be catered by world-renowned celebrated chef / restaurateur Kevin Taylor. Galleries will be open for your viewing of the exceptionally creative art collections at the Denver Art Museum, including works by Pablo Picasso, Marcel Duchamp, Henri Matisse, Georgia O'Keeffe, Robert Motherwell, Camille Pissarro, Claude Monet, and many others. All will take place in the space dreamed up by architect Daniel Libeskind. This evening of socializing, music, art, and great food in a unique setting is one that will be remembered for a long time. Don't miss it! The PVSC-40 Conference Dinner is expected to sell out. Please ensure your spot by registering early, and including the Dinner with your registration.

SATURDAY, JUNE 14TH

PVSC HIKE
7:30 AM (Hyatt Lobby)

The more difficult hike will be Mt. Quandary the 13 tallest peak in Colorado at 14,265 ft. (4348 m) is 6.75 miles long with an elevation gain of 3450 ft. The trial is as easy as it gets for mountains over 14,000 ft. and is very popular. At 14,265 feet, Quandary Peak is the highest mountain in the Ten mile Range, its massive bulk and sweeping east ridge rising above the range like a huge behemoth from the deep. Breaking through tree line, a sharp, long neighboring ridge follows you as you head west. The summit pitch comes into view fairly soon after you leave the trees, looking like a massive pyramid that is often graced with snow well into the summer.

If interested, please contact keith.emery@nrel.gov

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Photovoltaics International

EXHIBIT DIRECTORY

Abet Technologies, Inc - Abet Technologies manufactures as line of steady state solar simulators and complete IV measurement systems with illuminated field sizes from 35 mm diameter to 30 x 30 cm. A wide range of probe stations for different types of cells and contact geometries are also offered.
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www.atonometrics.com
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Bay Area PV Consortium - The Bay Area Photovoltaic Consortium is a unique partnership joining universities, industry, and the US DOE. Created under the PV Manufacturing Initiative, BAPVC finds and funds the best university research to create technologies industry will use. Active participation by industry interacting with leading university teams sparks great innovation.
bapvc.stanford.edu
Booth(s): 127

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www.eko-usa.com/
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Evans Analytical Group - Evans Analytical Group (EAG) is the world's leading provider of analytical services for the photovoltaic industry. We analyze all raw materials and processed materials including: c-Si, &#945 -Si/µc-Si, CdTe, CIGS, CZTS and III-V materials. We can determine dopant concentration, dopant profiles, contaminant presence, crystal structure, layer structure, defect location and type, and more. We also look at finished cells for failure analysis and construction analysis. By choosing EAG you gain access to 30+ analytical techniques and to over 200 scientists and engineers with PV materials experience.
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www.horiba.com/scientific
Booth(s): 320

IEEE Women in Engineering - IEEE Women in Engineering is a vessel to support and inform a global community on the best practices and visions in the marketplace for attracting and retaining women in STEM. IEEE WIE facilitates the global recruitment and retention of women in technical disciplines, and envisions a vibrant community of IEEE women and men collectively using their diverse talents to innovate for the benefit of humanity.
www.ieee.org/women
Booth(s): 123

J.A. Woollam Co. - J.A. Woollam Company offers a wide range of spectroscopic ellipsometers for nondestructive materials characterization, including thin film thickness (single and multilayer), optical constants, composition, growth/etch rates, and more. Instruments available for research and manufacturing metrology covering spectral ranges from vacuum ultra-violet to far infrared. Offering table-top, in-line, and in-situ models.
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Kopel/Kyoshin Electric Co., Ltd. - We are manufacture of PV Cell and Module I-V measurement testing system in Japan. We will release new pulse measurement system for HIT and High Efficiency (Capacitance) PV Cell and Module by KOPEL Method. Also we can provide high quality I-V Tester and Cell Setter.
www.kopel.jp/en/
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MVSystems Inc. - MVSystems, Inc. provides ultra high vacuum multi-chamber PECVD/sputtering systems, arranged in a cluster tool configuration, specifically designed for thin film semiconductor materials and devices. We guarantee the opto electronic properties of thin film semiconductors, dielectrics and electronic device performance for solar cells, thin film transistor and image sensors.
www.mvsystemsinc.com
Booth(s): 305

National Renewable Energy Laboratory (NREL) - NREL's booth has information about the National Center for Photovoltaics (NCPV) and the Energy Systems Integration Facility (ESIF). The NCPV studies all PV technologies, provides performance measurements and reliability testing. The ESIF supports research to overcome challenges related to grid interconnection and integration of renewable energy technologies.
http://www.nrel.gov/about/
Booth(s): 103 / 105 / 202 / 204

NSERC Photovoltaic Innovation Network - The NSERC Photovoltaic Innovation Network is a partnership between NSERC, university professors, and industry partners across Canada, focused on the development of novel, cost-effective photovoltaic technologies. The network aims to provide a networking ground for the photovoltaic community across the nation. Visit our booth to learn more about our research.
www.pvinnovation.ca
Booth(s): 322

OAI - OAI manufactures Class AAA Solar Simulators (52mm-300mm) &amp I-V Testers for C-Si &amp thin film. Also offered are application specific Solar Simulators for DSSC, High Efficiency, Organic, CPV, and Multi-junction Cells. Introducing: The NEW LED Class A+++A+A+ Cell & Panel I-V Testing/Spectral Response System and the EL Imaging Test Systems.
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www.newport.com
Booth(s): 121

Photo Emission Tech., Inc - Manufacturer of Cell Testers & Steady State Solar Simulators Class AAA - Illumination area: 50mm x 50mm to 400mm x 400mm. I-V Measurement Systems - Current Range from 1A to up to 20A, Optional temperature control Spectral Response & QE Systems- EQE/IPCE Optional IQE Flexible configuration Spectro-Radiometers - 300-2,200nm Range
www.photoemission.com
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ProtoFlex Corporation - ProtoFlex designs and builds UHV thin film deposition tools for research laboratories around the world. Our portfolio includes roll to roll web coaters, stand alone PECVD systems, multi-source sputtering systems with a load lock, multi-process multi-chamber cluster tools and inline rapid proto-typing systems.
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PV Measurements - PV Measurements designs and manufactures high-accuracy, precision instrumentation for photovoltaics industry and research. Core competencies include Quantum Efficiency (QE)/ IPCE / Spectral Response and I-V measurements in the lab, on the production line and in the field. Other products include reference cells, and solar simulator spectroradiometers and uniformity mappers.
www.pvmeasurements.com/pvsc
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www.qioptiq.com/
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Semilab - Semilab is a leading metrology provider to the Semiconductor and PV industries, offering a full range of both in-line and off-line mapping tools for Si bricks, wafers, cells and thin film type PV devices. Measurements include lifetime, thickness, resistivity, LBIC, reflectance, ellipsometry, photoluminescence and complete wafer sorting solutions.
www.semilab.hu
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Sinton Instruments - Sinton Instruments provides test and measurement instruments for use in Silicon PV manufacturing and R&D at each stage of the solar cell production process. We provide in-line or off-line QSSPC carrier-lifetime measurement, Suns-Voc, cell & module test equipment for every step from crystallization to module test.
sintoninstruments.com
Booth(s): 313 / 315

Solar Aid - SolarAid are a charity tackling poverty and climate change by building a sustainable market for solar in Africa. Solar lamps provide families with safe, clean, free light improving health, saving money and allowing children to study after dark. Our goal is to eradicate the kerosene lamp from Africa by 2020.
www.solar-aid.org
Booth(s): 323

Solar Energy Research Institute for India and the US - The Indian Institute of Science (Bangalore, India) and the National Renewable Energy Laboratory (Colorado, USA) co-lead the Solar Energy Research Institute for India and the United States (SERIIUS) which contributes to the long-term success of India's Jawaharlal Nehru National Solar Energy Mission and the U.S. Department of Energy's SunShot Initiative.
www.seriius.org
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Tau Science - Tau Science builds unique, world class, process control and device characterization equipment for the PV industry. In addition to custom services and component sales, our signature product lines are: FlashQE, a one second QE measurement PixEL, a highly configurable PL/EL imaging platform and IRIS, an inline/EOL hotspot inspection system. www.tauscience.com
www.tauscience.com
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U.S. Naval Research Laboratory - The Naval Research Laboratory provides primary in-house research for the physical, engineering, space and environmental sciences broadly based applied research and advanced technology development programs in response to identified and anticipated Navy and Marine Corps needs broad multidisciplinary support to the Naval Warfare Centers and space and space systems technology, development, and support.
www.nrl.navy.mil
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U.S. Photovoltaic Manufacturing Consortium - The U.S. Photovoltaic Manufacturing Consortium (PVMC), headquartered in New York State, is an industry-led consortium for cooperative R&D among industry, university, and government partners to accelerate the development, commercialization, manufacturing, field testing and deployment of next-generation solar PV systems.
http://www.uspvmc.org
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IEEE ELECTRON DEVICES SOCIETY

MEMBERSHIP PROMOTIONS FOR 40TH PVSC ATTENDEES

IEEE Members: If you're not currently a member of the Electron Devices Society, don't worry. Your registration fee includes a half-year membership in EDS. Members enjoy free online access to the new IEEE Journal of Photovoltaics!

Non-IEEE Members: Stop by the EDS membership booth in the registration area to learn about special offers to join IEEE and EDS. And, if you are a member of another scientific/technical society, you can receive FREE EDS membership for one-half year by joining IEEE as an Affiliate Member. Enjoy all the benefits of being a part of EDS.

Students: If you registered and paid for the conference at the student, non-member rate, you will receive one half-year of FREE IEEE and EDS.

Learn more! Visit the EDS membership booth located in the PVSC registration area.

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IEEE-PVSC WOMEN IN PHOTOVOLTAICS (WIPV)

Join us in the IEEE-PVSC Women in Photovoltaics (WiPV) Luncheon on Thursday June 12th, from 12:00 pm to 1:30 pm in MR 501.

Invited speaker: Dr. Becca Jones-Albertus.

Dr. Becca Jones-Albertus is the Program Manager for Photovoltaics Research and Development in the U.S. Department of Energy's Solar Energy Technologies Office. Her team manages a multi-year portfolio of nearly $200 million in funding to advance solar cell efficiency and reliability and reduce cost, toward and beyond the goals of the SunShot Initiative.

Dr. Jones-Albertus has over a decade of experience working with solar cell materials and devices, from fundamental research and development to manufacturing. She began her research career looking at the strain response of amorphous silicon solar cells and low pressure deposition of organic solar cells. Her graduate research focused on electrical and optical characterization of group III-nitride alloys for photovoltaic and photoelectrochemical cells, including the discovery of p-type doping in InN. More recently, Dr. Jones-Albertus was the Characterization and Design Manager at Solar Junction, where she led work contributing to the development of the company's breakthrough dilute nitride solar cells, their two-time world record triple junction solar cells and then the successful transfer of that technology to a high volume manufacturing toolset. She has 34 technical publications and three patents.

Dr. Jones-Albertus graduated magna cum laude from Princeton University with a B.S. in electrical engineering, and also holds a M.S. and Ph.D. in materials science and engineering from the University of California, Berkeley.

Dr. Jones-Albertus will share her research and experience in the field of photovoltaics through a 45 minute presentation followed by a Q&A session. The event is open and free of cost to all PVSC attendees. Lunch will be provided.

TUTORIAL PROGRAM

MORNING TUTORIALS (8:30 AM - 12:00 PM)

AM1 - Introduction to Photovoltaics (PV101/201)
(MR 502)

AM2 - Technology Status and Critical Issues for Manufacturing High Volume Thin Film Photovoltaics
(MR 503)

AM3 - High Efficiency Multijunction Cell Technology for Terrestrial Concentrators and Space Photovoltaics
(MR 504)

AM4 - Characterization Part I: Advanced Electrical Characterization Techniques and Analysis
(MR 505)

AM5 - Photovoltaic System Performance Modeling
(MR 506)

AFTERNOON TUTORIALS (1:30 PM - 5:00 PM)

PM1 - Third Generation Photovoltaics: Advanced Concepts to Boost Efficiencies Beyond the Schockley-Queisser Limit
(MR 502)

PM2 - Photovoltaic Module Reliability
(MR 503)

PM3 - Silicon Solar Cell Technology
(MR 504)

PM4 - Characterization Part II: Electro-Optical and Structural Characterization of PV Materials and Devices
(MR 505)

PM5 - Distributed Grid Integration Using Solar PV Systems
(MR 506)

TECHNICAL PROGRAM

PROGRAM CHAIR GREETING

On behalf of the Technical Program Committee, I am happy and honored to welcome you to the 40th IEEE Photovoltaic Specialists Conference to experience the latest achievements in photovoltaics research, development, and applications. At the PVSC-40 you will find many topics which connect to the full spectrum of PV, ranging from material science to building integrated PV and from device performance to education and workforce development. As such I am hopeful that the PVSC-40 will offer a great platform to everyone involved in the exciting and still growing field of PV - a platform that enables you to connect with your colleagues, share information, learn from each other's results, discuss and take steps towards new future developments.

For the PVSC-40, we have expanded the number of technical areas to twelve. Descriptions of each area are presented to you in this Yellow Book and on the conference website. At the PVSC-40 we will continue to promote the cross-technology area focused on Reliability of PV, successfully introduced in 2013 and led by Dr. Sarah Kurtz of NREL. Moreover, we introduce another new interdisciplinary technical area 'PV Deployment' which is chaired by Dr. Martha Symko-Davies of NREL. This novel area will focus on technical, economic, and political challenges associated with high penetration of PV systems in electricity grids and in our society. Adding to this, a new area has been developed in the field of PV Modules and Manufacturing, which is led by Dr. Pierre Verlinden of Trina Solar in China. This area will pay attention to innovations in manufacturing. Finally we would like to point your attention to the renewed area on organic photovoltaics chaired by Moritz Riede of the University of Oxford. This area has gone through a complete transformation, drawing together expertise from chemistry, materials, physics and engineering to better match with ongoing exciting developments in this interdisciplinary field of organic PV.

Moreover we strengthened the Technical Program by early involvement and announcement of more than 40 Featured Speakers and by introducing 13 joint sessions between various Areas. This year the PVSC-40 received a record number of more than 1100 abstracts which lead to a Technical Program of more than 360 Oral presentations, and more than 670 Poster presentations. Besides publications of papers in the Conference Proceedings, we are continuing the very popular option of offering authors who have submitted particularly high quality PVSC review abstracts to submit their research results as a manuscript to IEEE Journal of Photovoltaics (J-PV). This path allowed 155 authors to enjoy both the PVSC conference experience as well as receiving a peer review citation from a highly regarded journal.

On behalf of the Technical Program Committee I wish you a great PVSC-40!

Angèle Reinders
PVSC-40 Technical Program Chair

AREA 1 OVERVIEW

FUNDAMENTALS AND NEW CONCEPTS FOR FUTURE TECHNOLOGIES

Chair: Jessica Adams, MicroLink Devices, USA

Co-Chair(s): Nicholas Ekins-Daukes, Imperial College London, UK
Peichen Yu, National Chiao Tung University, Taiwan
Stephen Bremner, University of New South Wales, Australia

Area 1 Description
Paradigm shifts in solar cell technology are invariably preceded by breakthroughs arising from basic scientific research. In recent years, there have been a number of exciting results in the fundamental arena, including the demonstration of two-photon absorption processes in nanostructured solar cell devices, and sophisticated optical management designs resulting in world record single-junction and dual-junction cell efficiencies.

Area 1 comprises fundamental research and novel device concepts that will provide a platform for the development of future photovoltaic technologies describing research in basic physical, chemical and optical phenomena, in addition to studies of new materials and innovative device designs. Subjects of particular interest include, but are not limited to, nanostructures, hybrid organic-inorganic devices, advanced optical management approaches, new materials and synthesis processes, and unconventional conversion mechanisms.

Sub-Area Chairs
Seth Hubbard (Rochester Institute of Technology, USA) Christopher Bailey (US Naval Research Laboratory, USA), Daniel Farrell, (University of Tokyo, Japan), Annick Anctil (Clemson University, USA), Jonathan Grandidier (Jet Propulsion Laboratory, USA), Bryce Richards, (Karlsruhe Institute of Technology, UK), Mariana Bertoni (Arizona State University, USA)

AREA 2 OVERVIEW

CHALCOGENIDE THIN FILM SOLAR CELLS

Chair: Susanne Siebentritt, University of Luxembourg, Luxembourg

Co-Chairs:
Tim Gessert, NREL, USA
Takeaki Sakurai, University of Tsukuba, Japan

Area 2 Description
Area 2 of the 40th IEEE PVSC continues a long tradition of meetings that focus on the science and technology of thin film solar cells based on chalcogenide materials. We present contributions discussing solar cells based on Cu(InGa)Se2, Cu2ZnSn(Se)4, CdTe, and related materials. These materials include the highest efficiency thin film solar cells, reaching the same efficiencies on a lab scale as multicrystalline Si, as well as being flexible. The aim of Area 2 is to provide a platform for presenting recent and on-going research leading to improved understanding of materials and devices, exploring new directions for more efficient production, and narrowing the gap between cell and module efficiencies. The topics range from novel insights into the basic material science, study of device properties and new device structures, and discussion of the progress in deposition methods and growth control.

Sub-Area Chairs
Charlotte Platzer-Björkman (U Uppsala, Sweden), Shogo Ishizuka (AIST, Japan), Bill Shafarman (U Delaware, USA), Thomas Unold (Helmholtz Zentrum Berlin, Germany), Takashi Minemoto (Ritsumeikan U, Japan), Yanfa Yan (U Toledo, US), Marcus Bär (HZB, Germany), Negar Naghavi (IRDEP, France), Norio Terada (Kagoshima U, Japan), Pawel Zabierowski (Warsaw University of Technology, Poland), Akira Yamada (Tokyo Tech, Japan), Roland Scheer (U Halle, Germany), Volker Probst (Bosch, Germany), Takayuki Negami (Panasonic, Japan), Markus Gloeckler (First Solar, US)

AREA 3 OVERVIEW

III-V SOLAR CELLS AND CONCENTRATOR PHOTOVOLTAICS

Area Chair: Frank Dimroth, Fraunhofer ISE, Germany

Co-Chairs:
Myles Steiner, NREL, USA
Kensuke Nishioka, University of Miyazaki, Japan

Area 3 Description
Area 3 covers the science and engineering of III-V single- and multijunction solar cells with all aspects from theoretical modeling to growth related issues, material characterization, photon management, device processing and solar cell reliability. New technologies for advanced III-V multijunction solar cell architectures are presented in this area, since materials science is the basis for continuous improvements in the understanding and further development of III-V solar cell structures. III-V multijunction solar cells are the basis for the growing terrestrial market of high-concentration photovoltaics and concentrator silicon solar cells are the basis for systems in the low and medium concentration range. Area 3 covers all aspects of concentrator photovoltaics (CPV) system development including primary and secondary optics, solar cell receivers, module components, trackers, modules and CPV power plants. Reliability is an important aspect for this growing industry as well as market development, financing, power prediction, industry standards, balance of systems (BOS) and installation-related issues. In the field of low and medium concentration, high efficiency silicon solar cells offer interesting applications.

Sub-Area Chairs
Marc Stan (Emcore Photovoltaics, USA), Scott Burroughs (Semprius, USA), Daniel Biro (Fraunhofer ISE, Germany)

AREA 4 OVERVIEW

CRYSTALLINE SILICON PHOTOVOLTAICS

Chair: Stefan Glunz, Fraunhofer ISE, Germany

Co-Chairs:
Ron Sinton, Sinton Instruments, USA
Mariana Bertoni, ASU, USA
Donghwan Kim, Korea University, Korea

Area 4 Description
Crystalline silicon photovoltaics is the dominant solar cell technology, with a market share of around 85% in 2012. Silicon is non-toxic and abundantly available in the earth's crust; silicon PV modules have proven their long-term stability over decades in the field. The price reduction of silicon modules in the last 30 years can be described very well by a learning factor of 20%. Due to strong competition, this price decline was even stronger in the last years, resulting in module prices well below $1/W. This is an excellent situation for customers and PV installers, but rather challenging for producers of silicon solar cells and modules. Thus, cost reduction is still a major task. The cost distribution of a crystalline silicon PV module is clearly dominated by material costs, especially by the cost of the silicon wafer. Therefore, besides improved production technologies, the efficiency of the cells and modules is the main leverage to bring down the cost even more, especially when considering the full levelized cost of PV electricity. Area 4 of the 40th IEEE PVSC presents contributions reporting on all aspects of crystalline silicon technology, encompassing the whole value chain, as well as fundamental and scientific aspects.

S**ub-Area Chairs**
Daniel Macdonald (ANU, Australia), Pierre-Jean Ribeyron (CEA-INES, France), Bram Hoex (SERIS, Singapore), Giso Hahn (Uni Konstanz, Germany), Paul Basore (USA)

AREA 5 OVERVIEW

THIN FILM SILICON BASED PV TECHNOLOGIES

Chair: Franz-Josef Haug, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland

Co- Chair(s):
Ivan Gordon, IMEC, Belgium
Hitoshi Sai, AIST, Japan

Area 5 Description
Thin film silicon covers a class of materials that ranges from amorphous silicon and its group-IV alloys, over nano- and microcrystalline silicon, silicon-oxides and -carbides, to thin films of crystalline silicon. Research and development in this active area addresses fundamental concepts of material quality, recent insight into light induced degradation, and passivation of internal interfaces and heterojunctions. This area will also be a forum to discuss innovative cell architectures with multiple junctions and the application of mature concepts in large area industrial production.

Sub-Area Chairs
Hitoshi Sai (AIST, Japan), Nikolas Podraza (University of Toledo, USA), Ivan Gordon (IMEC, Belgium), Sergey Varlamov (UNSW Sydney, Australia), Matthias Meier (Jülich Research Centre, Germany), Franz-Josef Haug (EPFL, Switzerland), Bernd Stannowski (Helmholtz Zentrum Berlin, Germany), Baojie Yan (formerly UniSolar, USA)

AREA 6 OVERVIEW

ORGANIC PHOTOVOLTAICS

Chair: Moritz Riede, University of Oxford, United Kingdom

Co-Chairs:
Eszter Voroshazi, imec, Belgium
Dana Olson, NREL, CO, USA
Liaison Co-Chair:
Yang Yang, UCLA, CA, USA

Area 6 Description
This focus area covers the latest scientific and technical progress for a broad range of solar cells that fall in the category Organic Photovoltaics (OPV). OPV has continued to show tremendous progress in the past years. Solar cell efficiencies have rocketed to well above 10% and operating lifetimes have reached more than 10 years. Based on abundant materials and scalable coating technologies, OPV shows potential for low-cost, lightweight, and flexible solar power generation. Based on these prospects, many companies around the world are putting considerable efforts towards commercializing OPV. Organic photovoltaics – a prime example of interdisciplinary research drawing together expertise from chemistry, materials, physics, and engineering – will soon have to prove its viability in the market.

Despite this remarkable progress, much of the underlying physical processes and their limitations have yet to be better understood. Similarly, scale-up in manufacturing volume has proven challenging for fast progress towards commercialization. The goal of this focus area is to address these issues, ranging from fundamental science to technological advances.

Sub-Area Chairs
Hugo Bronstein (UCL, London, United Kingdom), Eric Hoke (Stanford University, USA), Sumit Chaudhary (Iowa State University, IA, USA), Wolfgang Tress (University of Linköping, Sweden), Suren Gevorgyan (DTU, Denmark), Jan Gilot (TNO, Netherlands)

AREA 7 OVERVIEW

SPACE TECHNOLOGIES

Chair: Mitsuru Imaizumi, JAXA, Japan

Co-Chairs:
Michael Piszczor, NASA, USA
Stephen Taylor, ESA, EU

Area 7 Description
Area 7 seeks all papers that deal with any subjects and issues related to space photovoltaics, including all subjects from fundamental studies to flight performance. Almost of all spacecraft are powered by PV generators, and thus advances in space PV technologies contribute significantly to improvement of spacecraft performance. Space engineering including PV is one of the most important key technologies which contribute to national security. On the other hand, the size of space industry is not sufficient to stand and maintain activities in a country or an area. Therefore, we should compete and collaborate at the same time in this particular area. Area 7 of this conference will offer such opportunity for the competition and also collaboration, owing to your contributions!

Sub-Area Chairs
Tatsuya Takamoto (SHARP, Japan), Claus Zimmermann (Astrium, Germany), Scott Messenger (Naval Research Lab., USA)

AREA 8 OVERVIEW

CHARACTERIZATION METHODS

Chair: Keith Emery, National Renewable Energy Lab, USA

Co-Chairs:
Wilhelm Warta, Fraunhofer ISE, Germany
Jim Sites, Colorado State University, USA
Dean Levi, NREL, USA
Mowafak Al-Jassim, NREL, USA

Area 8 Description
It is impossible to understand innovation in science without considering the support from measurements and characterization. Measurements are needed at all different levels of R&D and production – from investigating the operating principles of solar cells to developing standards for the performance of installed photovoltaic (PV) systems. The relationship between structure, physical properties, and the resulting PV performance is a challenge in materials science and engineering. Reliable and precise determination of the efficiency and thus power of solar cells and PV modules is crucial for the successful widespread deployment of PV and an ongoing challenge for flat-plate and concentrating PV technologies. Area 8 present the latest full range of scientific and technological challenges in the field of characterization of photovoltaics.

Sub-Area Chairs
Muhammad Huda (University of Texas, USA), Fude Liu (The University of Hong, Kong), Harvey Guthrey (NREL, USA), Steve Johnston (NREL, USA), Guy Feuillet (CEA, France), William Zaaiman (EU Joint Research Center, Italy)

AREA 9 OVERVIEW

PV MODULES AND MANUFACTURING

Chair: Pierre Verlinden, Trina Solar, China

Co-Chair:
Joshua Stein, Sandia National Laboratories, USA

Area 9 Description
Advances in PV module engineering and manufacturing have been remarkable and their impact in lowering levelized cost of energy (LCOE) is significant. The world requires safer PV modules with more embedded services, including safety switch disconnect, ground-fault protection, monitoring services, maximum power point (MPP) trackers, power optimizers or micro-inverters. New materials for PV modules are introduced on a regular basis and require new testing methods for characterization. New assembly technologies are proposed. PV module modeling is getting more sophisticated including mechanical, thermal and electrical models, sometimes combined. Customers require better energy prediction and energy rating of the modules. Papers that describe advancement in PV module design, technology and modeling to improve cost, safety, energy performance, monitoring, are sought in this Area. This Area also presents papers related to improvements in manufacturing along the entire production chain of PV, from raw material to modules, including automation, inline monitoring, statistical process control, manufacturing plant design, cost models and cost prediction.

Sub-Area Chairs
Annelene Dethlefsen (Schmid, Germany), Chris Deline (NREL, USA), Scott Norquist (3M, USA), Cliff Hansen (Sandia, USA), YingBin Zhang (Trina Solar, China)

AREA 10 OVERVIEW

PV SYSTEMS AND APPLICATIONS

Chair: Greg Ball, DNV GL, USA

Co-Chair:
Klaus Kiefer, Fraunhofer Institute, Germany

Area 10 Description
Terrestrial PV systems of all sizes are a growing part of the mainstream energy economy and yet some of the most important innovations are just beginning to emerge in response to rapid changes in demand for performance, capability and safety. Meanwhile, with lowered PV module costs attention is shifted towards squeezing savings from optimized designs, balance of system components, and more efficient installation and maintenance methods. Our focus is on the various aspects of PV system installations, from performance predictions to long term maintenance, power plants to remote off-grid supplies, DC module optimizers to multi-MW inverters, and ramping signal controls to enhanced fire protection. Area 10 covers resource and performance assessment, system design and implementation, component technologies, and off-grid and advanced applications. We are particularly interested in advancements and innovation driven by utility requirements, developer demand, and changes to codes and standards requiring more sophisticated fire and safety protection.

Sub-Area Chairs
Lauren Ngan (First Solar, USA) Rhonda Bailey (Radian Generation, USA), Mark Albers (SunPower Corporation, USA), Nicolas Bogdanski (TUV Rhineland, Germany), John Berdner (Enphase, USA), Ward Bower (Retired, Sandia National Labs, USA), Michael Schenck, (Ipsum Power, USA), Alexander Schies (Fraunhofer ISE, Germany)

AREA 11 OVERVIEW

PV DEPLOYMENT

Chair: Martha Symko-Davies National Renewable Energy Laboratory, USA

Co-Chairs:
Michael Coddington, National Renewable Energy Laboratory, USA Sarah Truitt, National Renewable Energy Laboratory, USA Elaine Ulrich, U.S. Department of Energy (DOE), USA

Area 11 Description
The power and energy environment is undergoing a radical change as the U.S. moves from traditional primary energy sources connected to an aging grid to a modernized grid that incorporates new technologies such as variable renewable energy sources. Utilities have a growing number of challenges associated with the various issues that arise under high penetration of solar systems. As the transformation to a modernized electric power system unfolds, utilities and the institutions that support the workforce pipeline to the power and energy sectors must evolve. Great emphasis is placed on finding ways to effectively increase the breadth of expertise engaged in PV deployment and technology support. Additionally, strategies to sustain or accelerate high growth rates and rapid cost reductions through government policy and economics are critical to the success of PV deployment. Area 11 presents papers about technical advances in PV Deployment with a focus on Interconnections, Workforce Development and Education, and Government Policy and Financing.

Sub-Area Chairs
Michael Coddington (National Renewable Energy Laboratory, USA), Sarah Truitt (National Renewable Energy Laboratory, USA), Elaine Ulrich (U.S. Department of Energy (DOE, USA)

AREA 12 OVERVIEW

RELIABILITY OF PV

Chair: Sarah Kurtz, National Renewable Energy Laboratory, USA

Co-Chairs:
Wei Zhou, Trina Solar, China
Ralph Gottschalg, Centre for Renewable Energy Systems Technology (CREST), Loughborough University, United Kingdom

Area 12 Description
As the PV industry has grown, it has become increasingly critical to have confidence in the long-term reliability and performance of the GWs of PV, representing billions of dollars or euros investment. This topic cuts across all technologies and throughout the supply chain. Topics especially critical to the success of the PV industry include: an up-to-date understanding of what is being observed for deployed products, the physics behind observed degradation/failure modes, and the quantitative correlation between accelerated test results and outcomes seen in the field as a function of site climate and installation method in order to move toward statistical service life predictions.

Area 12 presents papers on detailed scientific research studies and visionary papers addressing a full range of topics including: Field Experiences, Correlation of Accelerated Testing and Field Performance, Manufacturing Quality Assurance, PV Safety Issues, Cell Level Reliability Issues and Reliability Techniques for Application to PV.

Sub-Area Chairs
Charlie Hasselbrink (SunPower, USA), Michael Kempe (National Renewable Energy Laboratory, USA), Bengt Jaeckel (Underwriters Laboratories, USA), Masaaki Yamamichi (AIST, Japan), Jürgen Arp (Abastrial, Germany), Kent Whitfield (MEMC, USA), Chris Flueckiger (UL, USA), Allan Ward (First Solar, USA), Vivek Gade (Jabil, USA), Carole Graas (Colorado School of Mines, USA), Glenn Alers, (University of California, Santa Cruz, USA)

AREA 1 PROGRAM SUMMARY

MONDAY, JUNE 9
Plenary: Fundamentals and New Concepts for Future Technologies
8:30 - 9:00 AM (Ballroom 3-4)

Orals: Light Management 1: Spectral Shaping
2:00 - 3:30 PM (Ballroom 1AB)

Orals: Quantum Well and Superlattice Solar Cells
4:00 - 5:30 PM (Ballroom 1AB)

TUESDAY, JUNE 10
Posters: Pioneering Concepts and Materials
10:30 - 12:00 PM (Exhibit Hall D)

Orals: III-V on Silicon Materials
1:30 - 3:00 PM (MR 505-507)

Orals: Hybrid Organic / Inorganic and Perovskite Solar Cells
3:30 - 5:00 PM (MR 505-507)

Posters: Low-Dimensional Structures for Solar Cell Enhancement
7:00 - 8:15 PM (Exhibit Hall D)

Posters: Hybrid Organic / Inorganic and Perovskites
8:15 - 9:30 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Posters: Light Management for Enhanced Solar Cell Performance
1:30 - 3:00 PM (Exhibit Hall D)

Orals: Light Management 2: Light Trapping and Advanced ARCs
3:30 - 5:00 PM (Ballroom 1AB)

Orals: III-V on Silicon Solar Cells
3:30 - 5:00 PM (MR 505-507)

THURSDAY, JUNE 12
Posters: Quantum Confinement for Space and Multijunction Solar Cell Applications
10:30 - 12:00 PM (Exhibit Hall D)

Orals: Two-step Photon Absorption Concepts and Implementation
1:30 - 3:00 PM (Ballroom 1AB)

Orals: Advances in Hot Carrier Solar Cells
3:30 - 5:00 PM (Ballroom 1AB)

Orals: Novel Materials and Concepts
3:30 - 5:00 PM (Ballroom 1CD)

FRIDAY, JUNE 13
Orals: Quantum-Confined Structures
8:30 - 10:00 AM (Ballroom 1AB)

Orals: Advances in Intermediate Band Solar Cells
10:30 - 12:00 PM (Ballroom 1AB)

AREA 2 PROGRAM SUMMARY

MONDAY, JUNE 9
Orals: Kesterite 1
2:00 - 3:30 PM (MR 502-504)

Orals: CIGS 1
4:00 - 5:30 PM (MR 502-504)

Orals: Characterization Methods for CdTe and CZTS
4:00 - 5:30 PM (MR 505-507)

TUESDAY, JUNE 10
Posters: CIGS and CZTS
10:30 - 12:00 PM (Exhibit Hall D)

Orals: Kesterite 2
1:30 - 3:00 PM (MR 502-504)

Orals: Buffers and New Materials
3:30 - 5:00 PM (MR 502-504)

Posters: CIGS and CdTe
8:15 - 9:30 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Plenary: Chalcogenide Thin Film Solar Cells
9:30 - 10:00 AM (Ballroom 3-4)

Orals: Characterisation Methods for CIGS solar cells
10:30 - 12:00 PM (MR 502-504)

Posters: CdTe and CZTS
1:30 - 3:00 PM (Exhibit Hall D)

Orals: Manufacturing of Thin Film Chalcogenide Modules
3:30 - 5:00 PM (MR 502-504)

THURSDAY, JUNE 12
Orals: CdTe 1
1:30 - 3:00 PM (MR 502-504)

Orals: Novel Preparation Methods
3:30 - 4:30 PM (MR 502-504)

FRIDAY, JUNE 13
Orals: CdTe 2
8:30 - 10:00 AM (MR 502-504)

Orals: CIGS 2
10:30 - 11:45 AM (MR 502-504)

AREA 3 PROGRAM SUMMARY

MONDAY, JUNE 9
Orals: Highest Efficiency Space and CPV Solar Cells
2:00 - 3:30 PM (MR 505-507)

TUESDAY, JUNE 10
Plenary: III-V and Concentrator Technologies
9:00 - 9:30 AM (Ballroom 3-4)

Posters: III-V Epitaxy and Solar Cells
10:30 - 12:00 PM (Exhibit Hall D)

Orals: III-V on Silicon Materials
1:30 - 3:00 PM (MR 505-507)

Posters: III-V on Silicon and III-V Materials for Solar Cells
7:00 - 8:15 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Orals: Low Concentration Solar Cells and Receivers
10:30 - 12:00 PM (Ballroom 1CD)

Orals: III-V on Silicon Solar Cells
3:30 - 5:00 PM (MR 505-507)

THURSDAY, JUNE 12
Posters: Low and High Concentration CPV
10:30 - 12:00 PM (Exhibit Hall D)

Posters: Quantum Confinement for Space and Multijunction Solar Cell Applications
10:30 - 12:00 PM (Exhibit Hall D)

Orals: CPV Modules and Systems
1:30 - 3:00 PM (Ballroom 2B)

Orals: Material Aspects and Design of III-V Solar Cells
3:30 - 5:00 PM (Ballroom 2B)

FRIDAY, JUNE 13
Orals: III-V Solar Cells for Space and CPV
10:30 - 12:00 PM (MR 505-507)

AREA 4 PROGRAM SUMMARY

MONDAY, JUNE 9
Orals: Material Characterization
2:00 - 3:30 PM (Ballroom 1EF)

Orals: Analysis
4:00 - 5:30 PM (Ballroom 1EF)

TUESDAY, JUNE 10
Plenary: Crystalline Silicon Photovoltaics
8:30 - 9:00 AM (Ballroom 3-4)

Posters: Surface Passivation I
10:30 - 12:00 PM (Exhibit Hall D)

Orals: n-Type Cells and Young Professional Award
1:30 - 3:00 PM (Ballroom 1EF)

Orals: III-V on Silicon Materials
1:30 - 3:00 PM (MR 505-507)

Orals: Heterojunctions
3:30 - 5:15 PM (Ballroom 1EF)

Posters: Surface Passivation II
7:00 - 8:15 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Orals: Advanced Cell Structures
10:30 - 12:00 PM (Ballroom 1EF)

Posters: Contacts and Analysis
1:30 - 3:00 PM (Exhibit Hall D)

Orals: Contacts
3:30 - 5:00 PM (Ballroom 1EF)

Orals: III-V on Silicon Solar Cells
3:30 - 5:00 PM (MR 505-507)

THURSDAY, JUNE 12
Posters: Materials and Junction Formation
10:30 - 12:00 PM (Exhibit Hall D)

Orals: Surface Passivation
1:30 - 3:00 PM (Ballroom 1EF)

Orals: Passivated Contacts
3:30 - 5:00 PM (Ballroom 1EF)

FRIDAY, JUNE 13
Orals: Material Technology
8:30 - 10:00 AM (Ballroom 1EF)

Orals: Junction Technology and Gettering
10:30 - 12:00 PM (Ballroom 1EF)

AREA 5 PROGRAM SUMMARY

MONDAY, JUNE 9
Orals: Light Management
2:00 - 3:30 PM (Ballroom 2B)

TUESDAY, JUNE 10
Orals: Thin Crystalline Silicon Films
3:30 - 5:00 PM (Ballroom 1CD)

Posters: Crystalline Si-Films and Novel Concepts
7:00 - 8:15 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Plenary: Thin Film Silicon Based PV technologies
8:30 - 9:00 AM (Ballroom 3-4)

Orals: Amorphous, Nano- and Micro-Crystalline Silicon
3:30 - 5:00 PM (Ballroom 1CD)

THURSDAY, JUNE 12
Posters: Thin Film Si: Processing and Light Management
10:30 - 12:00 PM (Exhibit Hall D)

FRIDAY, JUNE 13
Orals: Manufacturing and Process Control
8:30 - 10:00 AM (Ballroom 2A)

AREA 6 PROGRAM SUMMARY

MONDAY, JUNE 9
Plenary: Organic Photovoltaics
9:00 - 9:30 AM (Ballroom 3-4)

Orals: Organic Semiconductor Based PV
2:00 - 3:30 PM (Ballroom 2A)

Orals: Novel OPV Concepts and Perovskite Solar Cells
4:00 - 5:30 PM (Ballroom 2A)

TUESDAY, JUNE 10
Orals: Hybrid Organic / Inorganic and Perovskite Solar Cells
3:30 - 5:00 PM (MR 505-507)

Posters: Organic PV Posters I: Organic Semiconductors
8:15 - 9:30 PM (Exhibit Hall D)

Posters: Hybrid Organic / Inorganic and Perovskites
8:15 - 9:30 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Orals: OPV Stability
10:30 - 12:00 PM (Ballroom 2A)

Posters: Organic PV Posters II: Interfaces, Stability and Fabrication
1:30 - 3:00 PM (Exhibit Hall D)

Orals: OPV Fabrication and Reliability
3:30 - 5:00 PM (Ballroom 2A)

AREA 7 PROGRAM SUMMARY

MONDAY, JUNE 9
Orals: Highest Efficiency Space and CPV Solar Cells
2:00 - 3:30 PM (MR 505-507)

TUESDAY, JUNE 10
Orals: III-V on Silicon Materials
1:30 - 3:00 PM (MR 505-507)

Posters: Space PV Cells and Systems
8:15 - 9:30 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Orals: Space PV Systems
10:30 - 12:00 PM (Ballroom 1AB)

Orals: III-V on Silicon Solar Cells
3:30 - 5:00 PM (MR 505-507)

THURSDAY, JUNE 12
Plenary: Space PV Devices and Systems
8:30 - 9:00 AM (Ballroom 3-4)

Posters: Quantum Confinement for Space and Multijunction Solar Cell Applications
10:30 - 12:00 PM (Exhibit Hall D)

Orals: Material Aspects and Design of III-V Solar Cells
3:30 - 5:00 PM (Ballroom 2B)

FRIDAY, JUNE 13
Orals: III-V Solar Cells for Space and CPV
10:30 - 12:00 PM (MR 505-507)

AREA 8 PROGRAM SUMMARY

MONDAY, JUNE 9
Orals: Characterization Methods for CdTe and CZTS
4:00 - 5:30 PM (MR 505-507)

TUESDAY, JUNE 10
Posters: Characterization I
10:30 - 12:00 PM (Exhibit Hall D)

Orals: Luminescence Characterization Methods
1:30 - 3:00 PM (Ballroom 2A)

Orals: Optical Characterization
3:30 - 5:00 PM (Ballroom 2A)

Posters: Characterization II
8:15 - 9:30 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Orals: Characterisation Methods for CIGS solar cells
10:30 - 12:00 PM (MR 502-504)

Posters: Characterization III
1:30 - 3:00 PM (Exhibit Hall D)

THURSDAY, JUNE 12
Plenary: Characterization Methods
9:00 - 9:30 AM (Ballroom 3-4)

Orals: Thin Film Characterization
1:30 - 3:00 PM (Ballroom 2A)

Orals: Silicon Characterization
3:30 - 5:00 PM (Ballroom 2A)

FRIDAY, JUNE 13
Orals: Cell & Module Characterization
10:30 - 12:00 PM (Ballroom 2A)

AREA 9 PROGRAM SUMMARY

MONDAY, JUNE 9
Orals: Manufacturing and Module Technology
4:00 - 5:30 PM (Ballroom 2B)

TUESDAY, JUNE 10
Orals: Module Power Electronics. Special Chinese Session: Module Materials
3:30 - 5:00 PM (Ballroom 2B)

Posters: Module Modeling & Integrated Electronics
7:00 - 8:15 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Plenary: PV Modules and Manufacturing
9:00 - 9:30 AM (Ballroom 3-4)

Posters: Module Technology and Manufacturing
1:30 - 3:00 PM (Exhibit Hall D)

Orals: Predicting Module Performance
3:30 - 5:00 PM (Ballroom 2B)

Orals: Manufacturing of Thin Film Chalcogenide Modules
3:30 - 5:00 PM (MR 502-504)

AREA 10 PROGRAM SUMMARY

MONDAY, JUNE 9
Orals: Solar Resource Assessment and Forecasting
2:00 - 3:30 PM (Ballroom 1CD)

Orals: System Modeling and Energy Predictions
4:00 - 5:30 PM (Ballroom 1CD)

TUESDAY, JUNE 10
Posters: Performance Modeling and Validation Session 1
10:30 - 12:00 PM (Exhibit Hall D)

Orals: System Performance Measurements and Validation
1:30 - 3:00 PM (Ballroom 1CD)

Posters: Performance Modeling and Validation Session 2
8:15 - 9:30 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Orals: System Grid Integration
10:30 - 12:00 PM (MR 505-507)

Posters: PV System Design and Protection
1:30 - 3:00 PM (Exhibit Hall D)

THURSDAY, JUNE 12
Plenary: PV Systems and Applications
9:30 - 10:00 AM (Ballroom 3-4)

Posters: Power Conversion
10:30 - 12:00 PM (Exhibit Hall D)

Orals: System Design
1:30 - 3:00 PM (Ballroom 1CD)

Orals: PV System Safety
3:30 - 5:00 PM (MR 505-507)

FRIDAY, JUNE 13
Orals: BOS and Off-Grid Advances
8:30 - 10:00 AM (Ballroom 1CD)

Orals: Inverter Innovations
10:30 - 12:00 PM (Ballroom 1CD)

AREA 11 PROGRAM SUMMARY

TUESDAY, JUNE 10
Plenary: PV Deployment
9:30 - 10:00 AM (Ballroom 3-4)

Orals: Government policy education and standards
1:30 - 3:00 PM (Ballroom 1AB)

Orals: Interconnection and High PV Penetration
3:30 - 5:30 PM (Ballroom 1AB)

Posters: Interconnections
7:00 - 8:15 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Orals: System Grid Integration
10:30 - 12:00 PM (MR 505-507)

FRIDAY, JUNE 13
Orals: Interconnection, Power Electronics & Inverters
10:30 - 12:00 PM (Ballroom 2B)

AREA 12 PROGRAM SUMMARY

MONDAY, JUNE 9
Plenary: Reliability of PV
9:30 - 10:00 AM (Ballroom 3-4)

TUESDAY, JUNE 10
Orals: PID
1:30 - 3:00 PM (Ballroom 2B)

Posters: Reliability 1
8:15 - 9:30 PM (Exhibit Hall D)

WEDNESDAY, JUNE 11
Orals: Correlation of Accelerated Testing with Field Experience
10:30 - 12:00 PM (Ballroom 2B)

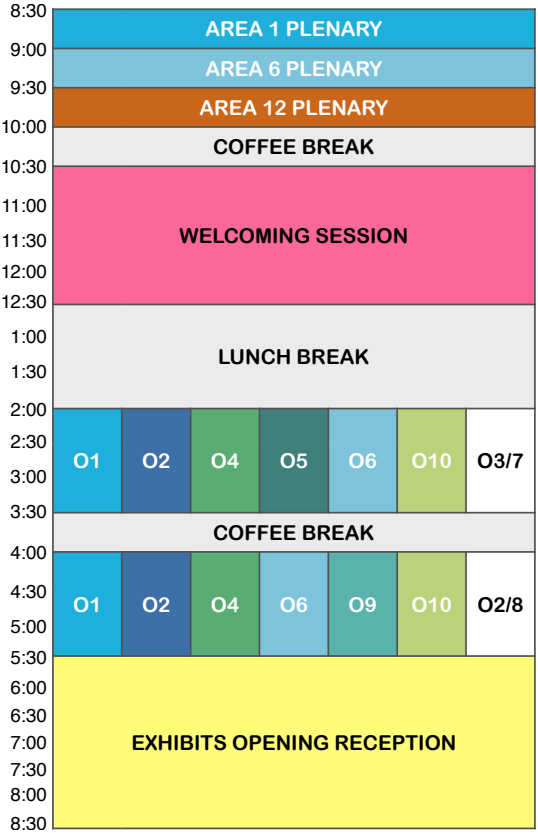
THURSDAY, JUNE 12
Posters: Reliability 2
10:30 - 12:00 PM (Exhibit Hall D)

Orals: Field Reliability Experience
1:30 - 3:00 PM (Ballroom 2C)

Orals: PV System Safety
3:30 - 5:00 PM (MR 505-507)

FRIDAY, JUNE 13
Orals: Design and Manufacturing for Reliability
8:30 - 10:00 AM (Ballroom 2B)

MONDAY PROGRAM SUMMARY



	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 1 - Plenary

8:30 - 9:00 AM **Ballroom 3-4**

Fundamentals and New Concepts for Future Technologies

Chair: Jessica Adams

8:30 **(1) A direct thin-film path towards low-cost large-area III-V photovoltaics**
Ali Javey
UC Berkeley, Berkeley, CA, USA

Area 6 - Plenary

9:00 - 9:30 AM **Ballroom 3-4**

Organic Photovoltaics

Chair: Moritz Riede

9:00 **(2) Tackling the performance limits of organic heterojunction solar cells**
Jenny Nelson
Department of Physics and Centre for Plastic Electronics, Imperial College London, UK

Area 12 - Plenary

9:30 - 10:00 AM **Ballroom 3-4**

Reliability of PV

Chair: Sarah Kurtz, Ralph Gottschalg

9:30 **(3) Quality requirements from a lenders/investors point of view**
Felix Holz
Vice President, Expertenteam Greentech, Deutsche Bank AG

10:00 - 10:30 AM **Ballroom Pre-function**

Coffee Break

Keynote - Plenary	
10:30 - 12:35 PM	**Ballroom 3-4**
Welcoming Session	

Chair: Richard King, Angèle Reinders

10:30 **(4) Opening Remarks**
Richard R. King

10:40 **(5) Keynote Speech - NREL**
Dana Christensen
National Renewable Energy Laboratory

11:00 **(6) Keynote Speech - DOE**
Michael Knotek
Department of Energy

11:20 **(7) Morton Prince Recognition and Introcution**
Larry Kazmerski

11:25 **(8) Morton Prince Recognition Speech**
Morton Prince

11:35 **(9) Conference Plenary - The Case For Design And Discovery Of Functional Materials**
Alex Zunger
University of Colorado

12:00 **(10) PVSC Young Professional Award Presentation**
Kyle Montgomery, Oliver Schultz-Wittmann

12:05 **(11) Cherry Award Introduction**
Jerry Olson

12:10 **(12) Cherry Award Speech**
Ron Sinton
Sinton Instruments

Joint Session: Areas 3,7 - Orals

2:00 - 3:30 PM **MR 505-507**

Highest Efficiency Space and CPV Solar Cells

Chair(s): Myles Steiner, Takeshi Ohshima

2:00 **(13) Application of InGaP/GaAs/InGaAs Triple Junction Solar cells to Space Use and Concentrator Photovoltaic**
Tatsuya Takamoto, Hidetoshi Washio, Hiroyuki Juso
SHARP Corp., Yamatokoriyama, Japan

2:30 **(14) Development of high efficiency wafer bonded 4-junction solar cells for concentrator photovoltaic applications**
Frank Dimroth[1], Thomas N.D. Tibbits[1], Paul Beutel[1], Christian Karcher[1], Eduard Oliva[1], Gerald Siefer[1], Maike Wiesenfarth[1], Rainer Krause[2], Matteo Piccin[2], Nicolas Blanc[2], Charlotte Drazek[2], Eric Guiot[2], Thierry Salvatat[3], Aurélie Tauzin[3], Thomas Signamarcheix[3], Thomas Hannappel[4]
[1]Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany, [2]SOITEC S.A., Bernin, France, [3]CEA-LETI, Grenoble, France, [4]Helmholtz-Zentrum Berlin HZB, Berlin, Germany

2:45 **(15) Continued progress on direct bonded 5J space and terrestrial cells**
Philip T Chiu, Daniel L Law, Robyn L Woo, Scott B Singer, William D Hong, Abdallah Zakaria, Joseph C Boisvert, Shoghig Mesropian, Richard R King, Nasser H Karam
Spectrolab Inc., Sylmar, CA, USA

3:00 **(16) Terrestrial Concentrator Four-junction Inverted Metamorphic Solar Cells With Efficiency > 45%**
Nate Miller, Pravin Patel, Claudia Struempel, Chris Kerestes, Dan Aiken, Paul Sharps
Emcore Photovoltaics, Albuquerque, NM, USA

3:15 **(17) Quadruple Junction Inverted Metamorphic Concentrator Devices**
Ryan M France[1], John F Geisz[1], Myles A Steiner[1], Ivan Garcia[1,2], William E McMahon[1], Daniel J Friedman[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Instituto de Energia Solar, Universidad Politecnica de Madrid, Madrid, Spain

Area 1 - Orals

2:00 - 3:30 PM **Ballroom 1AB**

Light Management 1: Spectral Shaping

Chair(s): Jeremy Munday, Louise Hirst

2:00 **(18) Enhancing Light Capture By Silicon - With The Help Of Molecules**
Tom Markvart[1], Nick Alderman[1,2], Lefteris Danos[3], Liping Fang[1], Thomas Parel[1]
[1]Solar Energy Laboratory, University of Southampton, Southampton, UK, [2]Department of Chemistry, University of Ottawa, Otawa, ON, Canada, [3]Department of Chemistry, University of Lancaster, Lancaster, UK

2:30 **(19) Can a hot-carrier solar cell also be an efficient up-converter?**
Daniel J Farrell, Hassanet Sodabanlu, Yunpeng Wang, Masakazu Sugiyama, Yoshitaka Okada
Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8504, Japan, Tokyo, Japan

2:45 **(20) Increasing Efficiency of Dual Junction Solar Cells by Intermediate Mirror Optimization**
Vidya Ganapati, Chi-Sing Ho, Eli Yablonovitch
University of California, Berkeley, Berkeley, CA, USA

3:00 **(21) Enhance Current Density and Power Conversion Efficiency in Solar Cells by Using luminescent downshifting phosphor**
Hau-Vei Han[1], Chien-Chung Lin[2], Wein-Yi Lin[1], Yu-Lin Tsai[1], Tien-Lin Shen[1], Hao-Chung Kuo[1], Peichen Yu[1]
[1]National Chiao Tung University, Hsinchu, Taiwan, [2]National Chiao Tung University, Tainan, Taiwan

3:15 **(22) Color, Graphic Design and High Efficiency for Photovoltaic Modules**
Efthymios Klampaftis[1], David Ross[1], Bryce S. Richards[1,2]
[1]Heriot-Watt University, Edinburgh, UK, [2]Nelson Mandela African Institute of Science and Technology, Tengeru, Tanzania

Area 2 - Orals

2:00 - 3:30 PM **MR 502-504**

Kesterite 1

Chair(s): Rakesh Agrawal, Guy Brammertz

2:00 **(23) Current Status and Future Prospects of Earth Abundant Kesterite Photovoltaics**
David B. Mitzi[1], Teodor Todorov[1], Oki Gunawan[1], Tayfun Gokmen[1], Wei Wang[1], Mark T. Winkler[1], Richard Haight[1], Sean Seefeld[1], Liang-Yi Chang[1], Byungha Shin[1], Talia Gershon[1], Supratik Guha[1], Masaru Kuwahara[2], Akimasa Nakamura[2], Homare Hiroi[3], Hiroki Sugimoto[3]
[1]IBM T. J. Watson Research Center, Yorktown Heights, NY, USA, [2]Tokyo Ohka Kogyo Co., Ltd., Kawasaki, Japan, [3]Solar Frontier K. K., Atsugi, Japan

2:30 **(24) Over 12% Efficiency $Cu_2ZnSn(SeS)_4$ Solar Cell Via Hybrid Buffer Layer**
Homare Hiroi[1,2], Jeehwan Kim[3], Masaru Kuwahara[4], Teodor K Todorov[3], Dhruv Nair[3], Marinus Hopstaken[3], Yu Zhu[3], Oki Gunawan[3], David B. Mitzi[3], Hiroki Sugimoto[1,2]
[1]Showa Shell Sekiyu K.K., Kanagawa, Japan, [2]Solar Frontier K.K., Kanagawa, Japan, [3]IBM Corporation, Yorktown, NY, USA, [4]Tokyo Ohka Kogyo Co., Ltd., Kanagawa, Japan

2:45 **(25) Different bandgaps in $Cu_2ZnSnSe_4$; A high temperature coevaporation study**
Alex Redinger, Jan Sendler, Rabie Djemour, Thomas Paul Weiss, Germain Rey, Susanne Siebentritt
University of Luxembourg, Laboratory for photovoltaics, Belvaux, Luxembourg

2:45 **(26) Fabrication and Optoelectronic Properties of CZTSe Single Crystals**
Douglas M. Bishop[1], Brian E. McCandless[1], Richard Haight[2], Robert Birkmire[1]
[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]IBM T. J. Watson Research Center, Yorktown Hts, NY, USA

3:15 **(27) Vibrational and Structural Properties of $Cu_2ZnSn(S_xSe_{1-x})_4$ ($0 \le x \le 1$) Solid Solutions**
Mirjana Dimitrievska[1], Galina Gurieva[2], Haibing Xie[1], Xavier Fontané[1], Andrew Fairbrother[1], Rene Günder[2], Edgardo Saucedo[1], Alejandro Pérez-Rodríguez[1, 3], Victor Izquierdo-Roca[1], Susan Schorr[2, 4]
[1]IREC, Barcelona, Spain, [2]HZB, Berlin, Germany, [3]IN2UB, Barcelona, Spain, [4]FUB, Berlin, Germany

Area 4 - Orals

2:00 - 3:30 PM **Ballroom 1EF**

Material Characterization

Chair(s): Tonio Buonassisi, Kyotaro Nakamura

2:00 **(28) Photoluminescence Spectroscopy and Topography of Defects in Photovoltaic Silicon**
Michio Tajima[1,2]
[1]Institute of Space and Astronautical Science/JAXA, Sagamihara, Japan, [2]Meiji University, Kawasaki, Japan

2:30 **(29) Recombination via Nano-precipitates … a New Mechanism for Efficiency Loss in Solar Silicon?**
Anthony R Peaker[1], Bruce Hamilton[1], Simon Leonard[1], Vladimir P Markevich[1], Khaled Youssef[2], George Rozgonyi[2]
[1]Photon Science Institute, The University of Manchester, Manchester, UK, [2]North Carolina State University, Materials Science, Raleigh, NC, USA

2:45 **(30) Temperature Dependence of Band-Band Absorption and Radiative Recombination in Crystalline Silicon from Spectral Photoluminescence**
Hieu T. Nguyen, Fiacre E. Rougieux, Simeon C. Baker-Finch, Daniel Macdonald
Research School of Engineering, College of Engineering and Computer Science, The Australian National University, Canberra, Australia

3:00 **(31) Grain boundary characterization in multicrystalline silicon using joint EBSD, EBIC, and atom probe tomography**
Andreas Stoffers[1], Oana Cojocaru-Mirédin[1], Otwin Breitenstein[2], Winfried Seifert[3,4], Stefan Zaefferer[1], Dierk Raabe[1]
[1]Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany, [2]Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany, [3]Brandenburgische Technische Universität, Cottbus, Germany, [4]IHP, Frankfurt (Oder), Germany

3:15 **(32) Quantification of Iron Redistribution between Acceptors in co-doped Silicon**
T Bartel[1], F Gibaja[1], M Kaes[1], A Turenne[2]
[1]Calisolar GmbH, Berlin, Germany, [2]Silicor Materials Inc, San Jose, CA, USA

Area 5 - Orals

2:00 - 3:30 PM **Ballroom 2B**

Light Management

Chair(s): Franz-Josef Haug, Matthias Meier

2:00 **(33) Coupling Incident Light to Guided Modes in Thin-Film Tandem Solar Cells with Intermediate Reflector**
André Hoffmann, Karsten Bittkau, Chao Zhang, Tsvetelina Merdzhanova, Uwe Rau
IEK5 – Photovoltaik, Forschungszentrum Jülich GmbH, Jülich, Germany

2:30 **(34) Improved Light-In-Coupling via Anti-Reflection Films in Thin Film Microcrystalline Silicon Solar Cells on Honeycomb-Patterned Substrates**
Hitoshi Sai[1], Takuya Matsui[1], Michio Kondo[1], Isao Yoshida[2]
[1]National Institute of Advanced Industrial Science and Techonology, Tsukuba, Japan, [2]Photovoltaic Power Generation Technology Research Association, Tsukuba, Japan

2:45 **(35) Development of Double-Textured ZnO:B Substrates for Microcrystalline Silicon Solar Cells**
Yusuke Abe[1], Taijiro Kagei[1], Keiichi Nishikubo[1], Porponth Sichanugrist[1], Makoto Konagai[1,2]
[1]Department of Physical Electronics, Tokyo Institute of Technology, 2-12-1, O-okayama, Meguro-ku, Tokyo, Japan, [2]Photovoltaic Research Center (PVREC), Tokyo Institute of Technology, 2-12-1, O-okayama, Meguro-ku, Tokyo, Japan

3:00 **(36) Electrodeposited Zinc Oxide Nanostructured electrodes as Light Trapping Structures in Amorphous Silicon Solar Cells**
Regina-Elisabeth Nowak[1], Peng Hui Wang[2], Martin Vehse[1], Nies Reininghaus[1], Oleg Sergeev[1], Alexandre G. Brolo[2], Karsten von Maydell[1], Carsten Agert[1]
[1]NEXT ENERGY, EWE Research Centre for Energy Technology, Oldenburg, Germany, [2]University of Victoria, Department of Chemistry, Victoria, BC, Canada

3:15 **Best Student Presentation Award Finalist**
(37) New Approaches to Improve the Performance of Thin Film Radial Junction Solar Cells Built over Silicon Nanowire Arrays
Soumyadeep Misra, Linwei Yu, Martin Foldyna, Pere Roca i Cabarrocas
Ecole Polytechnique, Palaiseau, France

Area 6 - Orals

2:00 - 3:30 PM **Ballroom 2A**

Organic Semiconductor Based PV

Chair(s): Dana Olson, Moritz Riede

2:00 **(38) All-Polymer Blend Solar Cells with Efficiencies Approaching 7%**
Antonio Facchetti
Polyera Corp and Northwestern University, Evanston, IL, USA

2:30 **Best Student Presentation Award Finalist**
(39) Enhancing Exciton Diffusion in Organic Photovoltaics Cells Incorporating Dilute Donor Layers
S. Matthew Menke, Russell J. Holmes
University of Minnesota, Minneapolis, MN, USA

2:45 **(40) Kinetic Monte Carlo Modeling of Low-Bandgap Polymer Solar Cells**
Tim Albes, Bogdan Popescu, Dan Popescu, Marius Loch, Francesco Arca, Paolo Lugli
Technical University Munich, Institute of Nanoelectronics, Munich, Germany

3:00 **(41) Fully printed organic tandem cells and modules: from concepts to demonstration**
Ning Li[1], George Spyropoulos[2], Tayebeh Ameri[1], Christoph Brabec[1,2]
[1]Institute of Materials for Electronics and Energy Technology (i-MEET), Friedrich-Alexander University Erlangen-Nürnberg, Martensstraße 7, 91058 Erlangen, Germany, [2]Bavarian Center for Applied Energy Research (ZAE Bayern), Haberstraße 2a, 91058 Erlangen, Germany

Area 10 - Orals

2:00 - 3:30 PM **Ballroom 1CD**

Solar Resource Assessment and Forecasting

Chair(s): Ken Sauer, Rhonda Bailey

2:00 **(42) Evaluation of Global Horizontal Irradiance to Plane of Array Irradiance Models at Locations across the United States**
Clifford W. Hansen[1], Andrew Pohl[1], Matthew Lave[2], William Hayes[3], Will Hobbs[4]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Sandia National Laboratories, Livermore, CA, USA, [3]First Solar Inc., San Francisco, CA, USA, [4]Southern Company, Atlanta, GA, USA

2:30 **(43) Benchmarking Solar Power and Irradiance Forecasting Accuracy: SMUD Solar Forecasting Trial and Analysis**
T Vargas[1], O Bartholomy[2], C Hansen[3], A Phol[4], M Simone[5]
[1]SMUD, Sacramento, CA, USA, [2]SMUD, Sacramento, CA, USA, [3]Sandia National Labs, Albuquerque, NM, USA, [4]Sandia National Labs, Albuquerque, NM, USA, [5]SMUD, Sacramento, CA, USA

2:45 **(44) A New Operational Solar Resource Forecast Model Service for PV Fleet Simulation**
Richard R. Perez[1], Adam Kankiewicz[2], James Schlemmer[1], Karl Hemker, Jr.[1], Sergey Kivalov[1], Thomas E. Hoff[2]
[1]ASRC, The University at Albany, Albany, NY, USA, [2]Clean Power Research, Napa, CA, USA

3:00 **(45) Short-Term PV Power Forecasts Based on a Real-Time Irradiance Monitoring Network**
Antonio T. Lorenzo, William F. Holmgren, Alexander D. Cronin
University of Arizona, Tucson, AZ, USA

3:15 **(46) An Operational, Real-Time Forecasting System for 250 MW of PV Power Using NWP, Satellite, and DG Production data**
William F. Holmgren[1], Antonio T. Lorenzo[1], Michael Leuthold[2], Chang Ki Kim[2], Alexander D. Cronin[1], Eric A. Betterton[2]
[1]University of Arizona, Department of Physics, Tucson, AZ, USA, [2]University of Arizona, Department of Atmospheric Sciences, Tucson, AZ, USA

3:30 - 4:00 PM **Ballroom Pre-function**

Coffee Break

Joint Session: Areas 2,8 - Orals

4:00 - 5:30 PM **MR 505-507**

Characterization Methods for CdTe and CZTS

Chair(s): Harvey Guthrey, Rebekah Feist, Yoshhiro Hishikawa

4:00 **(47) S-Te interdiffusion within grains and GBs in CdTe solar cells: direct structure property correlation through aberration-corrected STEM**
Chen Li[1, 2], Jonathan Poplawsky[1, 3], Naba Paudel[4], Timothy J. Pennycook[5, 6], Sarah J. Haigh[7], Mowafak Al-Jassim[8], Yanfa Yan[4], Stephen J. Pennycook[3]
[1]Oak Ridge National Laboratory, Oak Ridge, TN, USA, [2]Vanderbilt University, Nashville, TN, USA, [3]University of Tennessee, Knoxville, TN, USA, [4]The University of Toledo, Toledo, OH, USA, [5]University of Oxford, Oxford, UK, [6]SuperSTEM Laboratory, Daresbury, UK, [7]University of Manchester, Manchester, UK, [8]National Renewable Energy Laboratory, Golden, CO, USA

4:30 **(48) Atom Probe Tomography for Nanoscale Characterization of CdTe Device Absorber Layers and Interfaces**
David R Diercks, Jiaojiao Li, Colin A Wolden, Brian P Gorman
Colorado School of Mines, Golden, CO, USA

4:45 **(49) Simultaneous Measurement of Minority-Carrier Lifetime in Single-Crystal CdTe using Three Transient Decay Techniques**
Steve Johnston[1], Katherine Zaunbrecher[1,2], Richard Ahrenkiel[1,3], Darius Kuciauskas[1], David Albin[1], Wyatt Metzger[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado State University, Fort Collins, CO, USA, [3]Lakewood Semiconductors, Lakewood, CO, USA

5:00 **Best Student Presentation Award Finalist**
(50) Direct evaluation of defect distributions from admittance spectroscopy
Thomas P. Weiss, Alex Redinger, David Regesch, Marina Mousel, Susanne Siebentritt
Laboratory for Photovoltaics, University of Luxembourg, Belvaux, Luxembourg

5:15 **(51) Nanometer-Scale Study of Resistance on CdTe Solar Cell Device**
Huan Li[1,2], Chun-Sheng Jiang[1], Wyatt Metzger[1], Chih-Kang Shih[2], Mowafak Al-Jassim[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]University of Texas at Austin, Austin, TX, USA

Area 1 - Orals

4:00 - 5:30 PM **Ballroom 1AB**

Quantum Well and Superlattice Solar Cells

Chair(s): Christopher Bailey, Raymond Hoheisel, Jessica Adams

4:00 **(52) Strain-balanced Quantum Wells as an Efficiency Booster for III-V Solar Cells**
Masakazu Sugiyama
The University of Tokyo, Tokyo, Japan

4:30 **(53) Four-fold MQWs Absorption Enhancement in a 430 nm Thick InGaAs/GaAsP MQWs Solar Cell**
Benoît Behaghel[1,2], Ryo Tamaki[3], Nicolas Vandamme[1], Kentaroh Watanabe[3], Christophe Dupuis[1], Nathalie Bardou[1], Hassanet Sodabanlu[3], Andrea Cattoni[1], Yoshitaka Okada[3], Masakazu Sugiyama[3], Stéphane Collin[1], Jean-François Guillemoles[2]
[1]LPN-CNRS, Marcoussis, France, [2]IRDEP-CNRS, Chatou, France, [3]RCAST-The University of Tokyo, Tokyo, Japan

4:45 **(54) Effect of barrier thickness on lattice-matched quantum well solar cells**
Michael K. Yakes[1], Christopher G. Bailey[2], Louise C. Hirst[2], Matthew P. Lumb[3], David V. Forbes[4], Maria Gonzalez[5], Kenneth J. Schmieder[2], Joeseph G. Tischler[1], Seth M. Hubbard[4], Robert J. Walters[1]
[1]Naval Research Laboratory, Washington, DC, USA, [2]NRC Postdoc residing at NRL, Washington, DC, USA, [3]George Washington University, Washington, DC, USA, [4]Rochester Institute of Technology, Rochester, NY, USA, [5]Sotera Defense Solutions, Herndon, VA, USA

5:00 **Best Student Presentation Award Finalist**
(55) Improving Epitaxial Regrowth Interfaces as a Means of Improving Doping Superlattice Solar Cell Performance
Michael A. Slocum, David V. Forbes, Nichole M. Hoven, Seth M. Hubbard
Rochester Institute of Technology, Rochester, NY, USA

5:15 **Best Student Presentation Award Finalist**
(56) Carrier Time-of-Flight Measurement Using a Probe Structure for Direct Evaluation of Carrier Transport in Quantum Structure Solar Cells
Kasidit Toprasertpong[1], Naofumi Kasamatsu[3], Hiromasa Fujii[1], Tomoyuki Kada[3], Shigeo Asahi[3], Yunpeng Wang[2], Kentaroh Watanabe[2], Masakazu Sugiyama[1], Takashi Kita[3], Yoshiaki Nakano[1]
[1]School of Engineering, the University of Tokyo, Tokyo, Japan, [2]Research Center for Advanced Science and Technology, Tokyo, Japan, [3]Graduate School of Engineering, Kobe University, Kobe, Japan

Area 2 - Orals

4:00 - 5:30 PM **MR 502-504**

CIGS 1

Chair(s): Susanne Siebentritt

4:00 **(57) Introduction of Si PERC rear contacting design to boost efficiency of ultra-thin Cu(In,Ga) Se_2 solar cells**
Bart Vermang[1], Jörn T. Wätjen[1], Viktor Fjällström[1], Fredrik Rostvall[1], Marika Edoff[1], Ratan Kotipalli[2], Frederic Henry[2], Denis Flandre[2]
[1]Ångström Solar Center (University of Uppsala), Uppsala, Sweden, [2]ICTEAM (Université catholique de Louvain), Louvain-la-Neuve, Belgium

4:30 **(58) Improved Performance of Ultrathin Cu(InGa) Se_2 Solar Cells With a Backwall Superstrate Configuration**
Hamed Simchi[1,2], Jes Larsen[1], William Shafarman[1,2]
[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]Department of Materials Science and Engineering, University of Delaware, Newark, DE, USA

4:45 **(59) The importance of sodium control in CIGSe superstrate solar cells**
Marc D. Heinemann[1], Varvara Brackmann[2], Reiner Klenk[1], Thomas Unold[1], Hans-Werner Schock[1], Christian Kaufmann[1]
[1]Helmholtz Zentrum Berlin, Berlin, Germany, [2]Leibniz Institut für Festkörper- und Werksstoffforschung, Dresen, Germany

5:00 **(60) Resent R&D Progress in Solar Frontier's Small-sized Cu(InGa)(SeS)2 Solar Cells**
Motoshi Nakamura, Nobutaka Yoneyama, Kyouhei Horiguchi, Yasuaki Iwata, Koji Yamaguchi, Hiroki Sugimoto, Takuya Kato
Energy Solution Business Center, Showa Shell Sekiyu K.K., Atsugi, Japan

5:15 **(61) A study of Fluorine Doping AZO Transparent Conductive Oxide Films for Thin Film Copper Indium Gallium Selenide Solar Cells on Flexible Substrates**
Swati Sevvana, Bob Zubeck, Kee Kee Cheung, Neil Mackie
Miasole Hi-Tech Corp., Santa Clara, CA, USA

Area 4 - Orals	
4:00 - 5:30 PM	**Ballroom 1EF**
Analysis	

Chair(s): Paul Basore, Adeline Sugianto

4:00 **(62) Quantifying the Optical Losses in Back-contact Solar Cells**
Keith R McIntosh[1], Kean C Fong[2], Teng C Kho[2], Yimao Wan[2], Simeon C Baker-Finch[1], Malcolm D Abbott[1], Soe Zin[2], Da Wang[2], Nicholas E Grant[2], Er-Chien Wang[2], Matthew Stocks[2], Evan Franklin[2], Andrew W Blakers[2]
[1]PV Lighthouse, Coledale, Australia, [2]Australian National University, Canberra, Australia

4:30 **(63) A GUI for comfortable batch simulation of luminescence intensity combining PC1D electrical simulation with analytical optical models**
Hannes Höffler, Johannes Greulich, Jonas Haunschild, Stefan Rein
Fraunhofer ISE, Freiburg, Germany

4:45 **Best Student Presentation Award Finalist**
(64) Multi-Probe Characterization of Inversion Charge for Parameterization of HIT™ Cells
Raghu V. K. Chavali[1], Sanchit Khatavkar[2], Brij Mohan Arora[2], Pradeep Nair[2], Jeffery L. Gray[1], Muhammad A. Alam[1]
[1]School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA, [2]School of Electrical Engineering, Indian Institute of Technology,Bombay, Mumbai, India

5:00 **(65) Parameterization of Carrier Mobility Sum in Silicon as a Function of Doping, Temperature and Injection Level: Extension to p-type Silicon**
Peiting Zheng, Fiacre E. Rougieux, Daniel Macdonald, Andres Cuevas
Research School of Engineering, College of Engineering and Computer Science, The Australian National University, Canberra, Australia

5:15 **(66) Sponge LID – a new degradation mechanism?**
Christian Fahrland[1], Yvonne Ludwig[1], Friederike Kersten[2], Kai Petter[1]
[1]Hanhwa Q Cells GmbH, Bitterfeld-Wolfen, Germany, [2]TU Bergakademie Freiberg, Freiberg, Germany

Area 6 - Orals

4:00 - 5:30 PM **Ballroom 2A**

Novel OPV Concepts and Perovskite Solar Cells

Chair(s): Sumit Chaudhary, Dana Olson

4:00 **Best Student Presentation Award Finalist**
(67) Highly Efficient (11.1%) Small Molecule Multi-junction Organic Photovoltaic Cells
Xiaozhou Che[1], Xin Xiao[2], Stephen R. Forrest[1,2,3,4]
[1]Applied Physics Program, University of Michigan, Ann Arbor, MI, USA, [2]Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA, [3]Department of Physics, University of Michigan, Ann Arbor, MI, USA, [4]Department of Materials Science and Engineering, University of Michigan, Ann Arbor, MI, USA

4:30 **Best Student Presentation Award Finalist**
(68) Organic photovoltaic cell relying on energy transfer with over 20% efficiency in indoor lighting
Kjell Cnops[1,2], Eszter Voroshazi[1], Carl Hart de Ruijter[1], Paul Heremans[1], David Cheyns[1]
[1]imec, Leuven, Belgium, [2]ESAT, KU Leuven, Leuven, Belgium

4:45 **(69) Comprehensive Device Modeling of Plasmon-Enhanced and Optical Field-Dependent Photocurrent Generation in Organic Bulk Heterojunctions.** Devin M. Rourke[1], Sungmo Ahn[2], Alexandre Nardes[3], Jao v.d. Lagemaat[3], Nikos Kopidakis[3], Wounjhang Park[2]. *[1]Department of Physics, University of Colorado, Boulder, CO, USA, [2]Department of Electrical, Computer, and Energy Engineering, University of Colorado, Boulder, CO, USA, [3]National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO, USA.*

5:00 **(70) All-solid Sn halide perovskite sensitized solar**
Shuzi Hayase
Kyushu Institute of Technology, Kitakshu, Japan

5:15 **(71) Organometal Halide Peroskites: Optical Absorption Edge and Perspectives for Silicon-Based Tandem Solar Cells**
Philipp F.H. Löper[1], Jakub Holovsky[3], Soo-Jin Moon[2], Björn Niesen[1], Zdenek Remes[3], Martin Ledinsky[1,3], Franz-Josef Haug[1], Jun-Ho Yum[2], Stefaan De Wolf[1], Christophe Ballif[1,2]
[1]Photovoltaics and Thin-Film Electronics Laboratory, Ecole Polytechnique Fédérale de Lausanne (EPFL), Neuchâtel, Switzerland, [2]PV Center, Centre Suisse d'Electronique et de Microtechnique (CSEM), Neuchâtel, Switzerland, [3]Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Area 9 - Orals

4:00 - 5:30 PM **Ballroom 2B**

Manufacturing and Module Technology

Chair(s): Scott Norquist, Franck Zhang

4:00 **(72) Challenges and Opportunities of modern PV manufacturing**
Peter Fath
Rena / RCT Solutions, Konstanz, Germany

4:30 **(73) Economic Measurements of Polysilicon for the Photovoltaic Industry: Market Competition and Manufacturing Competitiveness**
Ran Fu, Michael Woodhouse, Ted L. James
National Renewable Energy Laboratory (NREL), Golden, CO, USA

4:45 **(74) Printed monolithic interconnects for photovoltaic applications**
Jeremy D. Fields, Matthew S. Dabney, Vincent P. Bollinger, Maikel F.A.M. van Hest
National Renewable Energy Laboratory, Golden, CO, USA

5:00 **(75) Progress Toward Developing a Novel Module Architecture for Increased Reliability and Reduced Costs**
Kurt L. Barth[1,2], Davis Hemenway[1,2]
[1]Direct Solar LLC, Fort Collins, CO, USA, [2]Colo. State University, Fort Collins, CO, USA

5:15 **(76) Resistive power loss analysis of PV modules made from half-cut 15.6×15.6cm² silicon PERC solar cells with efficiencies up to 20.0%**
Jens Mueller, David Hinken, Susanne Blankemeyer, Heike Kohlenberg, Ulrike Sonntag, Karsten Bothe, Thorsten Dullweber, Marc Koentges, Rolf Brendel
Institute for Solar Energy Research Hamelin (ISFH), Hamelin, Germany

Area 10 - Orals

4:00 - 5:30 PM **Ballroom 1CD**

System Modeling and Energy Predictions

Chair(s): Billy Hayes, Matthew Lave

4:00 **Best Student Presentation Award Finalist**
(77) Introduction to the open source PV_LIB photovoltaic system modelling package
Robert W. Andrews[1], Joshua S. Stein[2], Cliff Hansen[2], Dan Riley[2]
[1]Calama Consulting Inc, Toronto, ON, Canada, [2]Sandia National Laboratories, Albuquerque, NM, USA

4:30 **(78) Which Models Matter: Uncertainty and Sensitivity Analysis for Photovoltaic Power Systems**
Clifford W Hansen, Andrew Pohl
Sandia National Laboratories, Albuquerque, NM, USA

4:45 **(79) Determining Uncertainty for I-V Translation Equations**
Benjamin C Duck[1,2], Christopher J Fell[1], Mark Campanelli[2], Brian Zaharatos[2], Bill Marion[2], Keith Emery[2]
[1]CSIRO, Newcastle, Australia, [2]NREL, Golden, CO, USA

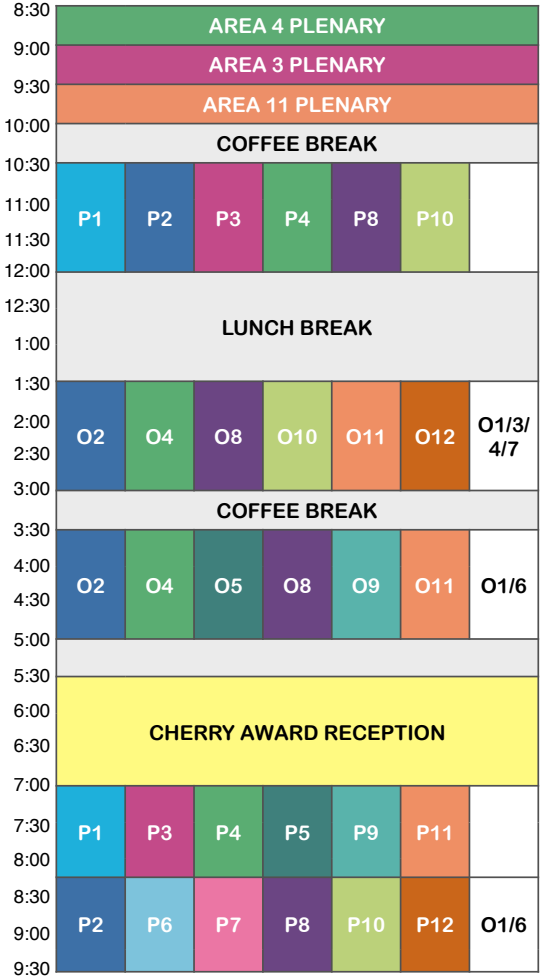
5:00 **(80) *Ashes to Ashes, Dust to Dust*: Averting a Showstopper for Solar Photovoltaics**
Lawrence L. Kazmerski[1,2], Mohammed Al Jardan[1,3], Yasser Al Jnoobi[1,3], Yousef Al Shaya[1,3], Jim John[4]
[1]NREL, Golden, CO, USA, [2]University of Colorado, Boulder, CO, USA, [3]K.A.CARE, Riyadh, Saudi Arabia, [4]IIT-Bombay, Mumbai, India

5:15 **(81) Determination of a Minimum Soiling Level to Affect Photovoltaic Devices**
Patrick D. Burton, Bruce H. King
Sandia National Laboratories, Albuquerque, NM, USA

5:30 - 8:30 PM **Exhibit Hall D**

Exhibits Opening Reception

TUESDAY PROGRAM SUMMARY



	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 4 - Plenary

8:30 - 9:00 AM **Ballroom 3-4**

Crystalline Silicon Photovoltaics

Chair: Stefan Glunz, Ron Sinton

8:30 **(82) Status and future of crystalline silicon PV**
Richard Swanson
Sunpower Corp.

Area 3 - Plenary

9:00 - 9:30 AM **Ballroom 3-4**

III-V and Concentrator Technologies

Chair(s): Frank Dimroth

9:00 **(83) Engineering a Path Forward for Low Cost Concentrator Photovoltaic Systems**
Scott Burroughs
Semprius, Durham, NC, USA

Area 11 - Plenary

9:30 - 10:00 AM **Ballroom 3-4**

PV Deployment

Chair(s): Martha Symko-Davies

9:30 **(84) Energy Systems Integration – leveraging other technologies to integrate high levels of solar into the energy system**
Benjamin Kroposki[1], Bryan Hannegan[1], Mark O'Malley[2]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]University College Dublin, Dublin, Ireland

10:00 - 10:30 AM **Exhibit Hall D**

Coffee Break

Area 1 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Pioneering Concepts and Materials

Chair(s): Stephen Bremner, Glenn Teeter, Tom Markvart

(85-A1) **Optical Characterization of SixGe1-x Films Grown on Nanostructured Si Substrates.** Ayu Wazira Azhari[1,2], Adnan Ali[3], Kamaruzzaman Sopian[1], Uda Hashim[4], Saleem H. Zaidi[1]. *[1]Universiti Kebangsaan Malaysia, Bangi, Malaysia, [2]Universiti Malaysia Perlis, Kangar, Malaysia, [3]Government College University, Faisalabad, Pakistan, [4]Universiti Malaysia Perlis, Kangar, Malaysia.*

(86-A4) **Fabrication of 0.9 eV bandgap a-Si/c-Si1-xGex heterojunction solar cells.** Ryuji Oshima, Mitsuyuki Nakayama, Hitoshi Kawanami, Isao Sakata, Koji Matsubara. *AIST, Tsukuba, Japan.*

(87-A7) **Grain boundaries characterization of semiconducting BaSi2 thin films on a polycrystalline Si substrate.** Masakazu Baba[1], Kosuke O. Hara[2], Kentaro Watanabe[1], Weijie Du[1], Daichi Tsukahara[1], Kaoru Toko[1], Karolin Jiptner[3], Takashi Sekiguchi[3], Noritaka Usami[2,4], Takashi Suemasu[1,4]. *[1]University of Tsukuba, Tsukuba, Japan, [2]University of Nagoya, Nagoya, Japan, [3]NIMS, Tsukuba, Japan, [4]JST-CREST, Tokyo, Japan.*

(88-A10) **Electrical and Optical Characterizations of an n-BaSi2/p-Si Hetero-junction for Solar Cell Applications.** Weijie Du[1], Masakazu Baba[1], Kaoru Toko[1], Noritaka Usami[2,3], Takashi Suemasu[1,3]. *[1]Institute of Applied Physics, University of Tsukuba, Tsukuba, Japan, [2]Materials, Physics and Energy Engineering, Nagoya University, Nagoya, Japan, [3]JST-CREST, Tokyo, Japan.*

(89-A13) **Performance Enhanced of MOS-Structure Silicon Solar Cell Based on the Integration of Photovoltaic Biasing Source.** Wen-Jeng Ho, Min-Chun Huang, Guo-Chang Yang, Chia-Ming Chan, Yi-Yu Lee, Zhong-Fu Hou, Jian-Jyun Liao. *National Taipei University of Technology, Taipei, Taiwan.*

(90-A16) **Non-pn-junction-based Solar Cells: Charge Carrier Separation in Solar Cells with Bound Surface Charges.** Fude Liu[1], Wentao Wang[1], Chor Man Lau[1], Lei Wang[1], Guandong Yang[1], Dawei Zheng[1], Zhigang Li[2]. *[1]The University of Hong Kong, Hong Kong, Hong Kong, [2]The Hong Kong University of Science and Technology, Hong Kong, Hong Kong.*

(91-A19) **Multi-Stage Photovoltaic Devices with a Cutoff Wavelength of ~3µm.** Hossein Lotfi[1], Robert T. Hinkey[1,2], Lu Li[1], Rui Q. Yang[1], John F. Klem[3], Joel C. Keay[2], Matthew B. Johnson[2]. *[1]School of Electrical and Computer Engineering, University of Oklahoma, Norman, OK, USA, [2]Homer L. Dodge Department of Physics and Astronomy, University of Oklahoma, Norman, OK, USA, [3]Sandia National Laboratories, Albuquerque, NM, USA.*

(92-A22) **Embedded InN Dot-Like Structures with Modulating Growth Temperature in Nitride-Based Solar Cell.** Lung-Hsing Hsu[1,3], Chien-Chung Lin[2], Yen-Hua Lo[2], Hau-Vei Han[3], Da-Wei Lin[3], Hao-Chung Kuo[3]. *[1]Institute of Lighting and Energy Photonics, National Chio Tung University, Tainan, Taiwan, [2]Institute of Photonics System, National Chio Tung University, Tainan, Taiwan, [3]Institute of Photonics, National Chio Tung University, Hsinchu, Taiwan.*

(93-A25) **Local conductivity characteristics of individual ErAs nanoparticle for solar cell tunnel junction application.** Chao-Yu Hung, Tomah Sogabe, Naoya Miyashita, Yasushi Shoji, Shunya Naito, Yoshitaka Okada. *Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Tokyo, Japan.*

(94-A28) **Enhanced Light Trapping and Carrier Collection in Glancing Angle Deposited Nanostructures.** Hilal Cansizoglu, Mehmet F. Cansizoglu, Tansel Karabacak. *University of Arkansas at Little Rock, Little Rock, AR, USA.*

(95-A31) **N+ and P+ double diffused GaSb PV cells with interdigitated back contacts for monolithically interconnected modules.** Jose M Borrego[1], Eric Brown[2], Paul Greif[3], Amy W K Liu[4], Geeta Rajagopalan[5]. *[1]MTPV Power Corp., Austin, TX, USA, [2]MTPV Power Corp., Austin, TX, USA, [3]MTPVPower Corp., Austin, TX, USA, [4]IQE, Bethlehem, PA, USA, [5]United Semiconductor LLC, Rensselaer, NY, USA.*

(96-A34) **Numerical Method to Separate the Photo-Current and Contact Injection Current in Solar Cells.** Raghu V. K. Chavali, Jeffery L. Gray, John R. Wilcox. *School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA.*

(97-A37) **Characterization, Modeling and Analysis of InAlAsSb Schottky Barrier Solar Cells Grown on InP.** Matthew P Lumb[1,2], Maria Gonzalez[2,3], Joshua Abell[2], Joseph G Tischler[2], David S Scheiman[2], Michael K Yakes[2], Igor Vurgaftman[2], Jerry R Meyer[2], Robert J Walters[2]. *[1]The George Washington University, Washington, DC, USA, [2]US Naval Research Laboratory, Washington, DC, USA, [3]Sotera Defense Solutions, Crofton, MD, USA.*

(98-A40) **ALD grown absorber materials for bulk heterojunction solar cells.** Neha Mahuli, Shaibal K Sarkar. *Indian Institute of Technology Bombay, Mumbai, India.*

(99-A43) **Chemical and Spatial Control of Substitutional Intermediate Band Materials: Toward the Atomic Layer Deposition of V0.25In1.75S3.** Robert F McCarthy[1], Matthew S Weimer[1,2], Adam S Hock[1,2], Alex B F Martinson[1]. *[1]Argonne National Laboratory, Argonne, IL, USA, [2]Illinois Institute of Technology, Chicago, IL, USA.*

(100-A46) **Structural and morphological studies of Cuprous Oxide Thin Film Developed via Potentiostatic Electrodeposition.** Chandan Das[1], Balasubramaniam Kavaipatti[1]. *[1]Indian Institute of Technology Bombay, Mumbai, India, [2]Indian Institute of Technology Bombay, Mumbai, India.*

(101-B1) **"The Effects of Alkali Metal Diffusion in Zinc Phosphide Thin Films".** Brooke E. Paquin, Alex Cimaroli, Yanfa Yan., ,, .

(102-B4) **Computational design of p-type transparent conductors for photovoltaic applications.** Cynthia S Lo, Maria Stoica, Alireza Faghaninia, Xiaodi Sun. *Washington University, St. Louis, MO, USA.*

(103-B7) **Characterization of sulfurised CuSbS2 thin films for PV applications.** Enzo Peccerillo, Ken Durose, Jon Major, Laurie Phillips, Robert Treharne. *Stephenson Institute for Renewable Energy, Liverpool, UK.*

(104-B10) **Photonic Curing of Ligand-Capped CuInSe2 Nanocrystal Films.** C. Jackson Stolle, Taylor B Harvey, Brian A Korgel. *The University of Texas at Austin, McKetta Department of Chemical Engineering, Texas Materials Institute, Center for Nano- and Molecular Science, Austin, TX, USA.*

(105-B13) **Enhancement of Hybrid Tandem Photovoltaic Thermoelectric Devices by Fishnet through Metamaterials and Nanoporous TE Materials.** Mouli Ramasamy[1], Sechang Oh[1], Pratyush Rai[1], Vijay K Varadan[1,2,3,4]. *[1]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, USA, [2]Department of Biomedical Engineering, University of Arkansas, Fayetteville, AR, USA, [3]Penn State Hershey Medical Center, Hershey, PA, USA, [4]Global Institute of Nanotechnology, Fayetteville, AR, USA.*

(106-B16) **The Limiting Efficiency of Four-Band Cells Revisited.** Rune Strandberg. *University of Agder, Grimstad, Norway.*

(107-B19) **Metal/Insulator/Semiconductor Carrier Selective Contacts for Photovoltaic Cells.** Raisul Islam, Krishna C. Saraswat. *Stanford University, Stanford, CA, USA.*

(108-B21) **Investigation of RF-Sputtered Tin Sulfide Thin Films with in situ Heating for Photovoltaic Applications.** Rona E Banai, Hyeonseok Lee, Nicholas J. Tanen, Jacob J. Cordell, Mark W. Horn, Jeffrey R.S. Brownson. *The Pennsylvania State University, University Park, PA, USA.*

(109-B23) **Single Junction GaAs - Ge Stacked Thin Film Solar Cell.** Noura Al Wahshi, Ammar Nayfeh. *Institute Center for Future Energy Systems (iFES), Department of Electrical Engineering and Computer Science (EECS), Masdar Institute of Science and Technology,, Abu Dhabi, United Arab Emirates.*

Area 2 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

CIGS and CZTS

Chair(s): Yanfa Yan, Hiroki Sugimoto, James Burst, Jesse Frantz

(110-B26) **Nd:YAG Laser Annealing Investigation of Screen-printed CIGS Layer on PET: Layer Annealing Method for Photovoltaic Cell Fabrication Process.** Ahmed M. AlSaggaf[1,2,3], Erkki Alarousu[1], Samir Boulfrad[3], Alexander Rothenberger[1,3]. *[1]Solar and Photovoltaic Engineering Research Center, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia, [2]Saudi Aramco, Dhahran, Saudi Arabia, [3]Physical Science and Engineering Division, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia.*

(111-B29) **ALD Processed MgZnO Buffer Layers for Cu(In,Ga)S2 Solar Cells.** Johnathan C Armstrong[1, 2], Jingbiao Cui[3], Tar-Pin Chen[1, 2]. *[1]Arkansas GREEN Research Center for Solar Cells, Little Rock, AR, USA, [2]Department of Physics and Astronomy, University of Arkansas at Little Rock, Little Rock, AR, USA, [3]Department of Physics, University of Memphis, Memphis, TN, USA.*

(112-B32) **Ultrasonically Sprayed TCO Layers for Thin Film Solar Cells.** Panagiota Arnou, Jake W. Bowers, John M. Walls. *CREST (Centre for Renewable Energy Systems and Technology), Department of Electronic and Electrical Engineering, Loughborough University, Loughborough, Leicestershire, UK.*

(113-B35) **Effect of selenium evaporation rate on ultrathin Cu(In,Ga)Se2 films.** Krishna Aryal[1], Grace Rajan[1], Tasnuva Ashrafee[1], Vikash Ranjan[1], Angus Rockett[2], Robert W Collins[3], Sylvain Marsillac[1]. *[1]Virginia Institute of Photovoltaics, Old Dominion University, Norfolk, VA, USA, [2]Dept. of Materials Science & Engineering, Univ. of Illinois Urbana-Champaign, Urbana, IL, USA, [3]Dept. of Physics & Astronomy, University of Toledo, Toledo, OH, USA.*

(114-B38) **Real time spectroscopic ellipsometry studies of ultrathin CIGS films deposited by 1-stage, 2-stage and 3-stage co-evaporation processes.** Krishna Aryal[1], Grace Rajan[1], Tasnuva Ashrafee[1], Vikash Ranjan[1], Puruswottam Aryal[2], Angus Rockett[3], Robert W Collins[2], Sylvain Marsillac[1]. *[1]Virginia Institute of Photovoltaics, Old Dominion University, Norfolk, VA, USA, [2]Dept. of Physics & Astronomy, University of Toledo, Toledo, OH, USA, [3]Dept. of Materials Science & Engineering, Univ. of Illinois Urbana-Champaign, Urbana, IL, USA.*

(115-B41) **Growth Studies and Characterization of Atomic Layer Deposited (Zn,Mg)S Thin Films for Solar cell Applications.** Tasnuva Ashrafee[1], Yunus Erkaya[1], Krishna Aryal[1], Grace Rajan[1], Angus Rockett[2], Robert W Collins[3], Sylvain Marsillac[1]. *[1]Virginia Institute of Photovoltaics, Old Dominion University, Norfolk, VA, USA, [2]Dept. of Materials Science & Engineering, Univ. of Illinois Urbana-Champaign, Urbana, IL, USA, [3]Dept. of Physics & Astronomy, University of Toledo, Toledo, OH, USA.*

(116-B44) **H2S reaction of Se-capped metallic precursors to form CIGSSe absorber layers.** Dominik M. Berg, Frank Cheng, William N. Shafarman. *University of Delaware, Institute of Energy Conversion, Newark, DE, USA.*

(117-B47) **Influence of H2S annealing on CZTS solar cells sputtered from a quaternary compound target.** Patrice Bras[1,2], Jan Sterner[1]. *[1]Midsummer AB, Järfälla, Sweden, [2]Uppsala University, Uppsala, Sweden.*

(118-C2) **Characterization of Group I-Rich Growth During (Ag,Cu)(In,Ga)Se2 Three-stage Co-evaporation.** Lei Chen[1,2], JinWoo Lee[1], William N. Shafarman[1,2]. *[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]Department of Physics and Astronomy, University of Delaware, Newark, DE, USA.*

(119-C5) **Surface passivation of CIGS solar cells.** Tzu-Huan Cheng[1], Chia-Hung Tsai[2], Wei-Lun Xu[3]. *[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei City, Taiwan, [2]Department of Materials Science and Engineering, National Cheng Kung University, Tainan City, Taiwan, [3]Solar Energy Research Institute of Singapore, National University of Singapore, Singapore, Singapore.*

(120-C8) **Metastable Changes to the Temperature Coefficients of Thin-film Photovoltaic Modules.** Michael G. Deceglie, Timothy J Silverman, Bill Marion, Sarah R. Kurtz. *National Renewable Energy Laboratory, Golden, CO, USA.*

(121-C11) **Novel Application of Yttria Stabilized Zirconia as a Substrate for Thin Film CIGS Solar Cells.** David Fobare[1], Pradeep Haldar[1], Harry Efstathiadis[1], David Metacarpa[1], John Wax[1], John Olenick[2], Viswanathan Venkateswaran[2], Kathy Olenick[2]. *[1]US Photovoltaic Manufacturing Consortium (PVMC), SUNY College of Nanoscale Science and Engineering, Albany, NY, USA, [2]ENrG Inc., Buffalo, NY, USA.*

(122-C14) **Effect of Na on Cu(In,Ga)Se2 in-plane conductance and Seebeck coefficient.** Robert V. Forest[1,2], Erten Eser[2], Brian E. McCandless[2], Jingguang G. Chen[3], Robert W. Birkmire[2]. *[1]Department of Chemical and Biomolecular Engineering, University of Delaware, Newark, DE, USA, [2]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [3]Department of Chemical Engineering, Columbia University, New York, NY, USA.*

(123-C17) **Microstructured ZnO Coatings for Improved Performance in Cu(In,Ga)Se2 Photovoltaic Devices.** Jesse A. Frantz[1], Jason D. Myers[1], Robel Y. Bekele[2], Jasbinder S. Sanghera[1]. *[1]U.S. Naval Research Laboratory, Washington, DC, USA, [2]University Research Foundation, Greenbelt, MD, USA.*

(124-C20) **Efficient and Stable CIGS Solar Cells with ZnOS Buffer Layer.** Rebekah L. Garris, Miguel A. Contreras, Kannan Ramanathan, Lorelle M. Mansfield, Brian Egaas, Jian V. Li, Ana Kanevce. *National Renewable Energy Laboratory, Golden, CO, USA.*

(125-C23) **Co-electroplated Cu2ZnSnS4 Thin-film Solar Cells: the Role of Precursor Metallic Composition.** Jie Ge[1], Jinchun Jiang[2], Pingxiong Yang[3], Junhao Chu[2,3], Yanfa Yan[1]. *[1]Department of Physics & Astronomy, and Wright Center for Photovoltaics Innovation and Commercialization, The University of Toledo, Toledo, OH, USA, [2]Shanghai Center for Photovoltaics, Shanghai, China, [3]Key Laboratory of Polar Materials and Devices (MOE), East China Normal University, Shanghai, China.*

(126-C26) **H2S/H2 annealing as a controlled method for defect reduction and efficiency improvement in SnS solar cells.** Katy Hartman[1], R. Jaramillo[1], Vera Steinmann[1], Helen H. Park[2], Rupak Chakraborty[1], Jasmin Hofstetter[1], Alex Polizzotti[1], Riley E. Brandt[1], Jeremy Poindexter[1], Yun S. Lee[1], Roy G. Gordon[2], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Harvard University, Cambridge, MA, USA.*

(127-C29) **Fabrication and Characterization of Cu2ZnSn(S, Se)4 Solar Cells by Spray-deposited Precursor Stacks.** Wei-Chih Huang[1], Shih-Yuan Wei[1], Xin Zeng[2], Lydia Wong[2], Chih-Huang Lai[1]. *[1]Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan, [2]School of Materials Science & Engineering, Nanyang Technological University, Singapore, Singapore.*

(128-C32) **XPS analysis and structural characterization of CZTS thin films prepared using solution and vacuum based deposition techniques.** Mikel Hurtado[2], Saul Daniel Cruz[4], Raul Becerra[2], Clara Lilia Calderón[1], Pascual Bartolo Perez[3], Gerardo Gordillo[1]. *[1]Universidad Nacional de Colombia, Bogotá, Columbia, [2]Universidad Nacional de Colombia, Bogotá, Columbia, [3]CINVESTAV-IPN, Merida, Mexico, [4]Universidad Autónoma de Nuevo León, Monterrey, Mexico.*

(129-C35) **Solar Cells with Thin Cu(In1-xGax)Se2 Absorbers: Optical Modeling and Quantum Efficiency Predictions.** Abdel-Rahman Ibdah[1], Puruswattom Aryal[1], Puja Pradhan[1], Grace Rajan[2], Jian Li[1], Angus A. Rockett[3], Sylvain Marsillac[2], Robert W. Collins[1]. *[1]Center for PV Innovation & Commercialization and Dept. Physics & Astronomy, Univ. Toledo, Toledo, OH, USA, [2]Virginia Institute of Photovoltaics, Old Dominion Univ., Norfolk, VA, USA, [3]Dept. Materials Science & Engineering, Univ. Illinois Urbana-Champaign, Urbana, IL, USA.*

(130-C38) **Tin Sulfide Thin Films Prepared by Thermal Evaporation and Sulfurization.** Ming-Jer Jeng. *Chang Gung University, Taoyuan, Taiwan.*

(131-C41) **Impact of buffer and absorber properties in vicinity of the interface on wide-gap Cu(In,Ga)Se2 solar cells performance.** Ana Kanevce, Kannan Ramanathan, Miguel Contreras. *National Renewable Energy Laboratory, Golden, CO, USA.*

(132-C44) **In-situ stress and thermal stability studies of molybdenum bilayer back contacts for photovoltaic applications.** Sreejith Karthikeyan, Liyuan Zhang, Stephen A Campbell. *Department of Electrical and Computer Engineering, Minneapolis, MN, USA.*

(133-C47) **Sulfurization Approach Using Sulfur Vapor, Graphite Box and H2S gas Atmospheres for Co-sputtered Cu2ZnSnS4 Thin Film.** Arun Khalkar[1], Kwang-Soo Lim[1], Seong-Man Yu[1], Jin Hyeok Kim[2], Ji-Beom Yoo[1]. *[1]SKKU Advanced Institute of Nanotechnology (SAINT), Sungkyunkwan University, Suwon, Korea, [2]Department of Materials Science and Engineering, Chonnam National University, Gwangju, Korea.*

(134-D2) **Multi-Stage co-evaporation process for active Ga gradient control in CIGS solar cells.** Torben Klinkert[1,2,3], Marie Jubault[1,2,3], Frederique Donsanti[1,2,3], Daniel Lincot[1,2,3], Jean-François Guillemoles[1,2,3]. *[1]EDF R&D, Institute of Research and Development on Photovoltaic Energy (IRDEP), Chatou, France, [2]CNRS, IRDEP, UMR 7174, Chatou, France, [3]Chimie ParisTech, IRDEP, Chatou, France.*

(135-D5) **Raman investigation of epitaxial Cu2ZnSnSe4 layers from annealed Sn/Cu/ZnSe(001) precursors on GaAs(001).** Christoph Krämmer[1], Mario Lang[1], Johannes Sachs[1], Lukas Pfaffmann[2], Chao Gao[1], Dagmar Gerthsen[2], Heinz Kalt[1], Michael Powalla[3], Michael Hetterich[1]. *[1]Institute of Applied Physics, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, [2]Laboratory for Electron Microscopy, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, [3]Light Technology Institute, KIT, and Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Stuttgart, Germany.*

(136-D8) **Defects in Cu2ZnSn(S,Se)4 solar cells investigated by Photoluminescence, Admittance and IVT.** Sergiu Levcenco[1], J Just[1], G Larramona[2], S Bourdais[2], G Dennler[2], T Unold[1]. *[1]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany, [2]IMRA Europe S.A., SSophia Antipolis, France.*

(137-D11) **The Importance of Selenium Partial Pressure in the Laser Annealing of CuInSe2 Precursors.** Helene J. Meadows[1], David Regesch[2], Sudhajit Misra[3], Brian J. Simonds[4], Mike A. Scarpulla[3,4], Viktor Gerliz[5], Levent Gütay[5], Phillip J. Dale[1]. *[1]Laboratory for Energy Materials, University of Luxembourg, Belvaux, Luxembourg, [2]Laboratory for Photovoltaics, University of Luxembourg, Belvaux, Luxembourg, [3]Electrical and Computer Engineering, University of Utah, Salt lake City, UT, USA, [4]Materials Science and Engineering, University of Utah, Salt lake City, UT, USA, [5]Laboratory for Chalcogenide Photovoltaics, University of Oldenburg, Oldenburg, Germany.*

(138-D14) **Flexible CZTS Solar Cells on Flexible Corning® Willow® Glass Substrates.** Chien-Yi Peng[1,2], Tara P. Dhakal[2,3], Pravakar Rajbhandari[2,3], Sean M. Garner[4], Patrick Cimo[4], Susan Lu[1], Charles R. Westgate[2,3]. *[1]Department of Systems Science and Industrial Engineering, Binghamton University, Binghatmon, NY, USA, [2]Center for Autonomous Solar Power (CASP), Binghamton University, Binghamton, NY, USA, [3]Department of Electrical and Computer Engineering, Binghamton University, Binghamton, NY, USA, [4]Corning Incorporated, Corning, NY, USA.*

(139-D17) **In-Situ Cu(In,Ga)Se2 Composition Control by Optical Emission Spectroscopy During Hybrid Co-Sputtering/Evaporation Process.** Jorge Posada[1], Marie Jubault[1], Angélique Bousquet[2], Eric Tomasella[2], Daniel Lincot[1]. *[1]Institute of Research & Development of the Photovoltaic Energy (IRDEP), EDF - CNRS - Chimie ParisTech UMR 7174, Chatou, France, [2]Institute of Chemistry of Clermont-Ferrand (ICCF), UMR CNRS 6926 – Université Blaise Pascal, Aubière, France.*

(140-D20) **High VOC Cu2ZnSnSe4/CdS:Cu based solar cell: evidences of a Metal-Insulator-Semiconductor (MIS) type hetero-junction.** Yudania Sánchez[1], Markus Neuschitzer[1], Mirjana Dimitrievska[1], Moisés Espíndola-Rodríguez[1], Juan López-García[1], Víctor Izquierdo-Roca[1], Osvaldo Vigil-Galán[2], Edgardo Saucedo[1]. *[1]Catalonia Institute for Energy Research, Sant Adrià del Besòs-Barcelona, Spain, [2]Escuela Superior de Física y Matemáticas-Instituto Politécnico Nacional (IPN), México DF, Mexico.*

(141-D23) **Transparent Back Contacts for Superstrate (Ag,Cu)(In,Ga)Se2 Thin Film Solar Cells.** Hamed Simchi[1,2], Jes Larsen[1], William Shafarman[1,2]. *[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]Department of Materials Science and Engineering, University of Delaware, Newark, DE, USA.*

(142-D26) **Experimental and Theoretical Study on Band Gap Tuning of Cu2ZnSn(S1-xSex)4 Absorbers for Thin-Film Solar Cells.** Weiwei Sun[1], Xiumei Geng[1], Johnathan C. Armstrong[1], Jingbiao Cui[2], Tar-pin Chen[1]. *[1]Arkansas GREEN Research Center for Solar Cells, Department of Physics and Astronomy, University of Arkansas at Little Rock, Little Rock, AR, USA, [2]Department of Physics, University of Memphis, Memphis, TN, USA.*

(143-D29) **Impact of Mo density on Mo/CIGSe interfaces : an XPS study.** HAREL sylvie, TOMASSINI Mathieu, ARZEL Ludovic, GAUTRON Eric, BARREAU Nicolas. *IMN - Université de Nantes, Nantes, France.*

(144-D32) **Improvement of the open-circuit voltage of Cu2ZnSnS4 cells using a two-layered process.** Shin Tajima, Tadayoshi Itoh, Hirofumi Hazama, Keiichiro Ohishi, Ryoji Asahi. *Toyota Central R&D Labs., Inc., Nagakute, Japan.*

(145-E3) **On the Impact of Defects in Solar Modules and the Interaction between Monolithically Interconnected Cells.** Thi Minh Hang Tran, Bart Elger Pieters, Andreas Gerber, Uwe Rau. *Forschungszentrum Jülich GmbH, Jülich, Germany.*

(146-E6) **Combinatorial Study of Co-sputtered Cu2ZnSnS4 Thin-film Stoichiometry for Photovoltaic Devices.** Matteo Valentini[1,2], Claudia Malerba[1,3], Enrico Salza[1], Marta de Luca [2], Mario Capizzi[2], Alberto Mittiga[1]. *[1]ENEA, Roma, Italy, [2]Sapienza University of Rome, Roma, Italy, [3]University of Trento, Trento, Italy.*

(147-E9) **Sputtered Zinc Selenide buffer layers for Cu(InGa)Se2 Substrate and Superstrate Solar Cells.** Peipei Xin, Christopher P. Thompson, Jes K. Larsen, William N. Shafarman. *Institute of Energy Conversion, University of Delaware, Newark, DE, USA.*

(148-E12) **Effects of Spin Speed on the Properties of sulfurized Cu2ZnSnS4 Thin Films Deposited by Spin Coating Using DMSO-based Precursors.** Yue Yu, Jie Ge, Tejas Prabhakar, Yanfa Yan. *University of Toledo, Toledo, OH, USA.*

(149-E15) **Drive-Level Capacitance Profiling of Cu(In,Ga) Se_2 Solar Cells for Different Cu/III Ratios.** Geordie Zapalac, Korhan Demirkan, Neil Mackie. *MiaSole Hi-Tech Corp, Santa Clara, CA, USA.*

Area 3 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

III-V Epitaxy and Solar Cells

Chair(s): Ryan France, Philip Chiu

(150-E19) **Numerical Simulation of Temperature Dependent Performance of InP-based Tunnel Junctions.** Chaffra A. Affouda[1], Matthew P. Lumb[1,2], Maria Gonzalez[1,3], Michael K. Yakes[1], Christopher G. Bailey[1], Robert J. Walters[1]. *[1]Naval Research Laboratory, Washington, DC, USA, [2]The George Washington University, Washington, DC, USA, [3]Sotera Defense Solutions, Annapolis Junction, MD, USA.*

(151-E22) **Homojunction GaAs Solar Cells Grown by Close Space Vapor Transport.** Jason W. Boucher, Andrew J. Ritenour, Ann L. Greenaway, Shannon W. Boettcher. *University of Oregon, Eugene, OR, USA.*

(152-E25) **Growth, Characterization and Analysis of Record Performance High Band Gap Tunnel Junctions for Multijunction Solar Cells.** C Zachary Carlin, John R Hauser, Jeff L Harmon, Geoff K Bradshaw, Joshua P Samberg, Peter C Colter, Salah M Bedair. *North Carolina State University, Raleigh, NC, USA.*

(153-E28) **Optimization Tool for Multijunction Photovoltaic Systems.** Kevon C Charles, John R wilcox, Jeffery L Gray. *Purdue University, West Lafayette, IN, USA.*

(154-E31) **Power maximization in III-V sub-millimeter, radial front contacted cells for thin micro-concentrators.** Jose L. Cruz-Campa, Anna Tauke-Pedretti, Jeffery G. Cederberg, Carlos A. Sanchez, Gerald R. Girard, Charles Alford, Brandon A. Aguirre, Ian E. Addington-Luna, Murat Okandan, Jeffrey S. Nelson, Gregory N. Nielson. *Sandia National Laboratories, Albuquerque, NM, USA.*

(155-F2) **Modeling and Simulation of InAs/GaAs Quantum Dot Solar Cells in SILVACO TCAD.** Boqun Dong[1], Christopher G. Bailey[2], Andrei Afanasev[3], Mona E. Zaghloul[1]. *[1]The George Washington University, Washington, DC, USA, [2]Naval Research Lab, Washington, DC, USA, [3]The George Washington University, Washington, DC, USA.*

(156-F5) **Optimization of Multijunction Solar Cells Through Indoor Energy Yield Measurements.** Iván Garcia[1,2], Myles A. Steiner[1], William E. McMahon[1], John F. Geisz[1], Aron Habte[1], Daniel J. Friedman[1]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Instituto de Energía Solar - U.P.M., Madrid, Spain.*

(157-F8) **Study on 2.05 eV Al0.13GaInP sub-cell and its hetero-structure cell.** Xinyi Li, Wei Zhang, Dayong Zho, Hongbo Lu. *Shanghai Institute of Space Power-source, Shanghai, China.*

(158-F10) **Decreasing Dark Current in Long Wavelength InAs/GaSb Thermophotovoltaics via Bandgap Engineering.** Abigail S. Licht[1], Dante DeMeo[1], J. B. Rodriguez[2], Thomas E. Vandervelde[1]. *[1]Tufts University, Medford, MA, USA, [2]University of Montpellier II, Montpellier, France.*

(159-F12) **Characterization and Analysis of Ultra-thin GaAs Single-Junction Solar Cells with Reflective Back Scattering.** Shi Liu, Weiquan Yang, Jacob J Becker, Ying-Shen Kuo, Yong-Hang Zhang. *Center for Photonics Innovation and School of Electrical, Computer, and Energy Engineering, Arizona State University, Tempe, AZ, USA.*

(160-F14) **Development of InGaAs Solar Cells for >44% Efficient Transfer-Printed Multi-junctions.** Matthew P Lumb[1,2], Matthew Meitl[3], John Wilson[3], Salvatore Bonafede[3], Scott Burroughs[3], David V Forbes[4], Christopher G Bailey[2], Nichole M Hoven[4], Maria Gonzalez[2,5], Michael K Yakes[2], Stephen J Polly[4], Seth M Hubbard[4], Robert J Walters[2]. *[1]The George Washington University, Washington, DC, USA, [2]Naval Research Laboratory, Washington, DC, USA, [3]Semprius Inc., Durham, NC, USA, [4]Rochester Institute of Technology, Rochester, NY, USA, [5]Sotera Defense Solutions, Annapolis Junction, MD, USA.*

(161-F16) **Highly Efficient and Reliable Mechanically Stacked Multi-Junction Solar Cells Using Advanced Bonding Method with Conductive Nanoparticle Alignments.** Kikuo Makita, Hidenori Mizuno, Ryuji Oshima, Takeyoshi Sugaya, Hironori Komaki, Koji Matsubara. *National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan.*

(162-F18) **Defect Creation in Low Lattice-Mismatched Epitaxial Structures.** Aymeric Maros, Nikolai Faleev, Christiana Honsberg. *School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA.*

(163-F20) **Effect of substrate offcut angle on AlGaInP and GaInP solar cells grown by molecular beam epitaxy.** Taizo Masuda, Stephanie Tomasulo, Jordan R. Lang, Minjoo Larry Lee. *Yale University, New Haven, CT, USA.*

(164-F22) **GaAs solar cells for Indoor Light Harvesting.** Ian Mathews, Gerard Kelly, Paul J. King, Ronan Frizzell. *Bell Labs, Alcatel-Lucent, Dublin, Ireland.*

(165-F24) **Modeling and fabrication of GaAs solar cells with high dislocation tolerance.** Akhil Mehrotra, Wei Wang, Alex Freundlich. *University of Houston, Houston, TX, USA.*

(166-F26) **Concentrating Photovoltaic Properties of GaInNAsSb/Ge Dual Junction Tandem Solar Cell.** Naoya Miyashita, Nazmul Ahsan, Yoshitaka Okada. *The University of Tokyo, Tokyo, Japan.*

(167-F28) **Development of ZnO-InP Heterojunction Solar Cells for Thin Film Photovoltaics.** Kyle H. Montgomery[1], Qiong Nian[2], Xin Zhao[1], Haoyu U. Li[3], Gary J. Cheng[2], Thomas N. Jackson[3], Jerry M. Woodall[1]. *[1]University of California, Davis, CA, USA, [2]Purdue University, West Lafayette, IN, USA, [3]The Pennsylvania State University, University Park, PA, USA.*

(168-F30) **Selfconsistent Model of Photoconversion Efficiency for Multijunction Solar Cells.** Anatoliy V. Sachenko[1], Anatoli I. Shkrebtii[2], Vitaliy P. Kostylyov[1], Mykola R. Kulish[1], Igor O. Sokolovskyi[1]. *[1]V. Lashkaryov Institute of Semiconductor Physics, NAS of Ukraine, Kyiv, Ukrenia, [2]University of Ontario Institute of Technology, Oshawa, ON, Canada.*

(169-F32) **Hybrid Triple-Junction Solar Cells by Surface Activate Bonding of III-V Double-Junction-Cell Heterostructures to Ion-Implantation-Based Si Cells.** Naoteru Shigekawa[1], Li Chai[1], Masashi Morimoto[1], Jianbo Liang[1], Ryusuke Onitsuka[2], Takaaki Agui[2], Hiroyuki Juso[2], Tatsuya Takamoto[2]. *[1]Osaka City University, Osaka, Japan, [2]Sharp Corporation, Yamatokoriyama, Japan.*

(170-F33) **Low Cost III-V Solar Cells Grown by Hydride Vapor Phase Epitaxy.** John Simon, David Young, Aaron Ptak. *NREL, Golden, CO, USA.*

(171-F34) **MBE-grown InGaP/GaAs/InGaAsP triple junction solar cells fabricated by advanced bonding technique.** Takeyoshi Sugaya[1], Kikuo Makita[1], Hidenori Mizuno[1], Akihiro Takeda[2], Toru Mochizuki[2], Ryuji Oshima[1], Koji Matsubara[1], Yoshinobu Okano[2], Shigeru Niki[1]. *[1]AIST, Tsukuba, Japan, [2]Tokyo City University, Tokyo, Japan.*

(172-F35) **Bonded InGaAs Cells for Microsystems Enabled Photovoltaics.** Anna M Tauke-Pedretti, Jeffrey G Cederberg, Charles Alford, Jose L Cruz-Campa, Carlos A Sanchez, Ian Luna, Jeffrey S Nelson, Gregory N Nielson. *Sandia National Laboratories, Albuquerque, NM, USA.*

(173-F36) **GaNAsSb 1-eV Solar Cells For Use in Lattice-Matched Multi-Junction Architectures.** Tomos Thomas[1], Markus Führer[1], Ned Ekins-Daukes[1], Kian Hua Tan[2], Satrio Wicaksono[2], Wan Khai Loke[2], Soon Fatt Yoon[2], Andrew Johnson[3]. *[1]Imperial College London, London, UK, [2]Nanyang Technological University, Singapore, Singapore, [3]IQE plc, Cardiff, UK.*

(174-F37) **Advancement in the MOVPE technology to increase the process yield and expand the band gap engineering possibilities.** Gianluca Timo'[1], Nicola Armani[1], Giovanni Abagnale[1], Bernd Schineller[2]. *[1]RSE, Piacenza, Italy, [2]RSE, Piacenza, Italy, [3]RSE, Piacenza, Italy, [4]AIXTRON, Herzogenrath, Germany.*

(175-F38) **Development of the Monolithically Interconnected InGaP/GaAs Dual Junction Solar Cell with Bypass Diode for Ultrahigh Concentrator Application.** Kentaroh Watanabe[1], Minato Seno[2], Masakazu Sugiyama[2], Yoshiaki Nakano[2]. *[1]Research Center for Advanced Science and Technology, University of Tokyo, Tokyo, Japan, [2]Department of Electrical Engineering and Information Systems, University of Tokyo, Tokyo, Japan.*

Area 4 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Surface Passivation I

Chair(s): Oliver Schultz-Wittmann, Benedicte Demaurex, Laura Ding

(176-F39) **Reactive Ion Etched Black Silicon Texturing: A Comparative Study.** Thomas G. Allen[1], James Bullock[1], Andres Cuevas[1], Simeon C. Baker-Finch[1,2], Fouad Karouta[3]. *[1]Research School of Engineering, College of Engineering and Computer Science, Australian National University, Canberra, Australia, [2]PV Lighthouse, Coledale, Australia, [3]ANFF, Research School of Physics and Engineering, Australian National University, Canberra, Australia.*

(177-G3) **AlOx Passivation Of Ion Implanted B Emitters Using Batch ALD Process.** Vikram M Bhosle[1], Mac Hathaway[2], Christopher E Dube[1]. *[1]Applied Materials, Varian Semiconductor Equipment, Gloucester, MA, USA, [2]Center for Nanoscale Systems, Harvard University, Cambridge, MA, USA.*

(178-G7) **Controlled Field Effect Surface Passivation of Crystalline N-Type Silicon and its Application to Back-Contact Silicon Solar Cells.** Ruy S Bonilla[1], Christian Reichel[2], Martin Hermle[2], Semih Senkader[1], Peter Wilshaw[1]. *[1]Department of Materials, University of Oxford, Oxford, UK, [2]Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany.*

(179-G11) **High VOC on Thin Silicon Solar Cells.** Stuart Bowden, Stanislau Y Herasimenka, William J Dauksher, Clarence J Tracy, Christiana B Honsberg. *Arizona State University, Temp, AZ, USA.*

(180-G15) **Study of the passivation mechanism of c-Si by Al2O3 using in situ infrared spectroscopy.** Rohan P Chaukulkar[1], William Nemeth[2], Arrelaine Dameron[2], Paul Stradins[2], Sumit Agarwal[1]. *[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(181-G19) **Anodic Aluminium Oxide Rear Passivated Laser-Doped Selective-Emitter Solar Cells.** Jie Cui, Xi Wang, Dong Lin, Pei Hsuan Lu, Alison J Lennon. *School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney, Australia.*

(182-G23) **The role of back contact patterning on stability and performance of Si IBC heterojunction solar cells.** Ujjwal K. Das, Hsiang-Yu Liu, Jianbo He, Steven Hegedus. *Institute of Energy Conversion, University of Delaware, Newark, DE, USA.*

(183-G27) **Optical Properties of Screen-Printed Aluminum Contacts.** Kristopher O Davis[1,2,3], Jianing Sun[4], Kaiyun Jiang[5], Winston V Schoenfeld[1,2,3]. *[1]Florida Solar Energy Center, University of Central Florida, Cocoa, FL, USA, [2]CREOL, College of Optics and Photonics, University of Central Florida, Orlando, FL, USA, [3]c-Si Division, U.S. Photovoltaic Manufacturing Consortium, Orlando, FL, USA, [4]J.A. Woollam Co., Inc., Lincoln, NE, USA, [5]Gebr. Schmid GmbH & Co., Freudenstadt, Germany.*

(184-G31) **Conventionally-Processed Silicon Nanowire Solar Cells Demonstrating Efficiency Improvement Over Standard Cells.** Michael P. Jura[1], Jeff B. Miller[1], Joanne W. L. Yim[1], Joanne Forziati[1], Brian Murphy[1], Richard Chleboski[1], Ian B. Cooper[2], Ajeet Rohatgi[2], Marcie R. Black[1]. *[1]Bandgap Engineering, Salem, NH, USA, [2]University Center of Excellence for Photovoltaics Research and Education, Georgia Institute of Technology, Atlanta, GA, USA.*

(185-G35) **Study on Surface Passivation by YZO/AlOx Stacking Double Layer for Crystalline Si Solar Cells.** Takaaki Katsumata[1,2,4], Norihiro Ikeno[1], Shin-inchi Satoh[3,4], Haruhiko Yoshida[3,4], Koji Arafune[3,4], Toyohiro Chikyow[2,4], Atsushi Ogura[1,4]. *[1]Meiji university, Tama-ku, Kawasaki, Kanagawa, Japan, [2]NIMS, Tsukuba, Ibaraki, Japan, [3]University of Hyogo, Himeji, Hyogo, Japan, [4]JST-CREST, Kawaguchi, Saitama, Japan.*

(186-G39) **Optimizing Inverted Pyramidal Grating Texture for Maximum Photoabsorption in Thick to Thin Crystalline Silicon Photovoltaics.** K. Kumar, A. Khalatpour, E.G. Liu, J. Nogami, P.R. Herman, N.P. Kherani. *University of Toronto, Toronto, ON, Canada.*

(187-H3) **Al2O3 Surface Passivation of Silicon Solar Cells by Low Cost ALD Technology.** Vladimir Kuznetsov[1], Marius Ernst[2], Ernst Granneman [3]. *[1]Levitech BV, Almere, Netherlands, [2]Levitech BV, Almere, Netherlands, [3]Levitech BV, Almere, Netherlands.*

(188-H7) **Heterojunction Rear Passivated Contact for High Efficiency n-Cz Si Solar Cells.** Benjamin G Lee, William Nemeth, Hao-Chih Yuan, David L Young, Paul Stradins. *National Renewable Energy Lab, Golden, CO, USA.*

(189-H11) **Effect of Post Deposition Annealing of Printed AlOx Film on PERC Solar Cells.** Yung-Sheng Lin[1], Jui-Yi Hung[2], Tsung-Cheng Chen[1], Chen-Hao Ku[1], Jung-Ching Wang[3], Shian-Wen Chen[3]. *[1]E-ton Solar Tech, Tainan, Taiwan, [2]New E Materials, Kaohsiung, Taiwan, [3]Eternal Chemical, Kaohsiung, Taiwan.*

(190-H15) **Stored Charge Properties of Anodic Aluminium Oxide on Silicon Substrate.** Zhong Lu[1], Pei Hsuan Lu[1], Ziv Hameiri[2], Kai Wang[1], Jie Cui[1], Yang Li[1], Alison Lennon[1]. *[1]The School of Photovoltaics and Renewable Energy Engineering, The University of New South Wales, Sydney NSW, Australia, [2]Solar Energy Research Institute of Singapore, National University of Singapore, Singapore, Singapore.*

(192-H23) **Double-scale texturing for light trapping in Thin Film Crystalline Silicon Solar Cells.** Xianqin Meng[1,2,4,*], Emmanuel Drouard[1,2], Guillaume Gomard[1,2,5], Valérie Depauw[3], Rafael Kleiman[4], Christian Seassal[1,2]. *[1]Institut des Nanotechnologies de Lyon (INL), Ecole Centrale de Lyon, Lyon, France, [2]Institut des Nanotechnologies de Lyon (INL), INSA de Lyon, Lyon, France, [3]Imec, Leuven, Belgium, [4]Engineering Physics, McMaster University, Hamilton, ON, Canada, [5]Light Technology Institute (LTI), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany.*

(193-H27) **Inductively coupled plasma deposited amorphous silicon alloys using industrial equipment for heterojunction silicon solar cells.** Thomas Mueller[1], Jia Ge[1], Muzhi Tang[1], Johnson Wong[1], Zhi Peng Ling[1], Zhenhao Zhang[2], Manfred Doerr[2], Torsten Dippell[2], Oliver Hohn[2], Marco Huber[2], Peter Wohlfart[2]. *[1]Solar Energy Research Institute of Singapore (SERIS), Singapore, Singapore, [2]Singulus Technologies AG, Kahl am Main, Germany.*

(194-H31) **Dielectric Stack Passivation and Optimization on N-Type Diffused Surfaces.** Bill Nemeth[1], Hao-Chih Yuan[1], Matt Page[1], Vincenzo LaSalvia[1], Rohan Chaulkulkar[2], Lynn Gedvillas[1], Jian Li[1], Robert White[1], Paul Stradins[1]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado School of Mines, Golden, CO, USA.*

(195-H35) **p+ Emitters on n-Type c-Si dry-etched with nitrogen trifluoride and passivated with ALD aluminum oxide.** Tim Reblitz, Clarence Tracy, Bill Dauksher, Stuart Bowden. *Arizona State University, Tempe, AZ, USA.*

(196-H39) **Improved Cleaning Process for Post-Texture Surface Contamination Removal for Single Heterojunction Solar Cells on ~25µm Thick Exfoliated and Flexible Mono-crystalline Silicon Substrates.** Sayan Saha[1], Emmanuel U Onyegam[1], Sushant S Sonde[1], Mohamed M Hilali[1], Dharmesh Jawarani[2], Rajesh A Rao[3], Leo Mathew[3], Ajay Upadhyaya[4], Sanjay K Banerjee[1]. *[1]University of Texas - Austin, Austin, TX, USA, [2]AstroWatt, Inc., Austin, TX, USA, [3]Applied Novel devices, Austin, TX, USA, [4]Georgia Institute of Technology, Atlanta, TX, USA.*

(197-I3) **Growth of Graded SixNy ARC for High Efficiency and Lower Cell-to-Module Power Loss in Multi-crystalline Silicon Solar Cells in a High Volume In-Line Production.** Virender Sharma[1,2], D.N Singh[1], Abhishek Verma[2], R.B Gupta[1], V.K Jain[2], C.M Kumar[1]. *[1]INDOSOLAR LTD, Greater Noida, India, [2]Amity University, Noida, India.*

(198-I7) **Micro-concentrated Silicon Heterojunction Solar Cell: PC2D Device Simulation for Harvesting Infrared Light.** Jianwei Shi, Zachary Holman. *Arizona State University, Tempe, AZ, USA.*

(199-I11) **Apparent doping-dependence of the a-Si:H/c-Si interface degradation upon ITO sputtering.** Igor P SOBKOWICZ[1,2], Antoine SALOMON[1], Pere ROCA i CABARROCAS[2]. *[1]TOTAL New Energies,, Paris La Défense, France, [2]LPICM CNRS Ecole Polytechnique, Palaiseau, France.*

(200-I15) **Some Challenges in Making Accurate and Reproducible Measurements of Minority Carrier Lifetime in High-Quality Si Wafers.** Bhushan Sopori[1], Srinivas Devayajanam[1,2], Prakash Basnyat[1,2], Vishal Mehta[1,2], Helio Moutinho[1], William Nemeth[1], Vencenzo LaSalvia[1], Steven Johnson[1], NM Ravindra[2], Jeff Binns[3], Jesse Appel[4]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]New Jersey Institute of Technology, Newark, NJ, USA, [3]Sun Edison, StPeters, MT, USA, [4]Sun Edison, Portland, OR, USA.*

Area 8 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Characterization I

Chair(s): Mowafak Al-Jassim, Rebekah Feist, Keith Emery

(201-K29) **Measuring Refractive Index Profiles within Thin-Film Photovoltaics with High Spatial Resolution using the Modified IM-IWKB Method.** Yutong T Pang[1,2], Matthew D Eisaman[1,2]. *[1]Brookhaven National Laboratory, Upton, NY, USA, [2]Department of Physics and Astronomy, Stony Brook University, Stony Brook, NY, USA.*

(202-K32) **InGaAs/GaAs MQWs: Correlation of crystal and physical properties.** Matthias M. Karow[1], Nikolai N. Faleev[1], David J. Smith[2], Christiana B. Honsberg[1]. *[1]Solar Power Laboratory, Ira A. Fulton Schools of Engineering, Arizona State University, Tempe, AZ, USA, [2]Department of Physics, Arizona State University, Tempe, AZ, USA.*

(203-K35) **Investigation on the effects of phosphine doping in Si nanocrystal material.** Lingfeng Wu, Ivan Perez-Wurfl, Ziyun Lin, Xuguang Jia, Tian Zhang, Binesh Puthen-Veettil, Terry Chien-Jen Yang, Hongze Xia, Gavin Conibeer. *University of New South Wales, Sydney, Australia.*

(204-K38) **Selective Passivation of Nitrogen Clusters and Impurities in GaInNAs Solar Cells.** M Fukuda[1], V. R. Whiteside[1], J. C. Keay[1], M. B. Johnson[1], M. Leroux[2], M. Al Khalfioui[2], K. Hossain[3], T. D. Golding[3], I. R. Sellers[1]. *[1]Department of Physics, University of Oklahoma, Norman, OK, USA, [2]CRHEA-CNRS, Valbonne, France, [3]Amethyst Research Inc., Ardmore, OK, USA.*

(205-L1) **Mapping Spectroscopic Ellipsometry of CdTe Solar Cell Processes: Optimization of Cu Incorporation for Different CdS/CdTe Thicknesses.** Prakash Koirala[1], Xinxuan Tan[1], Jian Li[1], Nikolas J Podraza[1], Sylvain Marsillac[2], Angus A Rockett[3], Robert W Collins[1]. *[1]The University of Toledo, Toledo, OH, USA, [2]Old Dominion University, Norfolk, VA, USA, [3]University of Illinois Urbana-Champaign, Urbana, IL, USA.*

(206-L4) **Application of Non-contact Corona-Kelvin Metrology for Characterization of PV Dielectrics on Textured Surfaces.** Marshall Wilson[1], Ziv Hameri[2], Naomi Nandakumar[2,3], Shubham Duttagupta[2,3]. *[1]Semilab SDI LLC, Tampa, FL, USA, [2]Solar Energy Research Institute of Singapore, Singapore, Singapore, [3]Department of Electrical and Computer Engineering, National University of Singapore, Singapore, Singapore.*

(207-L7) **Electrical Characterization of Interface Recombination and its Dependence on Band Offset, Barrier Height, and Inversion in Certain Heterojunction Solar Cells.** Jian V. Li, Sachit Grover, Ingrid L. Repins, Brian M. Keyes, Miguel A. Contreras, Kannan Ramanathan, Rommel Noufi. *National Renewable Energy Lab, Golden, CO, USA.*

(208-L10) **High-quality Cu(InGa)Se2 Crystalline Thin Film by Two-step Selenization.** JINXIN HE, SEN ZHANG, DONG WANG. *PEKING UNIVERSITY, BEIJING, China.*

(209-L13) **Assessing Local Voltage in CIGS Solar Cells by Nanoscale Resolved Kelvin Probe Force Microscopy and Sub-Micron Photoluminescence.** Elizabeth Tenysson[1,2], Joe Garrett[2,3], Chen Gong[1,2], Jesse Frantz[4], Jason Myers[4], Robel Bekele[4], Jas Sanghera[5], Jeremy Munday[2,6], Marina Leite[1,2]. *[1]1Department of Materials Science and Engineering, UMD, College Park, MD, USA, [2]Institute for Research in Electronics and Applied Physics, UMD, College Park, MD, USA, [3]Department of Physics, UMD, College Park, MD, USA, [4]U. S. Naval Research Laboratory, Washington, DC, USA, [5]University Research Foundation, Greenbelt, MD, USA, [6]Department of Electrical and Computer Engineering, UMD, College Park, MD, USA.*

(210-L16) **Direct imaging of quasi Fermi level splitting in photovoltaic absorbers.** Laurent Lombez, Myriam Paire, Amaury Delamarre, Gilbert ElHajje, Pierre Rale, Jean Rodière, Daniel Ory, Jean-François Guillemoles. *IRDEP, Institute of R&D on Photovoltaic Energy, UMR 7174, CNRS-EDF-Chimie ParisTech 6 Quai Watier-BP 49, 78401, Chatou, France.*

(211-L19) **EMIL: The Energy Materials In-Situ Laboratory Berlin.** Klaus Lips[1], David E. Starr[1], Marcus Bär[1,2], Tim F. Schulze[1], Bernd Rech[1], Silke Christiansen[1], Roel van de krol[1], Simone Raoux[1], Gerd Reichardt[1], Franz Schäfers[1], Stefan Hendel[1], Rolf Follath[1,3], Johannes Bahrdt[1], Axel Knop-Gericke[1], Michael Hävecker[1], Robert Schlögl[1]. *[1]Helmholtz-Zentrum Berlin für Materalien und Energie, Berlin, Germany, [2]Inst. f. Physik und Chemie, Brandenburgische TU Cottbus-Senftenberg, Cottbus, Germany, [3]Paul-Scherrer Institut, Villingen, Switzerland, [4]Inorganic Chemistry Department, Fritz-Haber-Institute of the Max-Planck-Society, Berlin, Germany.*

(212-L22) **Cadmium Chloride Assisted Re-Crystallization of CdTe: The effect of annealing over-treatment.** Ali Abbas[1], Geoff D West[1], Jake W Bowers[1], Piotr M Kaminski[1], Biancamaria Maniscalco[1], Kurt L Barth[2], W.S. Sampath[2], John M Walls[1]. *[1]Loughborough University, Loughborough, UK, [2]Colorado State University, Fort Collins, CO, USA.*

(213-L25) **Correlation of Dynamical, Vibrational and Optical Properties in c-Si with Bond-Centered-Hydrogen and Other Hydrogen Complexes.** Zahraa A. Ibrahim, Anatoli I. Shkrebtii, Frederick Zimmer-De Iuliis, Franco Gaspari. *Faculty of Science, University of Ontario Institute of Technology, Oshawa, ON, Canada.*

(214-L28) **Experimental Study on the Role of Parameters Affecting Surface Recombination and Emitter Passivation.** Marshall Wilson, Andrew Findlay, John D'Amico, Alexandre Savtchouk, Jacek Lagowski. *Semilab SDI LLC, Tampa, FL, USA.*

(215-L31) **Bulk Defect Generation during B-Diffusion and Oxidation of CZ Wafers: Mechanism for Degrading Solar Cell Performance.** Bhushan Sopori[1], Hao-Chih Yuan[1], Srinivas Devayajanam[1,2], Prakash Basnyat[1,2], Vincenzo LaSalvia[1], Andrea Norman[1], Mathew Page[1], William Nemeth[1], Pauls Stradins[1]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]New Jersey Institute of Technology, Newark, NJ, USA.*

(216-M2) **Epitaxial Growth: Model of Crystal Defect Creation.** Nikolai N Faleev, David J. Smith, Christiana B. Honsberg.

(217-M5) **Solar Wafer Emitter Measurement by Infrared Reflectometry for Process Control: Implementation and Results.** Gordon Deans[1], Steven McDonald[1], Carsten Baer[2], Kenneth Cadien[3]. *[1]Aurora Control Technologies Inc., North Vancouver, BC, Canada, [2]Hanwha Q CELLS GmbH, Bitterfeld-Wolfen, Germany, [3]University of Alberta, Dept. of Chemical and Materials Engineering, Edmonton, AB, Canada.*

(218-M8) **Temperature Dependence of Equivalent Circuit Parameters Used to Analyze Admittance Spectroscopy and Application to Cases of Dopant Freezeout Such as CZTSSe.** A. E. Caruso[1], D.S. Pruzan[2], V. Kosyak[2], A. Bhatia[2], E. A. Lund[1,3], C. Beall[4], I. Repins[4], M. A. Scarpulla[1,2]. *[1]Electical and Computer Engineering, University of Utah, Salt Lake City, UT, USA, [2]Materials Science and Engineering, University of Utah, Salt Lake City, UT, USA, [3]Chemical Engineering, University of Utah, Salt Lake City, UT, USA, [4]National Renewable Energy Laboratory, Golden, CO, USA.*

(219-M11) **Contactless Optical and Electrical Characterization of Si Wafers Using Hg Probes.** Harold J. Hovel. *IBM Corporation, Yorktown Hts, NY, USA.*

(220-M14) **Evaluation of Lights Soaking in Hydrogenated Polymorphous Silicon Solar Cells Structures.** Leon Hamui[1], Betsabee M. Monroy[1], Pere Roca i Cabarrocas[2], Guillermo Santana[1]. *[1]IIM, UNAM, Mexico, Mexico, [2]LPICM, Ecole polytechnique, Palaiseau, France.*

Area 10 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Performance Modeling and Validation 1

Chair(s): Lauren Ngan, Dirk Jordan, Jessica Forbess

(221-N15) **Estimating the performance of product integrated photovoltaic (PIPV) cells under indoor conditions for the support of design processes.** Georgia Apostolou[1], Martin Verwaal[1], Angele H.M.E. Reinders[1,2]. *[1]Design for Sustainability, Faculty of Industrial Design Engineering Delft University of Technology, Delft, Netherlands, [2]Department of Design, Production and Management,Faculty of Engineering Technology University of Twente, Enschede, Netherlands.*

(222-N19) **Modeling and Comparative Analysis of Jet Impingement Cooling and Conventional Channel Cooling for Photovoltaic Strings.** Haitham M.S. Bahaidarah[1], Ahmer A.B. Baloch[2], Palanichamy Gandhidasan[2]. *[1]Center of Research Excellence in Renewable Energy,King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, [2]Mechanical Engineering Department,King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.*

(223-N23) **Clear sky models performance quantification for PV production forecast over Non-Interconnected Territories.** Sylvain Cros[1], Jean-Baptiste Gadan[1], Cyril Voyant[2], Nicolas Schmutz[1]. *[1]Reuniwatt, Sainte-Clotilde, France, [2]University of Corsica, Ajaccio, France.*

(224-N27) **Inter-system time lag due to clouds in an urban PV ensemble.** Boudewijn Elsinga, Wilfried G. J. H. M. Van Sark. *Copernicus Institute of Sustainable Development, Utrecht, Netherlands.*

(225-N31) **CPV Field Performance Modeling using Semprius' System Performance Model (SPM).** Brent R. Fisher[1], Kanchan Ghosal[1], Dan Riley[2], Cliff Hansen[2], Bruce King[2], Scott Burroughs[1]. *[1]Semprius, Inc., Durham, NC, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA.*

(226-N35) **Economic Potential for Thermophotovoltaic Electric Power Generation in the Steel Industry.** Lewis M Fraas. *JX Crystals Inc, Issaquah, WA, USA.*

(227-N39) **Evaluation of a CdTe Spectrally Matched c-Si PV Reference Cell for Outdoor Applications.** Michael Gostein[1], J. Riley Caron[2], Bodo Littmann[2]. *[1]Atonometrics, Austin, TX, USA, [2]First Solar, San Francisco, CA, USA.*

(228-N43) **The Effect of Building Integration on the Temperature and Performance of Photovoltaic Panels – A UK perspective.** Airlangga Gunawan[1], KT Tan[2], Stuart Elmes[2], Pritesh Hiralal[1], Gehan Amaratunga[1]. *[1]University of Cambridge, Cambridge, UK, [2]Viridian Solar, Cambridge, UK.*

(229-N47) **A simple hybrid MPPT technique for photovoltaic systems under rapidly changing partial shading conditions.** Lianlian Jiang, Douglas L Maskell. *Nanyang Technological University, Singapore, Singapore.*

(230-O3) **Bifacial PV Module Installations: Design Factors and Performance Prediction.** Lev Kreinin[1], Asher Karsenty[1], Dov Grobgeld[1], Nelly Bordin[1], Naftali Eisenberg[1]. *[1]b-Solar, Jerusalem, Israel*

(231-O7) **Development of An Irradiance Sensor Network to Model Photovoltaic Plant-Average Irradiance Time Series.** Houtan Moaveni, David K. Click, Anthony Pappalardo. *University of Central Florida, Florida Solar Energy Center, Cocoa, FL, USA.*

(232-O11) **Simulation of the impact of moving clouds on large scale PV-plants.** Kasper M. Paasch[1], Morten Nymand[1], Søren B. Kjær[2]. *[1]University of Southern Denmark, Odense, Denmark, [2]Danfoss Solar Inverters A/S, Nordborg, Denmark.*

(233-O15) **Image Aided Dynamic Reconfiguration of SPV Array under Non-Uniform Illumination.** Bhawani Patnaik[1], Aswani Uppada[1], Gargi Sarkar[2], Siddhartha P Duttagupta[1]. *[1]IIT Bombay, Mumbai, India, [2]MPSTME, Mumbai, India.*

(234-O18) **An Estimation Method of Maximum Power Point for Solar Units in Series under Uneven Lighting Conditions.** Wang Yun Ping[1], Ruan Xin Bo[1], Li Ying[1]. *[1]Nanjing University of Aeronautics and Astronautics, Nanjing, China, [2]Nanjing University of Aeronautics and Astronautics, Nanjing, China, [3]Nanjing University of Aeronautics and Astronautics, Nanjing, China.*

(235-O21) **Validation of the MERRA Dataset for Solar PV Applications.** David B. Richardson[1], Robert W. Andrews[2]. *[1]University of Toronto, Toronto, ON, Canada, [2]Calama Consulting Inc., Toronto, ON, Canada.*

(236-O23) **1.6 Suns at 58°20'N – the Solar Resource in Southern Norway.** Georgi H. Yordanov[1], Tor Oskar Saetre[1], Ole-Morten Midtgård[2]. *[1]University of Agder (UiA), Grimstad, Norway, [2]Norwegian University of Science and Technology (NTNU), Trondheim, Norway.*

Joint Session: Areas 1,3,4,7 - Orals

1:30 - 3:00 PM **MR 505-507**

III-V on Silicon Materials

Chair(s): Thomas Hannappel, Tyler Grassman

1:30 **(237) Potential and Present Status of III-V/Si Tandem Solar Cells**
Masafumi Yamaguchi
Toyota Technological Institute, Nagoya, Japan

2:00 **(238) Dual-Junction GaAsP/SiGe on Silicon Tandem Solar Cells**
Martin B. Diaz[1], Li Wang[1], Andrew Gerger[2], Anthony Lochtefeld[2], Chris Ebert[3], Robert Opila[4], Ivan Perez-Wurfl[1], Allen Barnett[1]
[1]School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney, Australia, [2]AmberWave Inc., Salem, NH, United States, [3]Veeco MOCVD, Somerset, NJ, United States, [4]Department of Electrical Engineering, University of Delaware, Newark, DE, United States

2:15 **Best Student Presentation Award Finalist**
(239) Towards high efficiency GaAsxP1-x solar cells on (001) GaP/Si
Kevin Nay Yaung, Jordan R. Lang, Minjoo L. Lee
Yale University, New Haven, CT, United States

2:30 **(240) Results from Coupled Optical and Electrical Sentaurus TCAD Models of a Gallium Phosphide on Silicon Electron Carrier Selective Contact Solar Cell.**
Steven Limpert[1], Kunal Ghosh[2], Hannes Wagner[3], Stuart Bowden[2], Christiana Honsberg[2], Stephen Goodnick[2], Stephen Bremner[1], Anita Ho-Baillie[1], Martin Green[1]
[1]University of New South Wales School of Photovoltaic and Renewable Energy Engineering, Sydney, Australia, [2]Arizona State University School of Electrical, Computer and Energy Engineering, Tempe, AZ, United States, [3]Massachusetts Institute of Technology, Cambridge, MA, United States

2:45 **(241) Structural and Electrical Investigations of GaN-Si Interface for a Heterojunction Solar Cell**
Joshua J. Williams[1,2], April M. Jeffries[1], Mariana I. Bertoni[1], Todd L. Williamson[2], Stuart G. Bowden[1], Christiana B. Honsberg[1]
[1]Arizona State University, Tempe, AZ, United States, [2]Los Alamos National Laboratory, Los Alamos, NM, United States

Area 2 - Orals

1:30 - 3:00 PM **MR 502-504**

Kesterite 2

Chair(s): Ayodhya Tiwari, Glenn Teeter

1:30 **(242) Defect characterization in $Cu_2ZnSnSe_4$-CdS-ZnO solar cells**
Guy Brammmertz[1,2], Souhaib Oueslati[1,2,3,4], Marie Buffiere[5,6], Jonas Bekaert[7], Christine Koeble[8], Marc Meuris[1,2], Jef Poortmans[5,6]
[1]imec division IMOMEC - partner in Solliance, Diepenbeek, Belgium, [2]Institute for Material Research (IMO) Hasselt University, Diepenbeek, Belgium, [3]KACST-Intel Consortium Center of Excellence in Nano-manufacturing Applications (CENA), Riyadh, Saudi Arabia, [4]Department of Physics, Faculty of Sciences of Tunis, El Maner, Tunisia, [5]imec, Heverlee, Belgium, [6]Department of Electrical Engineering, KU Leuven, Heverlee, Belgium, [7]Condensed Matter Theory group, Department of Physics, University of Antwerp, Antwerp, Belgium, [8]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany

2:00 **(243) Vacuum-Free Preparation of $Cu_2ZnSn(S,Se)_4$ Solar Cells - Comparison Of $SnSe_2$ And Elemental Se As Se-Source**
Thomas Schnabel, Tobias Abzieher, Erik Ahlswede
Centre for Solar Energy and Hydrogen Research, Stuttgart, Germany

2:15 **(244) Efficiency Improvement of $Cu_2ZnSn(S,Se)_4$ Submodule with Graded Band Gap and Reduced Backside ZnS Segregation**
Takuya Kato[1,2], Noriyuki Sakai[1,2], Hiroki Sugimoto[1,2]
[1]Energy Solution Business Center, Showa Shell Sekiyu K.K., Atsugi, Kanagawa, Japan, [2]Atsugi Research Center, Solar Frontier K.K., Atsugi, Kanagawa, Japan

2:30 **(245) Impact of Cu Content in High Performance $Cu_2ZnSn(Se,S)_4$ Solar Cells**
Oki Gunawan, Wei Wang, Tayfun Gokmen, Teodor Todorov, David Mitzi
IBM T. J. Watson Research Center, Yorktown Heights, NY, USA

2:45 **(246) Photoelectron Spectroscopy, and Photovoltaic Device Study of $Cu_2ZnSnSe_4$ and ZnO_xS_{1-x} Buffer Layer Interface**
K. Xerxes Steirer, Rebekah Garris, Carolyn Beall, Ana Kanevce, Ingrid Repins, Glenn Teeter, Craig Perkins
National Renewable Energy Laboratory, Golden, CO, USA

Area 4 - Orals

1:30 - 3:00 PM **Ballroom 1EF**

n-Type Cells and Young Professional Award

Chair(s): Alison Lennon, Arthur Weeber

1:30 **(247) Development of High-Efficiency Crystalline Silicon Solar Cells: Choices, Choices, Choices. (Young Professional Award)**
Oliver Schultz-Wittmann
TetraSun / First Solar, Inc.

2:00 **(248) Building blocks for back-junction back-contacted cells and modules with ion-implanted poly-Si junctions**
Robby Peibst[1], Udo Römer[1], Yevgeniya Larionova[1], Henning Schulte-Huxel[1], Tobias Ohrdes[1], Michael Häberle[1], Bianca Lim[1], Daniel Stichenoth[2], Tobias Wütherich[2], Claus Schöllhorn[2], John Graff[3], Rolf Brendel[1]
[1]Institute for Solar Energy Research Hamelin, Emmerthal, Germany, [2]Bosch Solar Energy AG, Arnstadt, Germany, [3]Applied Materials/Varian Semiconductor Equipment Associates, Inc., Gloucester, MA, USA

2:30 **(249) Influence of the emitter coverage on interdigitated back contact (IBC) silicon heterojunction (Si-HJ) solar cells**
Thibaut Desrues, Sylvain de Vecchi, Guillaume d'Alonzo, Delfina Munoz, Pierre-Jean Ribeyron
CEA-INES, Le Bourget du Lac, France

2:45 **(250) Towards industrial advanced front-junction n-type silicon solar cells**
Yimao Wan[1], Chris Samundsett[1], Teng Kho[1], Josephine McKeon[1], Lachlan Black[1], Daniel Macdonald[1], Andres Cuevas[1], Jian Sheng[2], Yun Sheng[2], Shengzhao Yuan[2], Chun Zhang[2], Zhiqiang Feng[2], Pierre J. Verlinden[2]
[1]Research School of Engineering, The Australian National University, Canberra, Australia, [2]State Key Lab of PV Science and Technology, Trina Solar Limited, Changzhou, China,

Area 8 - Orals

1:30 - 3:00 PM **Ballroom 2A**

Luminescence Characterization Methods

Chair(s): Dean Levi, Andreas Bett

1:30 **(251) Harmonically Modulated Luminescence: Bridging Conceptual Gaps in Carrier Lifetime Metrology across the PV Production Chain**
Johannes A Giesecke, Martin C Schubert, Wilhelm Warta
Fraunhofer Institut für Solare Energiesysteme, Freiburg, Germany

1:45 **(252) Determining the Maximum Open Circuit Voltage from Absorber Photoluminescence in the Presence of Tail States**
John K. Katahara, Hugh W. Hillhouse
Department of Chemical Engineering, Seattle, WA, USA

2:00 **(253) Cathodoluminescence Study of Carrier Transport Across Grain Boundaries in CdTe**
Harvey L Guthrey[1], John Moseley[1,2], James Burst[1], Wyatt Metzger[1], Mowafak Al-Jassim[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado School of Mines, Golden, CO, USA

2:15 **(254) Dual Sensor Technique for the Advanced Characterization Of Recombination Parameters in Photovoltaic Materials**
Richard Ahrenkiel[1,2], Steve Johnston[2], Darius Kuciauskas[2], Jerry Tynan[2]
[1]Lakewood Semiconductors, Lakewood, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

2:30 **Best Student Presentation Award Finalist**
(255) Photovoltaic Material Characterization with Steady-State and Transient Photoluminesence
Xufeng Wang[1], Jayprakash Bhosale[1], James Moore[1], Rehan Kapadia[2,3], Peter Bermel[1], Ali Javey[2,3], Mark Lundstrom[1]
[1]Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA, [2]Electrical Engineering and Computer Sciences, University of California, Berkeley, CA, USA, [3]Material Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

2:45 **(256) Photoluminescence Image Evaluation Based on an Alternative Equivalent Circuit, Not Assuming a Constant Short Circuit Current Density**
Otwin Breitenstein[1], Höffler Halles[2], Haunschild Jonas[2]
[1]Max Planck Institute of Microstructure Physics, Halle, Germany, [2]Fraunhofer Institute of Solar Energy Systems (ISE), Freiburg, Germany

Area 10 - Orals

1:30 - 3:00 PM **Ballroom 1CD**

System Performance Measurements and Validation

Chair(s): Evan Riley, Lauren Ngan

1:30 **(257) PV System Energy Test**
Sarah Kurtz[1], Janine Freeman[1], Evan Riley[2], Tim Dierauf[3], Robert Flottemesch[4], Pramod Krishnani[5]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Black & Veatch, San Francisco, CA, USA, [3]SunPower Corporation, San Jose, CA, USA, [4]Constallation, Baltimore, MD, USA, [5]Belectric, Newark, CA, USA

2:00 **(258) Measuring Soiling Losses at Utility-scale PV Power Plants**
Michael Gostein[1], J. Riley Caron[2], Bodo Littmann[2]
[1]Atonometrics, Austin, TX, USA, [2]First Solar, San Francisco, CA, USA

2:15 **(259) Diffuse Shading Losses in Tracking Photovoltaic Systems**
Owen W Westbrook, Mark Reusser, Forrest Collins
juwi solar Inc, Boulder, CO, USA

2:30 **(260) Sandia Inverter Performance Test Protocol Efficiency Weighting Alternatives**
Jeffrey D Newmiller[1], William Erdman[2], Joshua S Stein[3], Sigifredo Gonzalez[3]
[1]DNV GL, San Ramon, CA, USA, [2]Cinch, Lafayette, CA, USA, [3]Sandia National Laboratories, Albuquerque, NM, USA

2:45 **(261) A Study of the Ability of Short Term Performance Tests to Reproduce the Results of a One-Year Adjusted Energy Test for Non-Concentrating Photovoltaic Systems**
Martin Waters[1], Irina Berdnik[1], Evan Riley[2], Tejas Tirumalai[2], Sarah Kurtz[3], Kevin Joyce[2]
[1]Recurrent Energy, San Francisco, CA, USA, [2]Black & Veatch, San Francisco, CA, USA, [3]National Renewable Energy Laboratory, Golden, CO, USA

Area 11 - Orals

1:30 - 3:00 PM **Ballroom 1AB**

Government Policy Education and Standards

Chair(s): John Benner, Elaine Ulrich

1:30 **(262) The Virtual Cell Factory: Teaching PV Manufacturing Science at QESST and Beyond**
Jeffrey Cotter[1], Jenefer Husman[1], Stuart Bowden[1], Klaus Weber[2], Alison Lennon[3], Tonio Buonassisi[4], Timothy Kirkpatrick[4]
[1]Arizona State University, Tempe, AZ, USA, [2]The Australian National University, Canberra, Australia, [3]The University of New South Wales, Sydney, Australia, [4]Massachusetts Institute of Technology, Boston, MA, USA

1:45 **(263) Growth in the US Market for Residential PV Systems and Buyer/Lessee Experience**
Paula J Mints
SPV Market Research, San Jose, CA, USA

2:00 **(264) Overview of Research and Development Projects for Solar Cells in Japan**
Masafumi Yamaguchi[1], Hiroyuki Yamada[2]
[1]Toyota Technological Institute, Nagoya, Japan, [2]New Energy and Industrial Technology Development Organization, Kawasaki, Japan

2:15 **(265) Effects of the Feed-in Tariff Program on the PV Market in Japan**
Haruki Yamaya, Takashi Ohigashi, Hiroshi Matsukawa, Izumi Kaizuka, Osamu Ikki
RTS Corporation, Tokyo, Japan

2:30 **(266) Ensuring the reliability of PV systems through the selection of International Standards for the IECRE Conformity Assessment System**
George J Kelly[1], Ted Spooner[2], Guido Volberg[3], Greg Ball[4], Jonas Bruckner[5]
[1]Sunset Technology Inc., Mount Airy, MD, USA, [2]University of New South Wales, Sydney, Australia, [3]TUV Rheinland, Koln, Germany, [4]DNV GL, San Francisco, CA, USA, [5]VDE, Offnebach am Main, Germany

2:45 **(267) Three-Prong Path to Comprehensive Technical Standards for PV Reliability**
Sarah Kurtz[1], John Wohlgemuth[1], Tony Sample[2], Masaaki Yamamichi[3], Michio Kondo[3]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]European Commission, JRC, Ispra, Italy, [3]National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan

Area 12 - Orals

1:30 - 3:00 PM **Ballroom 2B**

PID

Chair(s): Mike Kempe, Carole Graas

1:30 **(268) Thin Film PID Field Failures and Root Cause Determination**
Michelle L Propst, N.Anders Olsson
pearllaboratories, Fort Collins, CO, USA

2:00 **(269) Theory and numerical simulation of the physical processes involved in the potential-induced degradation of conventional silicon solar cells**
Nitsa Kindyni, Constantinos Lazarou, George E. Georghiou
FOSS Research Center for Sustainable Energy, Photovoltaic Technology Group, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus

2:15 **Best Student Presentation Award Finalist**
(270) Application of Reverse Bias Recovery Technique to Address PID Issue: Incompleteness of shunt resistance and quantum efficiency recovery
Jaewon Oh[1], Stuart Bowden[1], GovindaSamy TamizhMani[2]
[1]Solar Power Laboratory, Arizona State University, Tempe, AZ, USA, [2]Photovoltaic Reliability Laboratory, Arizona State University, Mesa, AZ, USA

2:30 **(271) Application of the Terrestrial Photovoltaic Module Accelerated Test-to-Failure Protocol**
Peter Hacke[1], Kent Terwilliger[1], Stephen Glick[1], Ryan Smith[2], Greg Perrin[1], Sarah Kurtz[1], Nick Bosco[1], John Wohlgemuth[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Pordis, Austin, TX, USA

2:45 **(272) Investigation of c-Si Modules Degradation and Recovery Effect under High Potentials**
Bengt Jaeckel[1], Marijo Cosic[2], Jürgen Arp[3]
[1]UL International GmbH, Neu-Isenburg, Germany, [2]UL International GmbH, Neu-Isenburg, Germany, [3]PV LAB Germany GmbH, Potsdam, Germany

3:00 - 3:30 PM **Exhibit Hall D**

Coffee Break

Joint Session: Areas 1,6 - Orals

3:30 - 5:00 PM **MR 505-507**

Hybrid Organic / Inorganic and Perovskite Solar Cells

Chair(s): Annick Anctil, Shuzi Hayase, Dana Olson

3:30 **(273) Power from the Sun: Perovskite Solar Cells**
Mohammad Nazeeruddin
EPFL, Lausanne, Switzerland

4:00 **Best Student Presentation Award Finalist**
(274) Double-Heterojunction Crystalline Silicon Solar Cell Fabricated at 250 ºC with 12.9 % Efficiency
Sushobhan Avasthi[1], Ken Nagamatsu[1,2], Janam Jhaveri[1,2], William E. McClain[1,3], Gabriel Man[1,2], Antoine Kahn[1,2], Jeffrey Schwartz[1,3], Sigurd Wagner[1,2], James C. Sturm[1,2]
[1]Princeton Institute for the Science and Technology of Materials (PRISM), Princeton, NJ, USA, [2]Department of Electrical Engineering, Princeton University, Princeton, NJ, USA, [3]Department of Chemistry, Princeton University, Princeton, NJ, USA

4:15 **(275) Ultrathin, Flexible, Hybrid Solar Cells in Sub-ten Micrometers Single Crystal Silicon Membrane**
Pushpa Raj Pudasaini, Manisha Sharma, Francisco Ruiz-Zepeda, Arturo A Ayon
The University of Texas at San Antonio, San Antonio, TX, USA

4:30 **(276) Ultra-thin Doping-free Amorphous Silicon/ Organic Hybrid Structure for Decorative Photovoltaic Applications**
Jae Yong Lee, Kyu-Tae Lee, Sungyong Seo, L. Jay Guo
University of Michigan, Ann Arbor, MI, USA

4:45 **(277) Photoelectronic Responses in Solution-Processed Perovskite $CH_3NH_3PbI_3$ Solar Cell Studied by Photoluminescence and Photoabsorption Spectroscopy**
Yasuhiro Yamada, Toru Nakamura, Masaru Endo, Atsushi Wakamiya, Yoshihiko Kanemits
Kyoto University, Kyoto, Japan

Area 2 - Orals

3:30 - 5:00 PM **MR 502-504**

Buffers and New Materials

Chair(s): Negar Naghavi, Takuya Kato

3:30 **(278) Sputtered Zn(O,S): A promising approach to dry in-line fabrication of Cd-free CIGS modules**
Reiner Klenk[1], Alexander Steigert[1], Paul Gerhardt[1], Frank Hergert[2], Christian A. Kaufmann[1], Iver Lauermann[1], Mike Oertel[3], Paul Pistor[1], Siegmund Zweigart[4], Martha C. Lux-Steiner[1]
[1]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany, [2]Bosch Solar CISTech, Brandenburg an der Havel, Germany, [3]Manz CIGS Technology GmbH, Schwäbisch-Hall, Germany, [4]Robert Bosch GmbH, Gerlingen-Schillerhöhe, Germany

4:00 **(279) Properties of Oxygenated Cadmium Sulfide (CdS:O) and Their Impact on CdTe Device Performance**
Daniel M Meysing[1], Michelle M Griffith[1], Matthew O Reese[2], James M Burst[2], William L Rance[2], Colin A Wolden[1], Teresa M Barnes[2]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

4:15 **(280) Structural Order and Thermodynamic Stability of (Cu,Zn,Sn)S_4 Alloys**
Sin Cheng Siah[1], R. Jaramillo[1], Pete Erslev[2], Glenn Teeter[2], Tsu-Chien Weng[3], Michael F. Toney[3], Tonio Buonassisi[1]
[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]Stanford Synchrotron Radiation Lightsource, Menlo Park, CA, USA

4:30 **(281) Development of Cu Chalcogenide Photovoltaic Materials, $CuInSe_2$, Cu_2ZnSnS_4, Cu_2SnS_3 and Related Compounds**
Takahiro Wada, Tsuyoshi Tsuyoshi
Department of Materials Chemistry, Ryukoku University, Seta, Otsu, Japan

Area 4 - Orals

3:30 - 5:15 PM **Ballroom 1EF**

Heterojunctions

Chair(s): Richard Swanson, Bram Hoex

3:30 **(282) High-Efficiency Silicon Heterojunction Solar cells: Status and Perspectives**
Stefaan De Wolf, Bénédicte Demaurex, Jonas Geissbühler, Philipp Löper, Silvia Martin de Nicolas, Bertrand Paviet-Salomon, Johannes Seif, Andrea Tomasi, Christophe Ballif
PV-Lab, IMT, EPFL, Neuchatel, Switzerland

4:00 **(283) Development of Hetero-Junction Back Contact Si Solar Cells**
Junichi Nakamura[1], Hiroyuki Katayama[1], Naoki Koide[2], Kyotaro Nakamura[3]
[1]Solar Systems Division, SHARP Corporation, 282-1 Hajikami, Katsuragi-shi, Nara Prefecture 639-2198, Japan, [2]Corporate Research & Development Division, SHARP Corporation, 2613-1 Ichinomoto-cho, Tenri-shi, Nara Prefecture 632-8567, Japan, [3]Meiji University, 1-1-1 Higashimita, Tama-ku, Kawasaki, 214-8571, Japan

4:15 **(284) Hole Selective MoO_x Contact for Silicon Heterojunction Solar Cells**
Corsin Battaglia[1,2], Silvia Martin de Nicolas[3], Stefaan De Wolf[3], Xingtian Yin[1,2], Maxwell Zheng[1,2], Christophe Ballif[3], Ali Javey[1,2]
[1]University of California Berkeley, Berkeley, CA, USA, [2]Lawrence Berkeley National Laboratory, Berkeley, CA, USA, [3]Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland

4:30 **(285) Application of Thin Epitaxial Hydrogenated Si Layers to High Efficiency Heterojunction Solar Cells on N-Type Si Substrates**
Bahman Hekmatshoar, Davood Shahrjerdi, Devendra K. Sadana
IBM T.J. Watson Research Center, Yorktown Heights, NY, USA

4:45 **(286) 19.9% MWT silicon heterojunction solar cell – A novel concept embedding low Ag consumption and high module efficiency.** Gianluca Coletti[1], Yu Wu[1], Jochen Loffler[1], Bart J. Geerligs[1], Bas B. van Aken[1], Gaby Janssen[1], F. Li[2], Y. Shen[2], W. Yang[2], J. Shi[2], G. Li[2], Z. Hu[2], J. Xiong[2]. *[1]ECN Solar energy, Petten, Netherlands, [2]Yingli Green Energy, Baoding, China*

5:00 **(Late News Result) Achievement of more than 25% conversion efficiency with crystalline silicon heterojunction solar cell.** Keiichiro Masuko, Masato Shigematsu, Taiki Hashiguchi, Daisuke Fujishima, Motohide Kai, Naoki Yoshimura, Tsutomu Yamaguchi, Yoshinari Ichihashi, Tsutomu Yamanishi, Tsuyoshi Takahama, Mikio Taguchi, Eiji Maruyama, Shingo Okamoto. *Sanyo Electric Co., Ltd., Eco Solutions Company of Panasonic Group, Kaizuka, Japan.*

Area 5 - Orals

3:30 - 5:00 PM **Ballroom 1CD**

Thin Crystalline Silicon Films

Chair(s): Ivan Gordon, Sergey Varlamov

3:30 **(287) Intermediate Layer Development for Laser-Crystallized Thin-Film Silicon Solar Cells on Glass**
Jonathon Dore[1,2], Sergey Varlamov[1], Martin A. Green[1]
[1]University of New South Wales, Sydney, Australia, [2]Suntech R&D Australia Pty Ltd, Sydney, Australia

4:00 **(288) Liquid-Phase Crystallized PECVD a-Si:H Precursor Layers Applied in Thin-Film Silicon Solar Cells on Glass Substrates**
O Gabriel[1], S Calnan[1], S Ring[1], T Frijnts[2], J-H Zollondz[2], A Heidelberg[2], B Stannowski[1], R Schlatmann[1]
[1]PVcomB/ Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany, [2]Masdar PV GmbH, Ichtershausen, Germany

4:15 **(289) Silicon thin film solar cells on glass with open circuit voltages above 620 mV formed by liquid phase crystallization**
Daniel Amkreutz, Jan Haschke, Lars Korte, Florian Ruske, Bernd Rech
Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

4:30 **Best Student Presentation Award Finalist**
(290) High Efficiency Screen Printed Silicon Solar Cell on Epitaxial Thin Active Layer with Porous Si Back Reflector using Standard Industrial Process
Chi-Wei Chen[1], Ruiying Hao[2], Vijaykumar Upadhyaya[1], Ian B. Cooper[1], Ajay Upadhyaya[1], Alan Zhang[1], T.S. Ravi[2], Ajeet Rohatgi[1,3]
[1]University Center of Excellence for Photovoltaic Research and Education, School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, USA, [2]Crystal Solar Inc., Santa Clara, CA, USA, [3]Suniva Inc., Norcross, GA, USA

4:45 **Best Student Presentation Award Finalist**
(291) Analysis of a 16.8% Efficient 18 um Silicon Solar Cell on Steel
Lu Wang[1], Anthony Lochtefeld[2], Jianshu Han[1], Andrew Gerger[2], Mark Carroll[2], Jingjia Ji[4], Hongzhao Li[1], Robert Opila[3], Allen Barnett[1]
[1]University of New South Wales, Sydney, Australia, [2]AmberWave Inc., Salem, NH, USA, [3]University of Delaware, Newark, DE, USA, [4]Sharesun Co. Ltd, Suzhou, China

Area 8- Orals

3:30 - 5:00 PM **Ballroom 2A**

Optical Characterization

Chair(s): Jim Sites, Robert Collins, Chris Fell

3:30 **(292) Analysis of Minority Carrier Lifetime and Surface Recombination Velocity in CdTe by Using Time-Resolved Photoluminescence with One-Photon and Two-Photon Excitation**
Darius Kuciauskas[1], Ana Kanevce[1], Pat Dippo[1], Shahram Seyedmohammadi[2], Roger Malik[2]
[1]NREL, Golden, CO, USA, [2]First Solar, Santa Clara, CA, USA

4:00 **(293) A novel optical method for mapping crystal orientations**
S. Fu, Z. Xiong, Y. Zhang, Z. Ding, P. J. Verlinden, Z. Feng
State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China

4:15 **(294) Rapid quantitative analysis of elemental composition and depth profile of Cu(In,Ga) Se_2 thin film using laser-induced breakdown spectroscopy**
Jung-Hwan In, Chan-Kyu Kim, Seok-Hee Lee, Jang-Hee Choi, Sungho Jeong
Gwangju Institute of Science and Technology, Gwangju, Korea

4:30 **(295) Quantitative Residual Stress Imaging of Multicrystalline, Quasi-Mono, and Kerfless Silicon Wafers by Infrared Birefringence and Sectioning**
Sergio Castellanos, Tonio Buonassisi
Massachusetts Institute of Technology, Cambridge, MA, USA

4:45 **(296) Differential Electroluminescence Imaging and the Current Transport Efficiency of Silicon Wafer Solar Cells**
Johnson Wong[1], Ranjani Sridharan[1], Yu Chang Wang[2], Thomas Mueller[1]
[1]Solar Energy Research Institute of Singapore, Singapore, Singapore, [2]IVT Solar Pte Ltd, Singapore, Singapore

Area 9- Orals

3:30 - 5:00 PM **Ballroom 2B**

Module Power Electronics. Special Chinese Session: Module Materials

Chair(s): Chris Deline, Yang Yang

3:30 **Best Student Presentation Award Finalist**
(297) Partial Shading Assessment of PV Installations via Module-Level Monitoring
Alex Hanson[1], Chris Deline[2], Christopher Schaef[1], Jason Stauth[1], Charles Sullivan[1]
[1]Dartmouth College, Hanover, NH, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

3:45 **Best Student Presentation Award Finalist**
(298) Purely Inductive Ripple Power Storage for Improved Lifetime in Solar Photovoltaic Micro-inverter Topology
Ramprakash Kathiresan[1,2], Pritam Das[1,2], Thomas Reindl[1], Sanjib Kumar Panda[1,2]
[1]Solar Energy Research Institute of Singapore, Singapore, Singapore, [2]Electrical and Computer Engineering Department, National University of Singapore, Singapore, Singapore

4:00 **(299) Evaluation of Maxim Module-Integrated Electronics at the DOE Regional Test Centers**
Chris Deline[1], Bill Sekulic[1], Josh Stein[2], Stephen Barkaszi[3], Jeff Yang[4], Seth Kahn[4]
[1]1National Renewable Energy Laboratory, Golden, CO, USA, [2]Sandia National Laboratory, Albuquerque, NM, USA, [3]Florida Solar Energy Center, Cocoa, FL, USA, [4]Maxim Integrated, San Jose, CA, USA

4:15 **(300) Predictive Linear Regression Model for Microinverter Internal Temperature**
Mohammad A. Hossain[1], Timothy J. Peshek[2], Yifan Xu[3], Liang Ji[4], Alexis R. Abramson[1], Roger H. French[2]
[1]Department of Mechanical and Aerospace Engineering, Case Western Reserve University, Cleveland, OH, USA, [2]Department of Materials Science and Engineering, Case Western Reserve University, Cleveland, OH, USA, [3]Department of Epidemiology and Biostatistics, Case Western Reserve University, Cleveland, OH, USA, [4]Underwriter's Laboratories, LLC, Northbrook, IL, USA

4:30 **(301) The influence of crosslinking agent on the properties of EVA resin**
Shudong Zhou[1], Zhengdong Jin[2]
[1]General Manager&Senior Engineer of Guangzhou Bothleader Electrical Materials Co., Ltd., Guangzhou, China, [2]Chief Engineer of Guangzhou Bothleader Electrical Materials Co., Ltd., Guangzhou, China

Area 11- Orals

3:30 - 5:00 PM **Ballroom 1AB**

Interconnection and High PV Penetration

Chair(s): Michael Coddington, Murali Baggu, Robert Broderick

3:30 ***(302) GIS based multi-criteria decision analysis for photovoltaic panel deployment in the Southeast United States.*** Kata Tisza, Scott Brames, Annick Anctil. *Clemson University, Clemson, SC, USA.*

3:45 **(303) Analysis of 100 Utility SGIP PV Interconnection Studies**
Jimmy E Quiroz, Santiago S Sena, Robert J Broderick
Sandia National Laboratories, Albuquerque, NM, USA

4:00 **(304) High Frequency Irradiance and Power Output for Grid Integration and Storage Evaluations**
Jacyln D Frank, Philip Beaucage, Michael C Brower
AWS Truepower, Albany, NY, USA

4:15 **Best Student Presentation Award Finalist**
(305) Energy Storage Management in Residential Feeders with High PV Penetration for Overvoltage Prevention
Seyedmostafa Hashemi, Jacob Østergaard
Center for Electric Power and Energy, Department of Electrical Engineering, Kongens Lyngby, Denmark

4:30 **(306) Automating the Sandia Advanced Interoperability Test Protocols**
Jay T Johnson[1], Bob Fox[2]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Loggerware, San Francisco, CA, USA

4:45 **(307) Testing Advanced Photovoltaic Inverters Conforming to IEEE Standard 1547 – Amendment 1**
Anderson Hoke, Sudipta Chakraborty, Thomas Basso
National Renewable Energy Laboratory, Golden, CO, USA

5:30 - 7:00 PM **Exhibit Hall D Pre-function & Terrace**
Cherry Award Reception

7:00 - 9:00 PM **Exhibit Hall D**
PV Jobs Fair

7:00 - 9:30 PM **Exhibit Hall D**
Evening Poster Reception

Area 1 - Posters

7:00 - 8:15 PM **Exhibit Hall D**

Low-Dimensional Structures for Solar Cell Enhancement

Chair(s): Rob Walters, Chaffra Affouda, Dave Forbes

(308-A2) **Improving mechanical stability and electrical properties of silver nanowire films with a zinc tin oxide overcoat.** Shruti Aggarwal[1,2], Maikel Hest[1], John Perkins[1], David Ginley[1]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Guru Gobind Singh Indraprastha University, New Delhi, India.*

(309-A5) **Dark Current Suppression in Quantum Dot Solar Cells through Interfacial Engineering.** Nauman Z Butt, Maham Masood Sadiq, Khurram Mazher. *Lahore unioversity of Managemnt Science, Lahore, Pakistan.*

(310-A8) **α-Germanium Nano Disk Array Fabrication by Combination of Bio Template and Neutral Beam Etching for Solar Cell Application.** Takuya Fujii[1,2], Takeru Okada[1], Mohd Erman Syazwan[1], Taiga Isoda[1,3], Hirotaka Endo[2], Mohammad Maksudur Rahman[1,3], Kohei Itoh[3,4], Seiji Samukawa[1,3,5]. *[1]IFS, Tohoku University, Sendai, Japan, [2]Honda R&D Co., Ltd., Fundamental Technology Center, Wako, Japan, [3]JST-CREST, Tokyo, Japan, [4]Keio University, Tokyo, Japan, [5]WPI-AIMR, Tohoku University, Sendai, Japan.*

(311-A11) **Drift-diffusion simulations of InAs/AlAsSb quantum dot intermediate-band solar cells.** Staffan Hellstroem, Seth M Hubbard. *NanoPower Research Laboratory, Rochester Institute of Technology, Rochester, NY, USA.*

(312-A14) **Bandgap Optimized III-V (GaAsP) Nanowire on Silicon Tandem Solar Cell, Device and Data.** Jeppe V Holm[1,3], Martin Aagesen[1], Yunyan Zhang[2], Jiang Wu[2], Sabina Hatch[2], Huiyun Liu[2]. *[1]Gasp Solar ApS, Copenhagen, Denmark, [2]Department of Electronic and Electrical Engineering, University College London, London, UK, [3]Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark.*

(313-A17) **Impact of Nanostructures and Radiation Environment on Defect Levels in III-V Solar Cells.** Seth M. Hubbard[1], Wyatt Strong[1], David V. Forbes[1], Christopher Bailey[2], Kenneth Schmieder[2], Raymond Hoheisel[3], Robert Walters[2]. *[1]Rochester Institute of Technology, Rochester, NY, USA, [2]Naval Research Laboratory, Washington, DC, USA, [3]George Washington University, Washington, DC, USA.*

(314-A20) **Charge Carrier transfer investigation in quantum dot sensitized solar cells.** Bita Janfeshan, Bahareh Sadeghimakki, Navid M.S. Jahed, Siva Sivoththaman. *Electrical and computer Engineering Department, University of Waterloo, Waterloo, ON, Canada.*

(315-A23) **Structural and optical properties of multi-stack InAs/GaAsSb quantum dots with different Sb composition.** Yeongho Kim[1], Nikolai Faleev[1], Darius Kuciauskas[2], Pat Dippo[2], Christiana Honsberg[1]. *[1]Department of Electrical Engineering, Arizona State University, Tempe, AZ, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(316-A26) **TCAD Simulation and Modeling of Impact Ionization Effect on Thin Film c-Si HIT Solar Cells.** Vikas Kumar, Ammar Nayfeh. *Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates.*

(317-A29) **MOCVD-Grown InGaN Nanowires for Photovoltaic Applications.** Hsun C. Kuo, Taesu Oh, S. J. Kim, Xiaoqing Pan, Pei-Cheng Ku. *University of Michigan, Ann Arbor, MI, USA.*

(318-A32) **Limiting Efficiencies of Integrating Single Junction with Intermediate Band Solar Cells for Multiphysical Effects.** Jongwon Lee, Christiana Honsberg. *School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA.*

(319-A35) **Hyperdoped Silicon Sub-Band Gap Photoresponse for an Intermediate Band Solar Cell in Silicon.** Jonathan P Mailoa[1], Austin J Akey[1], Christie B Simmons[1], David Hutchinson[2], Jay Mathews[3], Joseph T Sullivan[1], Daniel Recht[4], Mark T Winkler[1], James S Williams[5], Jeffrey M Warrender[3], Peter D Persans[2], Michael J Aziz[4], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Rensselaer Polytechnic Institute, Troy, NY, USA, [3]US Army Benét Laboratories, Watervliet, NY, USA, [4]Harvard School of Engineering and Applied Sciences, Cambridge, MA, USA, [5]The Australian National University, Canberra, Australia.*

(320-A38) **Multiple Exciton Generation Solar Cells: Effects of Nanocrystal Shape on Quantum Efficiency.** Ashley R. Marshall[1,2], Matthew C. Beard[2], Joseph M. Luther[2]. *[1]University of Colorado, Boulder, Boulder, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(321-A41) **Drift-Diffusion Modeling of a Superlattice p-i-n Device With Resonant Conduction-Band Assisted Photon Absorption and Carrier Extraction.** Akhil Mehrotra, Liberty A. Falcon, Gopi K. Vijaya, Alex Freundlich. *Photovoltaics and Nanostructures Laboratory, Center for Advanced Materials, University of Houston, Houston, TX, USA.*

(322-A44) **Toward an efficient extremely thin absorber solar cell based on ZnO nanowire arrays.** Jérôme Michallon[1,2], Mehdi Daanoune[1], Davide Bucci[1], Jérôme Garnier[2], Estelle Appert[2], Quentin Rafhay[1], Vincent Consonni[2], Anne Kaminski-Cachopo[1]. *[1]IMEP-LAHC, Grenoble, France, [2]LMGP, Grenoble, France.*

(323-A47) **Electron microscopy studies of III-Sb–based quantum dot solar cell structures.** Andrew G. Norman[1], Ramesh B. Laghumavarapu[2], Meng Sun[2], Paul J. Simmonds[2], Baolai Liang[2], Diana L. Huffaker[2]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Electrical Engineering Department University of California Los Angeles, Los Angeles, CA, USA.*

(324-B2) **Effects of Doping on Carrier Confinement in InAs QD Solar Cells.** Stephen J. Polly, Staffan Hellström, David V. Forbes, Seth M. Hubbard. *Rochester Institute of Technology, Rochester, NY, USA.*

(325-B5) **Effect of Miniband Formation in a Quantum Dot Super Lattice Fabricated by Combination of Bio-Template and Neutral Beam Etching for High Efficiency Quantum Dot Solar Cells.** Mohammad Maksudur Rahman[1,4], Makoto Igarashi[1,4], Weiguo Hu[1,4], Mohd Erman Syazwan[1,4], Takeru Okada[1], Yasuke Hoshi[2], Noritaka Usami[2], Seiji Samukawa[1,3,4]. *[1]1Institute of Fluid Science, Tohoku University, Sendai, Japan, [2]Graduate School of Engineering, Nagoya University, Nagoya, Japan, [3]WPI Advanced Institute for Materials Research, Tohoku University, Sendai, Japan, [4]Japan Science and Technology Agency, CREST, Tokyo, Japan.*

(326-B8) **Effect of Hydrogen Passivation on Optical Properties of a–Si/SiNX Multilayered Films with Si-QDs and without Si–QDs.** Dharmendra kumar R. Rai[1], Bikas Rajan[2], Ashish K. Panchal[3], K. R. Balasubramaniam[1], Chetan S. Solanki[1]. *[1]NCPRE, Department of Energy Science and Engineering, IIT Bombay, Powai, Mumbai - 400076, India, [2]Department of Nuclear and Atomic Physics, TIFR, Mumbai – 400005, India, [3]Electrical Engineering Department, S. V. NIT, Surat – 395007, India.*

(327-B11) **Effect of External Bias on Multi-stacked InAs/AlGaAs Quantum Dots Solar Cell.** Yasushi Shoji, Yoshitaka Okada. *Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan.*

(328-B14) **Investigation of the Cause of Reduced Open Circuit Voltage in Ge/Si Quantum Dot Solar Cells.** Takeshi Tayagaki[1,2], Yusuke Hoshi[3], Noritaka Usami[3]. *[1]Kyoto University, Uji, Japan, [2]PRESTO-JST, Kawaguchi, Japan, [3]Nagoya University, Nagoya, Japan.*

(329-B17) **Surface Recombination Dependent Performance of A Nano-scale P-n Junction Solar Cell.** Hung-Ruei Tseng, Shun-Chieh Hsu, Shih-Li Lin, Yin-Han Chen, Chien-Chung Lin. *Institute of Photonic System, National Chiao Tung University, Tainan, Taiwan.*

(330-B20) **Influence of the preparation conditions in the morphology and photoluminescence of CdS nanostructures.** Patricia Gutiérrez Zayas-Bazán[1], Karla Gutiérrez Z-B[1], Guillermo Santana[2], Jaime Santoyo-Salazar[3], Josué Esaú Romero-Ibarra[4], Gerardo Contreras-Puente[5], Luis Carlos Hernández[6], María Tamargo[6], Osvaldo de Melo[1]. *[1]Facultad de Física, Universidad de La Habana, La Habana, Cuba, [2]Instituto de Investigación en Materiales, UNAM, Mexico D.F., Mexico, [3]Departamento de Física, CINVESTAV-IPN, Mexico D.F., Mexico, [4]Laboratorio de nanoscopía electrónica, CINVESTAV-IPN, Mexico D.F., Mexico, [5]Escuela Superior de Física y Matemáticas-IPN, Mexico D.F., Mexico, [6]City College of New York, New York, NY, USA.*

(331-B22) **Capacitance-Voltage Characterization of In-situ Boron Doped Silicon Quantum Dot in Silicon Dioxide.** Tian Zhang, Ivan Perez Wurfl, Binesh Puthen Veettil, Lingfeng Wu, Xuguang Jia, Ziyun Lin, Chien Jen Yang, Gavin Conibeer. *The University of New South Wales, Sydney, Australia.*

(332-B24) **Polarization Insensitive Perfect Absorber with Nanorods Arrays.** Fengyun Zhao, Guangyao Su, Zhaoyu Zhang. *Peking University, Shenzhen, China.*

(333-B25) **Hierarchical modeling of electron and hole transport in nanoparticle thin films: from ab initio to monte carlo.** Gergely Zimanyi[1], Ian Carbone[2], Marton Voros[1]. *[1]University of California, Davis, CA, USA, [2]University of California, Santa Cruz, CA, USA.*

Area 3 - Posters

7:00 - 8:15 PM **Exhibit Hall D**

III-V on Silicon and III-V Materials for Solar Cells

Chair(s): John Geisz, Tyler Grassman

(334-E20) **Novel GaAs0.71P0.29 / Si Tandem Step-Cell Design.** Sabina Abdul Hadi[1], Evelina Polyzoeva[2], Tim Milakovich[2], Mayank Bulsara[2], Judy L. Hoyt[2], Eugene A. Fitzgerald[2], Ammar Nayfeh[1]. *[1]Institute Center for Future Energy Systems (iFES) Department of Electrical Engineering and Computer Science (EECS) Masdar Institute of Science and Technology, P.O. Box 54224, Abu Dhabi, United Arab Emirates, [2]MIT Microsystems Technology Laboratories, Cambridge, MA, USA.*

(335-E23) **Nonradiative recombination centers in GaAsN Grown by Chemical Beam Epitaxy.** Boussairi Bouzazi, Nobuaki Kojima, Yoshio Ohshita, Masafumi Yamaguchi. *Toyota Technological Institute, Nagoya, Japan.*

(336-E26) **Optimization of Tellurium Doped InGaAs Grown by MOCVD for Solar Application.** Daniel P. Byrnes, Chris Ebert, Ziggy Pulwin, Aaron Krahnert. *Veeco Process Equipment, Inc., Somerset, NJ, USA.*

(337-E29) **GaInN/GaN - Ni/Au Transparent Conducting Oxide Schottky Barrier Solar Cells.** Kevin T. Chern[1], Louis J. Guido[1], Oleg A. Laboutin[2], Roger E. Welser[3], Victor C. Elarde[4]. *[1]Virginia Tech, Blacksburg, VA, USA, [2]Kopin Corporation, Taunton, MA, USA, [3]Magnolia Solar, Woburn, MA, USA, [4]Microlink Devices, Niles, IL, USA.*

(338-E32) **Double Layer Antireflection Coating and Window Optimization for GaAsP/SiGe Tandem on Si.** Brianna Conrad[1], Tian Zhang[1], Anthony Lochtefeld[2], Andrew Gerger[2], Chris Ebert[3], Martin Diaz[1], Li Wang[1], Ivan Perez-Wurfl[1], Allen Barnett[1]. *[1]The University of New South Wales, Sydney, Australia, [2]AmberWave Inc., Salem, NH, USA, [3]Veeco MOCVD, Somerset, NJ, USA.*

(339-F3) **Doped and undoped GaAs thin films with single-crystalline-like properties on low-cost flexible metal substrates.** Pavel Dutta[1], Monika Rathi[1], Nan Zheng[2], Ying Gao[1], Yao Yao[1], Phil Ahrenkiel[2], Venkat Selvamanickam[1]. *[1]University of Houston, Houston, TX, USA, [2]South Dakota School of Mines and Technology, Rapid City, SD, USA.*

(340-F6) **Microstructure of the Nitrogen-Induced Localized State in GaAsN Thin Films Grown by Chemical Beam Epitaxy.** Atsuhiko Fukuyama[1], Goshi Morioka[1], Ding Weng[1], Akio Suzuki[1], Hidetoshi Suzuki[2], Masafumi Yamaguchi[3], Tetsuo Ikari[1]. *[1]Faculty of Engineering, University of Miyazaki, Miyazaki, Japan, [2]Interdisciplinary Research Organization, University of Miyazaki, Miyazaki, Japan, [3]Toyota Technological Institute, Nagoya, Japan.*

(341-F9) **Wafer Bonding for III-V -based Solar Cells: The Roles of Surface Preparation and Wafer Orientations.** Mark S Goorsky, Xiaolu Kuo, Jeffrey McKay, Mark Seal, Douglas Chen, Joseph Schlies, Brett Beekley. *UCLA, Los Angeles, CA, USA.*

(342-F11) **Performance Evaluation of Monolithically Integrated 3J InGaP/GaAs/Si Tandem Solar Cells for Concentrated Photovoltaics.** Nikhil Jain, Yan Zhu, Michael Clavel, Patrick Goley, Mantu Hudait. *Virginia Tech, Blacksburg, VA, USA.*

(343-F13) **Investigation of Heat Transfer through Germanium – AlN Ceramics Interface in Heterostructure Solar Cells by Laser Thermal Wave Method.** Vitali Stanislavovic Kalinovsky[3]. *[1]Alexej Glazov, St.-Petersburg, Russia, [2]Kirill Muratikov, St.-Petersburg, Russia, [3]Viacheslav Andreev, St.-Petersburg, Russia.*

(344-F15) **Growth of Layered (InxGa1-x)2Se3 Buffer Material for GaAs on Si System.** Nobuaki Kojima, Hiroya Nakamura, Yoshio Ohshita, Masafumi Yamaguchi. *Toyota Technological Institute, Nagoya, Japan.*

(345-F17) **Reducing dislocations in GaAs on Si by a novel GaAs1-xSbx buffer layer for multi-junction solar cells.** Osamu Morohara, Hirotaka Geka, Yoshitaka Moriyasu, Naohiro Kuze. *AsahiKASEI Corporation, Fuji, Japan.*

(346-F19) **Study of deep levels in InAlAsSb grown via MOCVD.** George T Nelson, Zac S Bittner, Brittany Smith, David F Forbes, Seth M Hubbard. *Rochester Institude of Technology, Rochester, NY, USA.*

(347-F21) **Material Selection and Fabrication Parameters for the Integration of Antireflective Nanostructures with Multijunction Photovoltaics.** Emmett E Perl[1], William E McMahon[2], John E Bowers[1], Daniel J Friedman[2]. *[1]University of California at Santa Barbara, Santa Barbara, CA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(348-F23) **Characterization of InAlAs Solar Cells Grown by OMVPE.** Brittany L. Smith, Staffan D. Hellstroem, George T. Nelson, Zachary S. Bittner, David V. Forbes, Seth M. Hubbard. *Rochester Institute of Technology, Rochester, NY, USA.*

(349-F25) **GaAsP Hall Mobility Characterisation for GaAsP/SiGe Tandem Solar Cell on Si Substrate.** Anastasia H. Soeriyadi[1], Anthony Lochtefeld[2], Andrew Gerger[2], Chris Ebert[3], Ivan Perez-Wurfl[1], Allen Barnett[1]. *[1]UNSW, Sydney, Australia, [2]AmberWave Inc, Salem, NH, USA, [3]Veeco MOCVD, Somerset, NJ, USA.*

(350-F27) **Effect of Material Choice on Spalling Fracture Parameters to Exfoliate Thin PV Devices.** Cassi Sweet[1], John Simon[2], David Young[2], Aaron Ptak[2], Corinne E. Packard[1,2]. *[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(351-F29) **Self-Catalyzed High-Quality GaAsP Nanowires for High-Efficiency Solar Cells Grown by Solid-Source Molecular Beam Epitaxy on Silicon.** Yunyan Zhang[1], Jiang Wu[1], Sabina Hatch[1], Martin Aagesen[2,3], Ana Sanchez[5], Jeppe V. Holm[3,4], Henrik I. Jørgensen[2], Huiyun Liu[1]. *[1]Department of Electronic and Electrical Engineering, University College London, London WC1E 7JE, UK, london, UK, [2]SunFlake A/S, Universitetsparken 5, Copenhagen DK-2100, Denmark, Denmark, Denmark, [3]Gasp Solar ApS, Gregersensvej 7, Taastrup DK-2630, Denmark, Denmark, Denmark, [4] Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, Universitetsparken 5, DK-2100 Copenhagen O, Denmark, Denmark, Denmark, [5]Department of Physics, University of Warwick, Coventry CV4 7AL, Warwick, UK.*

(352-F31) **AlGaAs Solar Cells Grown by Liquid Phase Epitaxy for Dual Junction Solar Cells Based on c-Si Bottom Sub-cell.** Xin Zhao, Kyle H. Montgomery, Jerry M. Woodall. *University of California, Davis, CA, USA.*

Area 4 - Posters

7:00 - 8:15 PM **Exhibit Hall D**

Surface Passivation II

Chair(s): Jan Benick, David Young, Tobias Pletzer

(353-F40) **The Influence of Texturing Bath Conditions on the Morphology and Optical Properties of Crystalline Silicon.** Hamda A. Al-Thani, Abeer AlYafeai, Ahlam AlJaeedi, Sahar AlShaibani, Falah S. Hasoon. *National Energy and Water Research Center, Abu Dhabi, United Arab Emirates.*

(354-G4) **Effect of Carbon Diffusion on Performance of Thin Film c-Si HIT Solar Cells with a-SiC Passivation Layer.** Aaesha Alnuaimi, Vikas Kumar, Farsad Chowdhury, Ammar Nayfeh. *Institute Center for Future Energy Systems (iFES), Department of Electrical Engineering and Computer Science (EECS), Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates.*

(355-G8) **Substrate Dependent Growth of Nanocrystalline Silicon.** Mark S Bailly, Joe V Carpenter, Zachary Holman. *Arizona State University, Tempe, AZ, USA.*

(356-G12) **Evaluation of Passivation Layers via Temperature-Dependent Lifetime Measurements.** Simone Bernardini[1], Adrienne L. Blum[2], Mariana I. Bertoni[1]. *[1]Arizona State Univeristy, Tempe, AZ, USA, [2]Sinton Instruments, Boulder, CO, USA.*

(357-G16) **Improve the performance of silicon nano-textured solar cell via Al2O3 passivation.** Bingfei Dou, Rui Jia, Yun Sun, Haofeng Li, Chen Chen, Zhi Jin, Xinyu Liu. *IME, Beijing, China.*

(358-G20) **Wafer Surface Preparation for High-Effiiency Solar Cells.** Ismail Kashkoush, Gim Chen, Dennis Nemeth, Jennifer Rieker. *Akrion Systems, Allentown, PA, USA.*

(359-G24) **Role of Micro and Nanostructures in Enhancing Near IR Optical Absorption in Silicon.** Cheow Siu Leong[1], Ayu W. Azhari[1,2], K. Sopian[1], Saleem H. Zaidi[1]. *[1]Universiti Kebangsaan Malaysia, Bangi, Malaysia, [2]Universiti Malaysia Perlis, Kangar, Malaysia.*

(360-G28) **High-Performance Hetero-Junction Crystalline Silicon Photovoltaic Technology.** Jacques Levrat[1], Christophe Allebé[1], Nicolas Badel[1], Loris Barraud[1], Jonathan Champliaud[1], Fabien Debrot[1], Antoine Descoeudres[1], Antonin Faes[1], Agata Lachowicz[1], Sylvain Nicolay[1], Laurent Sansonnens[1], Stefaan De Wolf[2], Jonas Geissbühler[2], Matthieu Despeisse[1], Christophe Ballif[1]. *[1]CSEM PV-center SA, Neuchâtel, Switzerland, [2]EPFL PV-LAB, Neuchâtel, Switzerland.*

(361-G32) **Optical Modelling for Multilayer and Geometric Light-Trapping Structures for Crystalline Silicon Solar Cells.** Yang Li, Zhongtian Li, Zhong Lu, Jie Cui, Zi Ouyang, Alison Lennon. *University of New South Wales, Kensington, Australia.*

(362-G36) **Impact of Surface Treatments on the Passivation Effect for N-Type Crystalline Silicon in Heterojunction Solar Cells.** Zhengxin Liu[1], Dongliang Wang[2], Jieyu Bian[1], Jinning Liu[1], Fanying Meng[1], Liping Zhang[1], Jian Bao[2], Wanwu Guo[2], Zhiqiang Feng[2]. *[1]Research Center for New Energy Technology, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences, Shanghai, China, [2]State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China.*

(363-G40) **The effect of silicon surface area on bulk lifetime after annealing at different temperatures.** Pei Hsuan Doris Lu, Nitin Mampalli, Malcolm Abbott, Stuart Wenham, Alison Lennon. *UNSW, Sydney, Australia.*

(364-H4) **Comparison of Microstructure and Surface Passivation Quality of Intrinsic a-Si:H Films Deposited by Remote Plasma Chemical Vapor Deposition using Argon and Helium Plasma.** Emmanuel U Onyegam[1], Karla F Weidmar[1], Sayan S Saha[1], Mohamed M Hilali[1], Rajesh Rao[2], Leo Mathew[2], William James[1], Sanjay K Banerjee[1]. *[1]The University of Texas at Austin, Austin, TX, USA, [2]Applied Novel Device, Inc, Austin, TX, USA.*

(365-H8) **Structural Studies of Light-induced Anodic Aluminum Oxide.** Zi Ouyang, Jie Cui, Yang Li, Zhongtian Li, Alison Lennon. *School of Photovoltaic and Renewable Energy Engineering, The University of New South Wales, Sydney, Australia.*

(366-H12) **Investigation of Effects of Rear Side Roughness Influencing the Effective Lifetime.** Maxi Richter, Yelena Fridekind, Andreas Fischer, Martin Zimmer, Jochen Rentsch. *Fraunhofer Institut für Solare Energiesysteme, Freiburg, Germany.*

(367-H16) **Photolithography Free Inverted Pyramidal Texturing for Solar Cell Applications.** Sandeep S Saseendran[1,2], Anil Kottantharayil[1,2]. *[1]National Center for Photovoltaic Education and Research, IIT Bombay, Mumbai, India, [2]Department of Electrical Engineering, IIT Bombay, Mumbai, India.*

(368-H20) **Evaluation of Hydrogen plasma effect in a-Si:H/c-Si interface by means of Surface Photovoltage measurement and FTIR spectroscopy.** Luca Serenelli[1], Massimo Izzi[1], Mario Tucci[1], Luca Martini[2], Rita Asquini[2], Domenico Caputo[2], Giampiero de Cesare[2]. *[1]ENEA Research Centre Casaccia, Rome, Italy, [2]University "la Sapienza", Rome, Italy.*

(369-H24) **Improvement of n-type nc-3C-SiC:H Heterojunction Emitter for c-Si Solar Cells.** Kazuki Shimizu[1], Eric Omondi Ateto[1], Shinsuke Miyajima[1], Makoto Konagai[1,2]. *[1]Department of Physical Electronics, Tokyo Institute of Technology, Meguro, Tokyo, Japan, [2]Photovoltaics Research Center (PVREC), Tokyo Institute of Technology, Meguro, Tokyo, Japan.*

(370-H28) **Light Trapping in Large-Scale Photonic Nanostructures Fabricated from Vertically Aligned Ge□Quantum Dots on Crystalline Silicon.** Takeshi Tayagaki[1], Yusuke Hoshi[2], Yuko Kishimoto[1], Noritaka Usami[2]. *[1]Kyoto University, Uji, Japan, [2]Nagoya University, Nagoya, Japan.*

(371-H32) **Simulation of Honeycomb-texture for optical and electrical characteristics of solar cells.** Anne-Kristin Volk[1], William Glover[1], Martin Zimmer[1], Jochen Rentsch[1], Holger Reinecke[2]. *[1]Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany, [2]Department of Microsystems Engineering - IMTEK University, Freiburg, Germany.*

(372-H36) **Spray pyrolysis coating Al2O3:Cl/TiO2 bilayer for PERC.** Hsing-Hua Wu[1], Sheng-Min Yu[2], Wan-Ying Chou [2], Sung-Yen Wei[2], Tai-Jui Wang[2], Wen-Ching Sun[2], Kuei-Bo Chen[1], Walt K. W. Huang [1], Nai-Tien Ou[1], Chung-Han Wu[1]. *[1]Gintech Energy Corporation, Miaoli, Taiwan, [2]Material & Chemical Research Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan.*

(373-H40) **Industrially Rear Side Passivated Cz Mono-crystalline Cells with 19.5% Efficiency.** Zhuo Xu, Xueliang Yang, Gaofei Li, Wenchao Zhao, Decheng yang, Zhiyan Hu. *Yingli Green Energy Holding Co., Ltd., Baoding, China.*

(374-I4) **Passivated Contacts for Silicon Solar Cells Based on Transparent Conducting Oxides.** David L. Young, William Nemeth, Benjamin G. Lee, Pauls Stradins. *National Renewable Energy Laboratory, Golden, CO, USA.*

(375-I8) **Surface Passivation of c-Si by Atomic Layer Deposition TiO2 Thin Films Deposited at Low Temperature.** Ing-Song Yu[1], I-Hsuan Chang[2], Hsyi-En Cheng[2], Yung-Sheng Lin[3]. *[1]Department of Materials Science and Engineering, National Dong Hwa University, Hualien, Taiwan, [2]Department of Electro-Optical Engineering, Southern Taiwan University of Science and Technology, Tainan, Taiwan, [3]R&D Department, E-Ton Solar Tech. Co., LTD., Tainan, Taiwan.*

(376-I12) **Comparative study of silver nanoparticles embedded in dielectric layers hybrid plasmonic structures for solar cell application.** Xiaoxia Zhao, Hui Shen. *School of Physics and Engineering, Institute for Solar Energy Systems, State Key Laboratory of Optoelectronic Materials and Technologies, Sun Yat-sen University,, Guangzhou, China.*

(377-I16) **Design Guidelines for Using Si Nanocone Arrays as Antireflection Layer in Crystalline Silicon Solar Cells.** Keya Zhou[1], Shutian Liu[1], Jung-Ho Lee[2]. *[1]Department of Physics, Harbin Institute of Technology, Harbin, China, [2]Department Chemical Engineering, Hanyang University, Ansan, South Korea.*

Area 5 - Posters

7:00 - 8:15 PM **Exhibit Hall D**

Crystalline Si-Films and Novel Concepts

Chair(s): Sergey Varlamov, Ivan Gordon

(378-I31) **Boron doped SRO/SiO2 and SRN/SiNx bilayers on Molybdenum substrates for vertical structured Si quantum dot solar cells.** Ziyun Lin, Lingfeng Wu, Xuguang Jia, Tian Zhang, Binesh Puthen-Veettil, Terry Chien-Jen Yang, Hongze Xia, Gavin Conibeer, Ivan Perez-Wurfl. *University of New South Wales, Sydney, Australia.*

(379-I33) **Effect of Deposition Temperature of Electron Beam Evaporated Silicon Thin Films on Glass Crystallized by Line Focus Diode Laser.** Jae Sung Yun[1], Jialiang Huang[1], Kyung Kim[1,2], Sergey Varlamov[1], Martin Green[1]. *[1]University of New South Wales, Sydney, Australia, [2]Suntech R&D Australia, Sydney, Australia.*

(380-I35) **Highly Controlled Crystalization of Silicon Thins Film on Low Cost Substrate by Pulsed Laser Annealing Process.** Munem Hossain, Mahbube Khoda Siddiki, Masud H Chowdhury. *University of Missouri – Kansas City, Kansas City, MO, USA.*

(381-I37) **Novel Fabrication of Si Thin film for Solar Cell Applications.** Chien-Ting Liu[1], Thiyagu Subramani[1], Chen-Chih Hsueh[1], Hong-Jang Syu[1], Song-Ting Yang[2], Ching-Fuh Lin[1,2,3]. *[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan, [2]Graduate Institute of Electronics Engineering, Nation Taiwan University, Taipei, Taiwan, [3]Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan.*

(382-I39) **Directional heating and cooling for controlled spalling.** Jan Hensen[1], Raphael Niepelt[1], Sarah Kajari-Schröder[1], Rolf Brendel[1,2]. *[1]Institute for Solar Energy Research Hamelin, 31860 Emmerthal, Germany, [2]Institute for Solid State Physics, Leibniz Universität Hannover, 30167 Hanover, Germany.*

(383-J1) **Heteroepitaxial silicon thin films on flexible polycrystalline metal substrates for crystalline photovoltaic solar cells: A comparison between physical vapor deposition and plasma-enhanced chemical vapor deposition.** Ying Gao, Pavel Dutta, Monika Rathi, Yao Yao, Milko Iliev, Jae-Hyun Ryou, Venkat Selvamanickam. *Department of Mechanical Engineering & Texas Center for Superconductivity, University of Houston, Houston, TX, USA.*

(384-J3) **Ion Energy Threshold in Low Temperature Silicon Epitaxy for Thin Film Crystalline Photovoltaic.** Bastien Bruneau[1], Romain Cariou[1,2], Jean-Christophe Dornstetter[1,3], Erik Johnson[1], Pere Roca i Cabarrocas[1]. *[1]LPICM, Ecole Polytechnique, Palaiseau, France, [2]2III-V lab a joint laboratory between Alcatel-Lucent Bell Labs France, Thales Research and Technology and CEA-LETI, Marcoussis, France, [3]Total, Paris la Defense, France.*

(385-J5) **Structural characterization of oriented crystalline silicon film grown on SiO2, Sapphire, TiO2 and Nickel Substrate by Hot Wire Chemical Vapour Deposition.** Md Abul Hossion[1], Brij M. Arora[2]. *[1]Applied Physics, Electronics and Communication Engineering, University of Dhaka, Dhaka, Bangladesh, [2]Electrical Engineering, Indian Institute of Technology Bombay,, Mumbai, India.*

(386-J7) **Nanostructured Silicon Oxide Film for Enhanced Crystalline Solar Cell.** Abdulla Tahhan[1], Zahir Dehouche[1], Tony Anson[2], George Fern[3]. *[1]School of Engineering and Design, Brunel University, Uxbridge, UK, [2]Experimental Techniques Centre, Brunel University, Uxbridge, UK, [3]Wolfson Centre for Materials Processing, Brunel University, Uxbridge, UK.*

(387-J9) **Titanium Dioxide Nanoparticles for Enhanced Monocrystalline Solar Cell.** Chiara Breda[1], Zahir Dehouche[1], Abdulla Tahhan[1], Tony Anson[2], George Fern[3]. *[1]School of Engineering and Design, Brunel University, Uxbridge, UK, [2]School of Engineering and Design, Brunel University, Uxbridge, UK, [3]School of Engineering and Design, Brunel University, Uxbridge, UK, [4]Experimental Techniques Centre, Brunel University, Uxbridge, UK, [5]Wolfson Centre for Materials Processing, Brunel University, Uxbridge, UK.*

(388-J11) **Inteference Lithography for the Fabrication of Light-Trapping Structures on Ultra-thin Crystalline Silicon Solar Cells.** Kevin M.W. Boyd, Rafael N. Kleiman. *McMaster University, Hamilton, ON, Canada.*

(389-J13) **Reliability Model Development for Microsystems-Enabled Photovoltaics.** Benjamin B. Yang, Jose Luis Cruz-Campa, Gaddi S. Haase, Paiboon Tangyunyong, Murat Okandan, Gregory N. Nielson. *Sandia National Laboratories, Albuquerque, NM, USA.*

(390-J15) **Comparative Studies of Single-crystalline-like Ge Thin Film on Inexpensive Flexible Metallic Substrates.** Yao Yao[1], Pavel Dutta[1], Monika Rathi[1], Ying Gao[1], Yongkuan Li[1], Bernhard Holzapfel[2], Venkat Selvamanickam[1]. *[1]University of Houston, Houston, TX, USA, [2]2Karlsruhe Institute of Technology, Karlsruhe, Germany.*

(391-J17) **Analyzing Si-SiGe thin-film solar cell by simulation and calculation.** C.-F. Hsieh[1], Y.-T. Li[1], H.-S. Wu[1], T.-C. Wu[1], M. H. Liao[2]. *[1]Industrial Technology Research Institute, Hsinchu, Taiwan, [2]National Taiwan University, Taipei, Taiwan.*

(392-J19) **PC1D Analysis of Thin-Film crystalline Si1-xGex/ Si Solar Cells.** Adnan Ali[1], Ayu Wazira[3], Kamaruzzaman Sopian[2], Saleem H Zaidi[2]. *[1]Government College University, Faisalabad, Pakistan, [2]Universiti Kebangsaan Malaysia, Bangi, Malaysia, [3]Universiti Malaysia Perlis, Kangar, Malaysia.*

(393-J21) **Numerical Analysis and Optimum Design of Efficient µc-Si/µc-Si1-xGex Thin-film Solar Cells.** M. Amimul Ehsan, Mahbube Khoda Siddiki, Yang Yi. *University of Missouri-Kansas City, Kansas City, MO, USA.*

(394-J23) **Synthesis of oriented and passivated polycrystalline silicon films on glass by hot wire chemical vapor deposition.** Brij M Arora[1], Gurleen Kaur[2], Abul Md. Hossion[3], Kulasekaran M[1]. *[1]Dept. of Electrical Engineering, IITBombay, Mumbai, India, [2]Dept. of Electronics Technology, Guru Nanak Dev University, Amritsar, India, [3]Department of Applied Physics, University of Dhaka, Dhaka, Bangladesh.*

Area 9 - Posters

7:00 - 8:15 PM **Exhibit Hall D**

Module Modeling & Integrated Electronics

Chair(s): Billy Hayes, Aron Dobos, Dragan Maksimovic

(395-M18) **Active Optimal Optical Filtering of Wavelengths for Increasing the Efficiency of Photovoltaic Modules.** Sharif Z Aljoaba, Aaron M Cramer, Bruce L Walcott. *Department of Electrical and Computer Engineering, University of Kentucky, Lexington, KY, USA.*

(396-M20) **Modeling the Incidence Angle Dependence of Photovoltaic Modules in PVsyst.** Junaid H. Fatehi, Kenneth J. Sauer. *Yingli Green Energy Americas, Inc., San Francisco, CA, USA.*

(397-M22) **Electrically Independent Subcircuits for a Seven-Junction Spectrum- Splitting Photovoltaic Module.** Cristofer A Flowers, Harry A Atwater. *California Institute of Technology, Pasadena, CA, USA.*

(398-M24) **Thermal Modeling of PV Modules Using Computational Simulation.** Davis R Hemenway[1,2], Walajabad Sampath[2], Hiroshi Sakurai[2], Kurt Barth[1,2]. *[1]Direct Solar, Fort Collins, CO, USA, [2]Colorado State University, Fort Collins, CO, USA.*

(399-M26) **Energy-economic comparison of photovoltaic modules equipped with a layer of conventional and improved phase-change material.** Ewald Japs, Stefan Krauter. *University of Paderborn, Paderborn, Germany.*

(400-M28) **A Comprehensive Method to Modeling and Simulation of Photovoltaic Module under Natural Environment.** Zhou Jian, Li Hongfei, Qiao Yingshuo, Gao Qi, Liu Yucheng, Liu Zhengxin. *Shanghai Institute of micro-system and information technology, Shanghai, China.*

(401-M30) **Outdoor characterizations to evaluate the low-light effect on photovoltaic modules yield.** Thomas Mambrini[1], Anne Migan[1], Christophe Longeaud[1], Laurent Prieur[2], Vincent Radivoniuk[2]. *[1]LGEP (Laboratoire de Genie Electrique de Paris), Gif sur Yvette, France, [2]Soleïs technologie, Noisiel, France.*

(402-M32) **New Data Set for Validating PV Module Performance Models.** Bill Marion[1], Allan Anderberg[1], Chris Deline[1], Joe del Cueto[1], Matt Muller[1], Greg Perrin[1], Jose Rodriguez[1], Steve Rummel[1], Timothy J Silverman[1], Frank Vignola[2], Rich Kessler[2], Josh Peterson[2], Steve Barkaszi[3], Nick Riedel[4], Larry Pratt[4], Bruce King[5]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]University of Oregon, Eugene, OR, USA, [3]Florida Solar Energy Center, Cocoa, FL, USA, [4]CFV Solar Test Laboratory, Albuquerque, NM, USA, [5]Sandia National Laboratories, Albuquerque, NM, USA.*

(403-N2) **Innovative AC photovoltaic module system using series connection and universal low-voltage micro inverters.** Mika Nuotio[1], Pierre J. Verlinden[2], Milan Ilic[1], Jon Bonanno[1]. *[1]Empower Micro Systems Inc., San Francisco, CA, USA, [2]Changzhou Trina Solar Energy Co. Ltd., Changzhou, China.*

(404-N4) **A Free and Open Source Finite-Difference Simulation tool for Solar Modules.** Bart E. Pieters. *Forschungszentrum Juelich, Juelich, Germany.*

(405-N6) **High Efficiency Flexible Triple Junction Solar Panels.** David A Scheiman[1], Phillip P Jenkins[1], Robert J Walters[1], Kelly Trautz[2], Raymond Hoheisel[3], Rao Tatavarti[4], Ray Chan[4], Haruki Miyamoto[4], Jessica Adams[4], Victor Elarde[4], Christopher Stender[4], Alexander Hains[4], Claiborne Mcpheeters[4], Chris Youtsey[4], Noren Pan[4], Mark Osowski[4]. *[1]Naval Research Laboratory, Washington, DC, USA, [2]George Washington University, Washington, DC, USA, [3]formerly Naval Research Laboratory, Washington, DC, USA, [4]Microlink Devices Inc, Niles, IL, USA.*

(406-N8) **Performance Evaluation of Novel Photovoltaic/ Thermal Module.** Huan-Liang Tsai, Chieh-Yen Hsu, Yung-Chou Chen. *Da-Yeh University, Chang-Hua, Taiwan.*

(407-N10) **Relating Indoor and Outdoor Performance of Bifacial Modules.** Bas B. Van Aken, Anna J. Carr. *ECN - Solar Energy, Petten, Netherlands.*

(408-N11) **Changes in the serial resistance of a- Si, a-/µc-Si and mono-crystalline PV modules during the year.** Johannes Arto Weicht, Frank U. Hamelmann, Alexander Domnik, Grit Behrens. *Fachhochschule Bielefeld - University of Applied Sciences Bielefeld, Minden, Germany.*

(409-N12) **Reconfigurable Power Management Using Novel Monolithically Integrated CMOS-on-PV Switch.** Jonathan West, Somayeh Imani, Olga Lavrova, William Cavanaugh, Jing Ji, Kanamu Pupijhu, Smitha Keshavmurthy, Jim Aarestad, Payman Zarkesh-Ha. *University of New Mexico, Albuquerque, NM, USA.*

(410-N13) **Relative Efficiency Revealed: Equations for k1-k6 of the PVGIS Model.** Georgi Hristov Yordanov. *University of Agder (UiA), Grimstad, Norway.*

(411-N14) **Determining the Effect of Temperature on Microinverter Inversion Efficiency.** Daniel M. Riley, Armando Fresquez. *Sandia National Laboratories, Albuquerque, NM, USA.*

Area 11 - Posters

7:00 - 8:15 PM **Exhibit Hall D**

Interconnections

Chair(s): Michael Coddington, Murali Baggu

(412-O25) **Evolution of the PV Industry in Argentina.** Julio A. Bragagnolo, Sebastian Kind, Andres Persello. *Universidad tecnologica Nacional, Buenos Aires, Argentina.*

(413-O26) **Robust Current Controller Based Solar-Inverter System Used for Voltage Regulation at a Substation.** Mohit Chhabra, Frank Barnes. *University of Colorado - Boulder, Boulder, CO, USA.*

(414-O27) **Robust Current Controller Design using Mu-Synthesis for Grid-Connected Three Phase Inverter.** Mohit Chhabra, Frank Barnes. *University of Colorado - Boulder, Boulder, CO, USA.*

(415-O28) **Photovoltaic Waste Characterization with Environmental Considerations.** Mary Kayla Collins, Annick Anctil. *Clemson University, Anderson, SC, USA.*

(416-O29) **Design and Performance of UNC-Charlotte Net-Zero Energy Solar House at the 2013 U.S. Department of Energy Solar Decathlon Competition.** Abasifreke Ebong[1,2], Valentina Cecchi[1,2], Mona Azarbayjani[1,3]. *[1]Energy Production and Infrastructure Center, Charlotte, NC, USA, [2]Department of Electrical and Computer Engineering, Charlotte, NC, USA, [3]College of Arts and Architecture, Charlotte, NC, USA.*

(417-O30) **Prospects for Photovoltaics in Sunny and Arid Regions: A Solar Grand Plan for Chile.** Vasilis Fthenakis[1,2], Alejandro Florenzano[3], Mario Grageda[4], Marco Lofat[3], Svetlana Ushak[4]. *[1]New York, NY, USA, [2]Upton, NY, USA, [3]Santiago, Chile, [4]ntofagasta, Chile.*

(418-O31) **Analysis Methodology to Identify the Technical Potential of Some Colombian Cities for the Development of Grid Connected PV Systems.** Johann Hernández[1], Carlos Arredondo[2], William Vallejo[3]. *[1]Universidad Distrital Francisco José de Caldas, Bogotá, Columbia, [2]Universidad de Medellín, Medellín, Columbia, [3]Universidad del Atlántico, Barranquilla, Columbia.*

(419-O32) **Criticality of Transparent Conductive Electrode Materials for PV Cells.** Ross J Jarrett[1], David A Dawson[2], Phillip Purnell[2]. *[1]Energy Research Institute, University of Leeds, Leeds, UK, [2]Institute for Resilient Infrastructure, University of Leeds, Leeds, UK.*

(420-O33) **Growth Rates In Metals Production for Large-scale PV Deployment.** Goksin Kavlak, James McNerney, Robert Jaffe, Jessika E. Trancik. *Massachusetts Institute of Technology, Cambridge, MA, USA.*

(421-O34) **Linking Performance of PV Systems in India with Socio-Economic Aspects of Installation.** Vivek Kuthanazhi[1], Shashwata Chattopadhyay[1], Rajiv Dubey[1], Jim Joseph John[1], Chetan Singh Solanki[1], Anil Kottantharayil[1], Brij M Arora[1], Narasimhan K.L. [1], Juzer Vasi[1], Arun Kumar[2], Sastry O.S[2]. *[1]National Centre for Photovoltaic Research and Education, Indian Institute of Technology Bombay, Mumbai, India, [2]Solar Energy Centre, Ministry of New and Renewable Energy, New Delhi, India.*

(422-O35) **Planning for Integration of Solar Photovoltaics into the Energy Needs of Villages through Local Self Governments: An experience in the state of Kerala, India.** Vivek Kuthanazhi, Anil Kottantharayil, Narayanan N. C. *National Centre for Photovoltaic Research and Educatioin, IIT Bombay, Mumbai, India.*

(423-O36) **Life cycle water use for photovoltaic electricity generation: a review and harmonization of literature estimates.** Jordan Macknick[1], Meldrum James[2], Syndi Nettles-Anderson[1], Garvin Heath[1], Ariel Miara[1]. *[1]National Renewable Energy Laboratory (NREL), Golden, CO, USA, [2]University of Colorado at Boulder, Boulder, CO, USA.*

(424-O37) **Photovoltaic Power Pattern Grouping Based on Bat Bio-Inspired Clustering.** Amr Abdullah A. Munshi, Yasser Abdel-Rady I. Mohamed. *University of Alberta, Edmonton, AB, Canada.*

(425-O38) **HOMER: A Valuable Tool to Facilitate the Financing Process of Photovoltaic Systems in Puerto Rico.** Anthony Perez-Santiago[1], Randy Ortiz-Dejesus[1], Eduardo I. Ortiz-Rivera[1]. *[1]IEEE, Mayaguez, PR, Puerto Rico, [2]IEEE, Mayaguez, PR, Puerto Rico, [3]IEEE, Mayaguez, PR, Puerto Rico.*

(426-O39) **"High-Resolution Residential Feeder Load Characterization and Variability Modelling".** Andrew Pohl, Jay Johnson, Santiago Sena, Robert Broderick, Jimmy Quiroz. *Sandia National Labs, Albuquerque, NM, USA.*

(427-O40) **Why Decentralised Solar Deployment can be a Game-Changer in India.** Janani Rangarajan.

(428-O41) **Kinesthetically Connecting Students to Power Produced by Photovoltaic Panels.** Steven S Robbins, Jeff L Alleman, Brent P Nelson. *NREL, Golden, CO, USA.*

(429-O42) **Representation of Solar Capacity Value in the ReEDS Capacity Expansion Model.** Benjamin O Sigrin, Patrick Sullivan, Eduardo Ibanez, Robert Margolis. *National Renewable Energy Laboratory, Golden, CO, USA.*

(430-O43) **Regional Atmosphere-Solar PV Interactions.** Parikhit Sinha[1], William Hayes[2], Lauren Ngan[2]. *[1]First Solar, Tempe, AZ, USA, [2]First Solar, San Francisco, CA, USA.*

(431-O44) **Profitability of PV electricity in Sweden.** Bengt Stridh[1,2], Stefan Yard[3], David Larsson[2,4], Björn Karlsson[2]. *[1]ABB Corporate Research, Västerås, Sweden, [2]Mälardalen University, Västerås, Sweden, [3]Lund University, Lund, Sweden, [4]Direct Energy, Örebro, Sweden.*

(432-O45) **Effect of Non-unity Power Factor Operation in Photovoltaic Inverters Employing Grid Support Functions** Sigifredo Gonzalez[1], Jason Neely[1], Michael Ropp[2] *[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Northern Plains Power Technologies, Brookings, SD, USA*

(433-O46) **Matching A/C Loads to Solar Peak Production Using Thermal Energy Storage in Building Cooling Systems – A Case Study at Arizona State University.** Natasa Vulic, Yongjie Zou, Malvika Patil, Sri Harsha Amilineni, Christiana B. Honsberg, Stephen M. Goodnick. *School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA.*

Joint Session: Areas 1,6 - Posters

8:15 - 9:30 PM **Exhibit Hall D**

Hybrid Organic / Inorganic and Perovskites

Chair(s): Annick Anctil, Yasuhiro Yamada, Woojun Yoon

(434-P40) **ZnO Nanowire/N719 dye/Polypyrrole-SWNT nanocomposite Solid State Dye Sensitized Solar Cells.** S. AbdulAmohsin[1,3], M. Mohammed[1,4], Z. Li[5], T. Chen[2]. *[1]Department of Applied Science, Unversity of Arkansas at Little Rock and Green Solar Cell Research, Little Rock, AR, USA, [2]Department of Physics and Astronomy, Unversity of Arkansas at Little Rock and Green Solar Cell Research, Little Rock, AR, USA, [3]College of Science, Thi-Qar University, Thi-Qar, Iraq, [4]College of Science, University of Al-Qadisiyah, Al-Qadisiyah, Iraq, [5]Electron Microbeam Analysis Laboratory, Ann Arbor, MI, USA.*

(435-P42) **Performance Optimization for Perovskite Based Solar Cells.** Sumanshu Agarwal[1], Pradeep R Nair[2]. *[1]Department of Energy Science and Engineering, IIT Bombay, Mumbai, India, [2]Department of Electrical Engineering, IIT Bombay, Mumbai, India.*

(436-P44) **Fabrication of Zinc Oxide Nanotube arrays for inverted solar cell.** Parvathy devi Balasubramaniam, Chi Cheng Yu, Yian Tai. *Department of Chemical Engineering, National Taiwan University of Science and Technology, Taipei, Taiwan.*

(437-P46) **Photovoltaic Properties of Synthesized Nanocrystalline Semiconductor.** Sagar Bhardwaj[1], Aisha Malik[1], S Hameed[1], M.J Siddiqui[2], M Muneer[3], M.M Haque[3]. *[1]Department of Electrical Engineering, Aligarh Muslim University, Aligarh, India, [2]Department of Electronics Engineering, Aligarh Muslim University, Aligarh, India, [3]Department of Chemistry, Aligarh Muslim University, Aligarh, India.*

(438-P48) **10% Efficiency Hybrid GaAs/PEDOT:PSS Solar Cells with Monolayer Graphene.** Kai-Yuan Cheng[1], Huai-Te Pan[1], Shu-Cheng Yu[1], Wei-Sheng Weng[1], Yi-Chun Lai[1], Yi-Cheng Lin[1], Yu-Chen Chen[1], Ming-Chin Li[2], H. W. Hu[1], Peichen Yu[1], Hsin-Fei Meng[2]. *[1]National Chiao-Tung University, Hsinchu, Taiwan, [2]National Chiao-Tung University, Hsinchu, Taiwan.*

(439-Q2) **Semi-transparent Perovskite Solar Cells for Hybrid Tandem Photovoltaics.** M. Greyson Christoforo[1], Colin D. Bailie[2], Jonathan P. Mailoa[3], Andrea Bowring[2], Eva L. Unger[2], William H. Nguyen[4], Julian Burschka[5], Norman Pellet[5], Jungwoo Z. Lee[3], Michael Grätzel[5], Rommel Noufi[6], Tonio Buonassisi[3], Alberto Salleo[2], Michael D. McGehee[2]. *[1]Department of Electrical Engineering, Stanford University, Stanford, CA, USA, [2]Department of Materials Science and Engineering, Stanford University, Stanford, CA, USA, [3]School of Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA, [4]Department of Chemistry, Stanford University, Stanford, CA, USA, [5]Laboratoire de Photoniques et Interfaces, Institut des Sciences et Ingénierie Chimiques, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland, [6]National Renewable Energy Laboratory, Golden, CO, USA.*

(440-Q4) **Characterization of Ion-Assisted, Coevaporated CH3NH3PbI3 Thin Films.** Alexander J. Cimaroli, Yanfa Yan. *University of Toledo, Toledo, OH, USA.*

(441-Q6) **Stable Low- Recombination at n-Si/TiO2 Hole-blocking Interface and Its Effect on Silicon Heterojunction Photovoltaics.** Janam Jhaveri[1,2], Sushobhan Avasthi[1], Ken A. Nagamatsu[1,2], James C. Sturm[1,2]. *[1]Princeton Institute for the Science and Technology of Materials (PRISM), Princeton, NJ, USA, [2]2Department of Electrical Engineering, Princeton University, Princeton, NJ, USA.*

(442-Q8) **Time and Light-Dependence of Electrical Passivation of c-Si Surfaces with Quinhydrone Constituent Solutions.** Nicole A. Kotulak, Meixi Chen, Nikolas Schreiber, Robert L. Opila. *University of Delaware, Newark, DE, USA.*

(443-Q10) **Highly Efficient Polymer Solar Cells with Inverted Structure by using KCl-Treated ZnO Nanorod Arrays.** Ching-Fuh Lin[1,2], Sheng Kai Chang[1], Chien Lee[1], Hsin-Che Lee[1]. *[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan, [2]Graduate Institute of Electronics Engineering, National Taiwan University, Taipei, Taiwan.*

(444-Q12) **P-type Semiconducting Polymer as the Emitter Layer of hydrogenated Amorphous Silicon Solar cells for Higher Cell Efficiency.** Abdul R Middya, Eric A Schiff. *Syracuse University, Syracuse, NY, USA.*

(445-Q14) **Fabrication of Low Cost Cu2CdSnS4 Based Counter Electrode for Dye Sensitized Solar Cells.** Krishnaiah Mokurala[1], Parag Bhargava [1], Sudhanshu Mallick[1]. *[1]Indian Institute of Technology Bombay, Mumbai, India, [2]Indian Institute of Technology Bombay, mumbai, India, [3]Indian Institute of Technology Bombay, mumbai, India.*

(446-Q16) **Transparent conductive oxide-less back contact dye-sensitized solar cell using Zinc porphyrin dye employing cobalt complex redox shuttle.** Md. Zaman Molla, Shyam S. Pandey, Yuhei Ogomi, Tingli Ma, Shuzi Hayase. *Kyushu Institute of Technology, Kitakyushu, Japan.*

(447-Q18) **Synthesis of Highly Crystalline 'Particle in Tube' TiO2 Nanostructures and its Application in Dye Sensitized Solar Cells.** Johns Naduvath[1], Parag Bhargava[2], Sudhanshu Mallick[3]. *[1]Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai, India, [2]Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai, India, [3]Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai, India.*

(448-Q20) **The influence of molecular interface modification on the charge dynamics of polymeric semiconductor / ZnO heterojunctions.** Elham Rezasoltani[1], Mingqing Wang[2], Ian. G. Hill[2], Carlos Silva[1]. *[1]Montreal University, Montreal, QC, Canada, [2]Dalhousie University, Halifax, NS, Canada.*

(449-Q22) **Non-toxic, Colloidal ZnS-AgInS2 Nanoparticles for Organic-Inorganic Hybrid Photovoltaics.** Erin M. Sanehira[1], Christine K. Luscombe[2], Lih Y. Lin[1]. *[1]Electrical Engineering Department, University of Washington, Seattle, WA, USA, [2]Materials Science and Engineering Department, University of Washington, Seattle, WA, USA.*

(450-Q23) **High Efficiency Hybrid Organic/Silicon-Nanohole Heterojunction Solar Cells.** Thiyagu Subramani[1], Chen-Chih Hsueh[1], Chien-Ting Liu[1], Hong-Jhang Syu[1], Song-Ting Yang[2], Ching-Fuh Lin[1,2,3]. *[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan, [2]Graduate Institute of Electronics Engineering, National Taiwan University, Taipei, Taiwan, [3]Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan.*

(451-Q24) **SURFACE-ENGINEERED SILICON NANOCRYSTALS AS HIGH ENERGY PHOTONS DOWNSHIFTERS FOR ORGANIC AND HYBRID SOLAR CELLS.** Vladimir Svrcek[1], Toshihiro Yamanari[1], Davide Mariotti[2], Somak Mitra[2], Koiji Matsubara[1]. *[1]AIST, Tsukuba, Japan, [2]Ulster University, Belfast, UK.*

(452-Q25) **Silicon Nanowire/Organic Hybrid Solar Cells with Zonyl Fluorosurfactanct Treated PEDOT:PSS.** Hong-Jhang Syu[1], Thiyagu Subramani[1], Chien-Ting Liu[1], Shu-Chia Shiu[1], Ching-Fuh Lin[1,2,3,4]. *[1]Graduate Institute of Photonics and Optoelectronics, National Taiwan University, Taipei, Taiwan, [2]Graduate Institute of Electronic Engineering, National Taiwan University, Taipei, Taiwan, [3]Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan, [4]Innovative Photonics Advanced Research Center, National Taiwan University, Taipei, Taiwan.*

(453-Q26) **The role of the hole-transport layer in perovskite solar cells – reducing recombination and increasing absorption.** Wolfgang Tress[1,2], Nevena Marinova[1], Olle Inganäs[2], Mohammad M Nazeeruddin[1], Shaik K Zakeeruddin[1], Michael Graetzel[1]. *[1]EPFL, Lausanne, Switzerland, [2]LiU, Linköping, Sweden.*

(454-Q27) **CdTe Solar Cells with A PCBM Back Contact.** Curtis J Walkons, Brett W Guralnick, Brian E McCandless, Robert W Birkmire. *University of Delaware, Newark, DE, USA.*

(455-Q28) **Low Temperature TiOx Compact Layer by Chemical Bath Deposition Method for Vapor Deposited Perovskite Solar Cells.** Kouhei Yamamoto[1], Ying Zhou[2], Takayuki Kuwabara[1,2], Koshin Takahashi[1,2], Masaru Endo[3], Atsushi Wakamiya[3,4], Yuhei Ogomi[5], Shuzi Hayase[5], Tetsuya

Taima[1,2,4]. *[1]Graduate School of Natural Science and Technology, Kanazawa University, Kanazawa, Japan, [2]RSET, Kanazawa University, Kanazawa, Japan, [3]Institute for Chemical Research, Kyoto University, Kyoto, Japan, [4]JST-PRESTO, Japan Science and Technology Agency (JST), Saitama, Japan, [5]Graduate School of Life Sciences and Systems Engineering, Kyushu Institute of Technology, Kitakyushu, Japan.*

(456-Q29) **Vapor Deposition of Organic-Inorganic Hybrid Perovskite Thin-films for Photovoltaic Applications.** Woojun Yoon[1], Janice E Boercker[1], Matthew P Lumb[1,2], Joseph G Tischler[1], PhillPhillip.Jenkins Jenkins[1], Robert J Walters[1]. *[1]Naval Research Laboratory, Washington, DC, USA, [2]The George Washington University, Washington, DC, USA.*

Area 2 - Posters

8:15 - 9:30 PM **Exhibit Hall D**

CIGS and CdTe

Chair(s): Oana Cojocaru-Mirédin, Reiner Klenk, Chris Ferekides

(457-B27) **All-Sputtered CdTe/CdS Thin Film Solar Cells with Indium Doped Highly Resistive Absorber Layer.** Tursunjan Ablekim, Santosh K. Swain, Kelvin G. Lynn. *Center for Materials Research, Washington State University, Pullman, WA, USA.*

(458-B30) **Method for Electrical-Structural Correlation in Isolated CdTe/CdS Islands.** Brandon A. Aguirre[1,2], Jose L. Cruz-Campa[2], Douglas Pete[3], Rafael Ordonez[1], Joseph Michael[2], David Zubia[1]. *[1]University of Texas at El Paso, El Paso, TX, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA, [3]Center for Integrated Nanotechnologies, Albuquerque, NM, USA.*

(459-B33) **Influence of Under-Laying Transparent Conducting Oxide on Properties of Cadmium Sulphide Layer Grown by RF Magnetron Sputtering.** Mohammed M. Aliyu[1], Muhammad A. Islam[2], Kammaruzzaman. Sopian[3], Nowshad Amin[4]. *[1]Kaduna Polytechnic, Kaduna, Nigeria, [2]Unversiti Kebangsaan, Bangi, Malaysia, [3]King Saudi University, Riyadh, Saudi Arabia.*

(460-B36) **Performance of transparent conductors on flexible glass and plastic substrates for thin film photovoltaics.** James M Burst[1], William L Rance[1], Daniel M Meysing[2], Colin A Wolden[2], Wyatt K Metzger[1], Sean M Garner[3], Pat Cimo[3], Timothy A Gessert[1], Teresa M Barnes[1], Matthew O Reese[1]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado School of Mines, Golden, CO, USA, [3]Corning, Inc., Corning, NY, USA.*

(461-B39) **A Molecular Dynamics Study on Defect Reduction in Thin Film Cd1-xZnxTe/CdS Solar Cells.** Jose J. Chavez[1], Xiaowang Zhou[2], Donald K. Ward[2], Jose L. Cruz-Campa[3], David Zubia[1]. *[1]University of Texas at El Paso, El Paso, TX, USA, [2]Sandia National Laboratories, Livermore, CA, USA, [3]Sandia National Laboratories, Albuquerque, NM, USA.*

(462-B42) **Injection Dependent Minority Carrier Lifetime and Defect Configuration in Thin Film CdTe Solar Cells.** Zimeng Cheng, Alan E. Delahoy, Ken K. Chin. *Department of Physics and CNBM New Energy Materials Research Center, New Jersey Institute of Technology, Newark, NJ, USA.*

(463-B45) **Electro-Optical Characterization Of n-CdS Nanowires/p-CdTe Heterojunction Solar Cell Devices.** Hongmei Dang[1], Sai Guduru[1], Vijay Singh[1]. *[1]University of Kentucky, Center for Nanoscale Science and Engineering, Department of Electrical and Computer Engineering, Lexington, KY, USA, [2]University of Kentucky, Center for Nanoscale Science and Engineering, Department of Electrical and Computer Engineering, Lexington, KY, USA, [3]University of Kentucky, Center for Nanoscale Science and Engineering, Department of Electrical and Computer Engineering, Lexington, KY, USA.*

(464-B48) **CIGS Absorber Layer by Single-step Non-vacuum Intense Pulsed Light Treatment of Inkjet-printed Film.** Sanjay R. Dhage, P.S. Chandrasekhar, S.B. Chandrasekhar, Shrikant V. Joshi. *International Advanced Research Center for Powder Metallurgy and New Materials, Hyderabad, India.*

(465-C3) **Characterization and modeling of Schottky barrier electron reflector in CdS/CdTe solar cells.** Hamid Z. Fardi. *University of Colorado, Denver, CO, USA.*

(466-C6) **Effect of Deposition Temperature on Reactively Sputtered CdS:O.** Corey R. Grice, Naba R. Paudel, Chuanxiao Xiao, Yanfa Yan. *The University of Toledo, Toledo, OH, USA.*

(467-C9) **Strong Surface Effects in Low Energy Electron Beam Induced Current Experiments – Experiment and Theory.** Paul M Haney, Yeayoung Yoon, Nikolai Zhitenev. *National Institute for Standards and Technology, Gaithersburg, MD, USA.*

(468-C12) **Design and Testing of Pilot-scale Cu and Mixed-vapor Ga-In Evaporation Sources.** Gregory M. Hanket, Shannon L. Fields, John R. Elliott. *Institute of Energy Conversion, University of Delaware, Newark, DE, USA.*

(469-C15) **The Formation of the MOSe2 Layer at CIGS/Mo interface and its Effect on the CIGS device Performance.** Falah S. Hasoon, Hamda A. Al-Thani. *National Energy and Water Research Center, Abu Dhabi, United Arab Emirates.*

(470-C18) **Oxygenated CdS window layers for thin film CdTe Photovoltaics by pulsed DC magnetron sputtering.** Piotr M Kaminski, Fabiana Lisco, Jake W Bower, Gianfranco Claudio, John M Walls. *CREST (Centre for Renewable Energy Systems and Technology), School of Electronic, Electrical and Systems Engineering, Loughborough, UK.*

(471-C21) **Challenges in deposition of wide band gap copper indium aluminum gallium selenide (CIAGS) thin films for tandem solar cells.** Sreejith Karthikeyan[1], Mandip Sibakoti[1], Richard Liptak[1,3], Sang Ho Song[1], Joel Abrahamson[2], Eray S Aydil[2], Stephen A Campbell[1]. *[1]Department of Electrical and Computer Engineering, University of Minnesota, Minneapolis, MN, USA, [2]Department of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, MN, USA, [3]Department of Physics and Optical Engineering, Rose-Hulman Institute of Technology, Terre Haute, IN, USA.*

(472-C24) **Multisource Close Space Sublimation Reactor for Deposition of Multilayer and Composite Films.** Damian Marrufo[1], Aldo Vidana[2], David Zubia[1], John McClure[2]. *[1]Electrical and Computer Engineering, University of Texas at El Paso, El Paso, TX, USA, [2]Metallurgical and Materials Engineering, University of Texas at El Paso, El Paso, TX, USA.*

(473-C27) **Morphological and Compositional Analysis of Electrodeposited Indium (III) Sulfide (In2S3) Films.** Maqsood Ali Mughal, M. Jason Newell, Joshua Vangilder, Shyam Thapa, Robert Engelken, B. Ross Carroll, J. Bruce Johnson, Kayla Wood. *Arkansas State University, Jonesboro, AR, USA.*

(474-C30) **Effect of Varying Process Parameters on CdTe Thin Film Device Performance and Its Relationship to Film Microstructure.** Amit H Munshi[1], Ali Abbas[2], John M Raguse[1], Kurt L Barth[1], Walajabad S Sampath[1], John M Walls[2]. *[1]Colorado State University, Fort Collins, CO, USA, [2]University of Loughborough, Loughboough, UK.*

(475-C33) **The Effect of Ga Content on the Selenization of Co-evaporated CuGa/In Films and their Photovoltaic Performance.** Christopher P. Muzzillo[1,2], Lorelle M. Mansfield[2], Clay DeHart[2], Karen Bowers[2], Robert C. Reedy[2], Bobby To[2], Rommel Noufi[3], Kannan Ramanathan[2], Timothy J. Anderson[1]. *[1]University of Florida, Gainesville, FL, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]Retired, Golden, CO, USA.*

(476-C36) **Numerical Modeling of CdTe Cell Degradation.** Marco Nardone[1], David Albin[2]. *[1]Bowling Green State University, Bowling Green, OH, USA, [2]National Renewable Energy Laboratory, Denver, CO, USA.*

(477-C39) **Stoichiometric Control via Periods of Open-circuit During Electrodeposition.** M. Jason Newell, Maqsood Ali Mughal, Joshua Vangilder, Shyam Thapa, Kayla Wood, Steven A. Hoke, Clay Kardas, J. Bruce Johnson, B. Ross Carroll, Robert Engelken. *Arkansas State University, Jonesboro, AR, USA.*

(478-C42) **Optical Emission Spectroscopy of High Power Impulse Magnetron Sputtering (HiPIMS) of CIGS Thin Films.** Jiří Olejníček[1], Zdeněk Hubička[1], Michal Kohout[1], Petra Kšírová[1], Michaela Brunclíková[1], Štěpán Kment[1], Martin Čada[1], Scott A. Darveau[2], Christopher L. Exstrom[2]. *[1]Institute of Physics of ASCR, Department of Low-Temperature Plasma, Prague, Czech Republic, [2]University of Nebraska at Kearney, Department of Chemistry, Kearney, NE, USA.*

(479-C45) **Band alignment of CBD deposited ZnOS/CIGS interface.** Joel W. Pankow, Glenn R. Teeter, K. Xerxes Steirer, Lorelle M. Mansfield, Rebekah L. Garris, Kannan Ramanathan. *National Renewable Energy Laboratory, Golden, CO, USA.*

(480-C48) **XPS study of sodium in Bridgman-grown CuInSe2+x.** Sunyoung Park, Clifford H. Champness, Ishiang Shih. *McGill University, Montreal, QC, Canada.*

(481-D3) **Study of CdS/CdTe solar cells activated with N-O2-CHClF2 gas mixture.** Juan Luis Peña[1], Inés Riech[2], Victor Rejón[1]. *[1]Applied Physics Department, CINVESTAV-IPN, Mérida, Mexico, [2]Materials Science Laboratory, Faculty of Engineering, University of Yucatán, Mérida, Mexico.*

(482-D6) **PbTe/CdTe Superlattices on ITO and a Solar Cell Made from CdTe/CdS.** Fei Qin, Pritpal Singh. *Department of Electrical and Computer Engineering, Villanova University, Villanova, PA, USA.*

(483-D9) **Optical Enhancement of Ultra-thin CIGS Solar Cells using Multi-layered Antireflection Coatings.** Grace Rajan[1], Abdel-Rahman Ibdah[2], Krishna Aryal[1], Tasnuva Ashrafee[1], Vikash Ranjan[1], Robert W Collins[2], Sylvain Marsillac[1]. *[1]Virginia Institute of Photovoltaics, Old Dominion University, Norfolk, VA, USA, [2]Department of Physics and Astronomy, The University of Toledo,, Toledo, OH, USA.*

(484-D12) **Structure Evolution In CIGS Deposition: An X-ray Diffraction Analysis With Rietveld Whole-Pattern Refinement.** Thaddeus A. Reese, Sandra B. Schujman, Richard J. Matyi. *SUNY College of Nanoscale Science and Engineering, Albany, NY, USA.*

(485-D15) **The CdS/CdTe solar cell protected by ITO/Mo bilayer at improved back contact.** Victor Rejón[1], Inés Riech[2], Eric Hernández[1], Patricia Quintana[1], Juan Luis Peña[1]. *[1]Applied Physics Department, CINVESTAV-IPN, Mérida, Mexico, [2]Materials Science Laboratory, Faculty of Engineering, University of Yucatán, Mérida, Mexico.*

(486-D18) **High lateral resolution of energy dispersive X-ray spectroscopy and cathodoluminescence on lamellae of CIGSe solar cells.** Sven Schönherr, Alexander Tille, Philipp Schöppe, Michael Oertel, Udo Reislöhner, Carsten Ronning. *Institut für Festkörperphysik, Friedrich Schiller Universität Jena, Max-Wien-Platz 1, Jena, Germany.*

(487-D21) **Optimization of Electrical Performance of Cu(In,Ga)Se2 Thin Film Solar Cells Sputtered from Quaternary Targets.** Grace H Shih[1], Sergey I Maximenko[2], Jesse Frantz[2], Jason Myers[2], Robel Bekele[3], Jeff Mittereder[2], Jas S Sanghera[2], Vinh Q Nguyen[2], David Scheiman[2], Raymond Hoheisel[4], Robert Walters[2]. *[1]Naval Surface Warfare Center, Crane Division, Crane, IN, USA, [2]Naval Research Laboratory, Washington, DC, USA, [3]University Research Foundation, Greenbelt, MD, USA, [4]The George Washington University, Washington, DC, USA.*

(488-D24) **Effect of sputtering sequence on the properties of Ag-Cu-In-Ga metal precursors and reacted (AgCu)(InGa)Se2 films.** Sina Soltanmohammad[1,2], Dominik M. Berg[1], William N. Shafarman[1,2]. *[1]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [2]Department of Materials Science and Engineering, University of Delaware, Newark, DE, USA.*

(489-D27) **Spray Pyrolysis of Backwall Superstrate CuIn(S,Se)2 Solar Cells.** Zhaoning Song, Adam B. Phillips, Patrick Krantz, Rajendra R. Khanal, Michael J. Heben. *Wright Center for Photovoltaics Innovation and Commercialization, School for Solar and Advanced Renewable Energy, Department of Physics and Astronomy, University of Toledo, Toledo, OH, 43606, USA, Toledo, OH, USA.*

(490-D30) **Anomalous dark current ideality factor (n > 2) in thin-film solar cells: the role of grain-boundary defects.** GIOVANNA SOZZI[1], ROBERTO MOSCA[2], MARCO CALICCHIO[2], ROBERTO MENOZZI[1]. *[1]Department of Information Engineering - University of Parma, PARMA, Italy, [2]IMEM-CNR Institute, PARMA, Italy.*

(491-E1) **A Combinatorial Approach to the Optimisation of Cd(1-x)ZnxS layers for CdTe Solar Cells.** Robert E Treharne[1], Andrew Clayton[2], Laurie, J Phillips[1], Jonathan D Major[1], Stuart J C Irvine[2], Ken Durose[1]. *[1]Stephenson Institute for Renewable Energy, University of Liverpool, Liverpool, UK, [2]Centre for Solar Energy Research, University of Glyndwr, St. Asaph, UK.*

(492-E4) **The Comparisons of Na Incorporation Into Epitaxial Single-crystal CIS and CIGS Cells.** Po-Chuan Tsai[1,2], Han-Ping D. Shieh[2], Angus Rockett[1], Robert Forest[3], Erten Eser[3]. *[1]University of Illinois, Urbana, IL, USA, [2]Department of Photonics & Display Institute, National Chiao Tung University, Hsinchu, Taiwan, [3]3Institute of energy conversion, University of Delaware, Newark, DE, USA.*

(493-E7) **Electrical and Compositional Characterization of Gallium Grading in Cu(In,Ga)Se2 Solar Cells.** Bradley West[1], Harvey Guthrey[2], Lei Chen[3], April Jeffries[1], Simone Bernardini[1], Barry Lai[4], Jorg Maser[4], William Shafarman[3], Mowafak Al-Jassim[2], Mariana Bertoni[1]. *[1]Ira A. Fulton Schools of Engineering, Arizona State University, Tempe, AZ, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]Institute of Energy Conversion, University of Delaware, Newark, DE, USA, [4]Advanced Photon Source, Argonne National Laboratory, Lemont, IL, USA.*

(494-E10) **Identifying Parasitic Current Pathways in CIGS Solar Cells by Modelling Dark JV Response.** Ben L Williams[1], S Smit[1], B J Kniknie[2], N J Bakkers[3], W M M Kessels[1], R E I Schropp[3], M Creatore[1]. *[1]Eindhoven University of Technology, Eindhoven, Netherlands, [2]TNO, Eindhoven, Netherlands, [3]ECN, Eindhoven, Netherlands.*

(495-E13) **Transition Metal Nitride Contacts for CdTe Photovoltaics.** Zhengfeng Yang, P. Koirala, R.W. Collins, K. Aryal, S. Marsillac, Angus Rockett., ,, .

(496-E16) **Application of CVD Graphene as Transparent Front Electrode in Cu(In,Ga)Se2 Solar Cell.** Ling Yin[1,2], Chunlei Yang[2], Kang Zhang[2], Hailin Luo[2], Xieqiu Zhang[1,2], Zhuang Liu[2], Guanming Cheng[2], Zhiyu Xiong[2], Xudong Xiao[1,2]. *[1]Department of Physics, The Chinese University of Hong Kong, Hong Kong, Hong Kong, [2]Center for Photovoltaic and Solar Energy, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China.*

Area 6- Posters

8:15 - 9:30 PM **Exhibit Hall D**

Organic PV Posters I: Organic Semiconductors

Chair(s): Dana Olson, Matt Menke, Moritz Riede

(497-J27) **Organic PV Cell Using Genetic Engineering.** Ami Elazari. *Millennium Solar, Tel Aviv, Israel.*

(498-J29) **Enhanced efficiency of inverted bulk heterojunction solar cells with embedded silica nanoparticles.** Sankara Rao Gollu[1], M S Murthy[2], Ramakant Sharma[1], Srinivas G[1], Swaroop Ganguly[2], Dipti Gupta[1,2]. *[1]Plastic Electronics and Energy Lab (PEEL), Department of Metallurgical Engineering and Material Science, Indian Institute of Technology Bombay, Mumbai, India, [2]National Centre for Photovoltaic Research and Education (NCPRE), Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai, India.*

(499-J31) **The Application of a Magnetic Field to Improve Polymer:fullerence Solar Cell Performance.** Fang-Chi Hsu[1], Chiang-Ting Chen[2], Chia-Chun Chen[3], Yang-Fang Chen[2]. *[1]Department of Materials Science and Engineering,National United University, Miaoli, Taiwan, [2]Department of Physics, National Taiwan University, Taipei, Taiwan, [3]Department of Chemistry, National Taiwan Normal University, Taipei, Taiwan.*

(500-J33) **Alternative Acceptors for Bulk Hetrojunction Organic Photovoltaics.** Chaz Keiderling. *Imperial College London, London, UK.*

(501-J35) **Influence of solvent on the molecular ordering of thin films of P3HT:PCBM blends and precursor solution.** Andres F Loaiza[1], Camilo A Otalora[1], Gerardo Gordillo[2]. *[1]Departamento de Química, Universidad Nacional de Colombia, Bogota, Columbia, [2]Departamento de Física, Universidad Nacional de Colombia, Bogota, Columbia.*

(502-J37) **Charge Transport Kinetics in Organic Bulk Heterojunction Morphologies: Mesoscale Monte Carlo Simulation Analysis.** Ishtiaq Maqsood[1,3], Lance D Cundy[2], Matt Biesecker[2], Jung-Han Kimn[2], Elise Darlington[3], Ethan P Hettwer[3], Sabina Schill[3], Venkat Bommisetty[1]. *[1]Department of Electrical Engineering and Computer Science, Brookings, SD, USA, [2]Department of Mathematics and Statistics, Brookings, SD, USA, [3]NSF-REU Participants, Brookings, SD, USA.*

(503-J39) **New Generation of Biomorph Integrated with TCO and Thermoelectric to Enhance Efficiency in Wide Solar Spectrum Solar Cell.** Kathleen E. Martin[1], Matt Erdman[1], Hope Quintana[2], Julio Martinez[2], John Shelnutt[1], Olga Lavrova[1], Tito Busani[1]. *[1]University of New Mexico, Albuquerque, NM, USA, [2]New Mexico State University, Las Cruces, NM, USA.*

(504-K1) **Synthesis and Photovoltaic Properties of a New Donor-Acceptor Conjugated Polymer Based on Fluorinated Benzothiadiazole Units.** Hussein Medlej[1], Ali Nourdine[1], Hussein Awada[2], Mamatimin Abbas[3], Christine Dagron-Lartigau[2], Guillaume Wantz[3], Lionel Flandin[1]. *[1]Université de Savoie - LEPMI/ LMOPS, Le Bourget du Lac, France, [2]Université de Pau - IPREM/ EPCP, Pau, France, [3]Univeristé de Bordeaux 1 - IMS, Pessac, France.*

(505-K3) **Influence of Valence band tail width on Performance of P3HT: PCBM Bulk-heterojunction Solar Cell: AMPS-1D simulation study.** BUSHRA MOHAMED OMER. *Taif University, Taif, Saudi Arabia.*

(506-K5) **High Open Circuit Voltage Organic Photovoltaics: Minimizing Energetic Loss with a High Band Gap Donor Polymer and a Small-Molecule Acceptor.** David P. Ostrowski[1], Unsal Koldemir[2], Ryan Anderson[2], Alan Sellinger[2,3], Sean E. Shaheen[1,4]. *[1]University of Colorado at Boulder, Boulder, CO, USA, [2]Colorado School of Mines, Golden, CO, USA, [3]National Renewable Energy Lab (NREL), Golden, CO, USA, [4]Renewable and Sustainable Energy Institute (RASEI), Boulder, CO, USA.*

(507-K7) **Synthesis, Electrochromic and Organic Photovoltaic Properties of a Benzotriazole and Triphenylamine Bearing Random Copolymer.** Serife Ozdemir Hacioglu[1], Gonul Hizalan[1], Ali Cirpan[1,2,3,4], Levent Toppare[1,3,4,5]. *[1]1, Department of Chemistry, Middle East Technical University, 06800 Ankara, Turkey, [2]2, Department of Micro and Nanotechnology, Middle East Technical University, Ankara 06800, Turkey, [3]3, Department of Polymer Science and Technology, Middle East Technical University, 06800 Ankara, Turkey, [4]4, The Center for Solar Energy Research and Application (GÜNAM), Middle East Technical University, 06800 Ankara, Turkey, [5]5, Department of Biotechnology, Middle East Technical University, 06800 Ankara, Turkey.*

(508-K9) **Explaining the Molecular Structure of the Bulk Heterojunction with Simple Electronic Measurements and Marcus-Hush Theory for Squaraine:PCBM Organic Photovoltaic Devices.** Susan Spencer[1], Patrick Heaphy[1], Cortney Bougher[2], Brad Conrad[2], John Andersen[1], Jeremy Cody[1], Scott Misture[3], Chris Collison[1]. *[1]Rochester Institute of Technology, Rochester, NY, USA, [2]Appalachian Institute of Technology, Boone, NC, USA, [3]Alfred University, Alfred, NY, USA.*

(509-K11) **2D Conjugated Systems and Inerfaces for Photovoltaic Devices.** Hsing-Lin Wang, Wanyi Nie, Aditya Mohite, Cheng-Yu Kuo, Hsinghan Hsai, Sergei Tretiak, Dmitry Yarotski, Gautam Gupta. *Los Alamos National Laboratory, Los Alamos, NM, USA.*

(510-K13) **liner-shaped d(a-ar)2 small molecule with enhanced π-system of arene-appended moiety for efficient solution-processed organic solar cells.** zhang youming, xiao manjun, tan hua, wang yafei, liu yu, zhu weiguo. *College of Chemistry, Xiangtan University, Key Lab of Environment-Friendly Chemistry and Application in Ministry of Education, xiangtan 411105, China.*

Area 7- Posters

8:15 - 9:30 PM **Exhibit Hall D**

Space PV Cells and Systems

Chair(s): Kazunori Shimazaki, David Scheiman

(511-K14) **Balance sheets of energy and carriers and subcell characteristics in a GaInP/GaAs/Ge tandem solar cell.** Shaoqiang Chen[1], Lin Zhu[1], Masahiro Yoshita[1], Toshimitsu Mochizuki[1], Changsu Kim[1], Hidefumi Akiyama[1], Mitsuru Imaizumi[2], Yoshihiko Kanemitsu[3]. *[1]Institute for Solid State Physics, University of Tokyo, and JST-CREST, Kashiwa, Japan, [2]Japan Aerospace Exploration Agency (JAXA), Tsukuba, Japan, [3]Institute for Chemical Research, Kyoto University, and JST-CREST, Kyoto, Japan.*

(512-K15) **Modeling and Parametric Simulation of Triple Junction Solar Cell for Space Applications.** Simone Colasanti[1], Helmut Nesswetter[1,2], Claus G. Zimmermann[2], Paolo Lugli[1]. *[1]Technical University Munich (TUM), Munich, Germany, [2]Solar Array Center, EADS Astrium, Munich, Germany.*

(513-K16) **An Electric Power Supply Design for the Space Plasma Ionic Charge Analyzer (SPICA) CubeSat.** Rachid Darbali-Zamora, Daniel A. Merced -Cirino, Cesar S. Gonzalez-Ortiz, Eduardo I. Ortiz-Rivera. *University of Puerto Rico, Mayagüez Campus, Mayagüez, PR, USA.*

(514-K17) **Dry Epitaxial Lift-off for III-V solar cells.** John Farah[1], John Nicholson[2], Sekar Thirunavukkarasu[2], Kilian Wasmer[3]. *[1]OptiCOMP Networks, Attleboro, MA, USA, [2]University of Massachusetts, Amherst, MA, USA, [3]University of Massachusetts, Amherst, MA, USA, [4]Swiss Federal Laboratory for Materials Science EMPA, Thun, Switzerland.*

(515-K18) **Fast Ambient Pressure Thermal cycling of space solar array samples under equivalent AM0 illumination conditions.** Emilio Fernandez Lisbona.

(516-K19) **Establishing Suitability of Standard Multijunction Solar Cells For MARS ORBITER MISSION.** Usha G, Vasudevan R, Krishnapriya G, Uma B R, Sankaran M. *Power Systems Group, ISRO Satellite Centre, Bangalore, India.*

(517-K20) **AM0 Solar Cell Calibration Under Near Space Conditions.** Raymond Hoheisel[1], David Wilt[2], David Scheiman[3], Phillip Jenkins[3], Robert Walters[3]. *[1]George Washington University, Washington, DC, USA, [2]Air Force Research Laboratory, Kirtland AFB, NM, USA, [3]Naval Research Laboratory, Washington, DC, USA.*

(518-K21) **Radiation Hardness Investigation of PECVD Silicon Carbide Layers for PV Applications.** Jozef Huran[1], Pavol Boháček[1], Sergey A. Kulikov[2], Eugeny P. Shabalin[2], Vlasta Sasinkova[3], Angela Kleinova[4], Alexander P. Kobzev[2], Maria Sekáčová[1], Juraj Arbet[1]. *[1]Institute of Electrical Engineering, Slovak Academy of Sciences, Bratislava, Slovakia, [2]Joint Institute for Nuclear Research, Dubna, Russia, [3]Institute of Chemistry, Slovak Academy of Sciences, Bratislava, Slovakia, [4]Polymer Institute, Slovak Academy of Sciences, Bratislava, Slovakia.*

(519-K22) **Properties of N-H Local Vibration Modes in GaAsN Grown by Chemical Beam Epitaxy.** Kazuma Ikeda, Akira Yamakata, Koushiro Demizu, Nobuaki Kojima, Yoshio Ohshita, Masafumi Yamaguchi. *Toyota Technological Institute, Nagoya, Japan.*

(520-K23) **In-Flight I-V Results from the 2nd Forward Technology Solar Cell Experiment.** Phillip P. Jenkins[1], Maria Gonzalez[2], Justin Lorentzen[1], Joseph M. Flatico[3], Michael J. Krasowski[4], Lawrence Greer[4], Kelly Trautz[1]. *[1]Naval Research laboratory, Washington, DC, USA, [2]Soltera Defense Solutions, Annapolis Junction, MD, USA, [3]Ohio Aerospace Institute, Cleveland, OH, USA, [4]NASA GLenn Research center, Cleveland, OH, USA.*

(521-K24) **Radiation Resistance of Super-Straight Type Amorphous Silicon Germanium Alloy Solar Cells.** Shin-ichiro Sato[1], Tomomi Meguro[2], Takashi Suezaki[2], Kenji Yamamoto[2], Takeshi Ohshima[1]. *[1]Japan Atomic Energy Agency, Takasaki, Japan, [2]Kaneka Corporation, Settsu, Japan.*

(522-K25) **The effects of Indium Pre-Evaporation on Rotational Twin Formation in GaAs films on Si(111).** Hidetoshi Suzuki[1], Daiki Ito[2], Akihiro Haga[2], Atsuhiko Fukuyama[2], Tetsuo Ikari[2]. *[1]Interdisciplinary Research Organization, University of Miyazaki, Miyazaki, Japan, [2]Faculty of Engineering, University of Miyazaki, Miyazaki, Japan.*

(523-K26) **Structural Design of Laser-Photovoltaic Power Converter.** Hiroaki Suzuki[1], Hiroyuki Yoshida[1], Katsuto Kisara[2], Tetsuya Nakamura[1], Mitsuru Imaizumi[1]. *[1]Japan Aerospace Exploration Agency, Tsukuba, Japan, [2]Japan Aerospace Exploration Agency, Kakuda, Japan.*

(524-K27) **Modeling of a Gallium Arsenide Solar Cell under Low Intensity and Low Temperature Conditions for Space Applications.** Paul von Allmen, Jonathan Grandidier, Paul Stella. *Jet Propulsion Laboratory, Pasadena, CA, USA.*

(525-K28) **Increased Radiation Hardness in Ultra-Thin GaAs Single-Junction Solar Cells.** Jacob J Becker, Ying-Shen Kuo, Yong-Hang Zhang. *Arizona State University, Tempe, AZ, USA.*

Area 8- Posters

8:15 - 9:30 PM **Exhibit Hall D**

Characterization II

Chair(s): Harvey Guthrey, Keith Emery

(526-K30) **Investigation of Low Injection Effects Using the Local Ideality Factor Obtained From Effective Lifetime Measurements.** Ziv Hameiri[1], Fa-Jun Ma[1], Keith R. McIntosh[2]. *[1]Solar Energy Research Institute of Singapore, Singapore, Singapore, [2]PV Lighthouse, Coledale, Australia.*

(527-K33) **Light-Beam-Induced-Current Characterization of CdTe Solar Cells.** Russell M. Geisthardt, James R. Sites. *Colorado State University, Fort Collins, CO, USA.*

(528-K36) **Interfaces of Zinc Phosphide Magnesium Schottky Diodes.** Melissa Mushrush[1], Manish Sharma[1], Steve Rozeveld[1], Meaghan Woodward[1], Charlie Wood[1], Nick Shinkel[1], Phillip Small[1], Scott Sprague[1], Britt Vanchura[1], Alex Cimaroli[2], Naba Paudel[2], Yanfa Yan[2]. *[1]The Dow Chemical Company, Midland, MI, USA, [2]The University of Toledo, Toledo, OH, USA.*

(529-K39) **Photoluminescence Spectroscopy as a Tool for Quality Control of GaN Thin Film to be Used in Solar Cell Devices.** Guillermo Santana Rodríguez[1], Adolfo Mejia-Montero[1], Marel Monroy[1], Gerardo Contreras-Puente[2], Máximo López-López[3], Osvaldo De Melo[4]. *[1]Instituto de Investigaciones en Materiales-UNAM, Mexico City 04510, Mexico, [2]Escuela Superior de Física y Matemáticas-IPN,, exico City 07738, Mexico, [3]Centro de Investigación y de Estudios Avanzados-IPN,, Mexico City 07360, Mexico, [4]Facultad de Física, Universidad de la Habana, San Lazaro y L,, La habana, 10400, Cuba.*

(530-L2) **Numerical simulation of solar cell efficiencies in dependence of mc-Si brick materials lifetime and iron measurements.** Hannes Wagner[1], Bernhard Mitchell[2], Pietro Altermatt[1]. *[1]University of Hannover, Hannover, Germany, [2]University of New South Wales, Sydney, Australia.*

(531-L5) **Quantitative Heterodyne Lock-in Carrierographic Imaging of Silicon Wafers and Solar Cells.** Qiming Sun[1], Alexander Melnikov[2], Andreas Mandelis[1,2]. *[1]School of Optoelectronic Information, University of Electronic Science and Technology of China, Chengdu, China, [2]Center for Advanced Diffusion-Wave Technologies (CADIFT), Mechanical and Industrial Engineering, University of Toronto, Toronto, ON, Canada.*

(532-L8) **Induction of Internal Capacitance Effect of Organic Photovoltaic Device (OPV) by Real-Time One-Sweep Method (RTOSM) in I-V Measurement.** Yean-San Long, Shu-Tsung Hsu, Teng-Chun Wu, Yu-Tai Li. *Rm.213, Bldg.3, No. 321, Kuang Fu Road, Sec. 2, Hsinchu, Taiwan.*

(533-L11) **Non-Intrusive Cell Quantum Efficiency Measurements of Accelerated Stress Tested Photovoltaic Modules.** Brett Knisely, Joseph Kuitche, Govindasamy TamizhMani, Aaron Korostyshevsky, Halden Field., ,, .

(534-L14) **Challenges of Irradiance-mode Spectral Response Measurements.** Behrang H. Hamadani, John Roller, Brian Dougherty, Howard Yoon. *National Institute of Standards and Technology, Gaithersburg, MD, USA.*

(535-L17) **I-V light and dark curves characterization of laser induced damage removal by alkaline etching for laser edge isolated crystalline solar cells.** Aloña Otaegi, Vanesa Fano, Muhammad Azam Rasool, Jose Ruben Gutierrez, Juan Carlos Jimeno. *Technological Institute of Microelectronics, Zamudio, Spain.*

(536-L20) **Study of Al/a-SiC/c-Si(p)/Al structure prepared by PECVD.** Michal Váry[1], Jozef Huran[2], Milan Perný[1], Miroslav Mikolášek[1], Vladimír Šály[1], Juraj Packa[1], Alexander P. Kobzev[3]. *[1]Slovak University of Technology, Faculty of Electrical Engineering and Information Technology, Bratislava, Slovakia, [2]Slovak Academy of Sciences, Institute of Electrical Engineering, Bratislav, Slovakia, [3]Joint Institute for Nuclear Research, Dubna, Russia.*

(537-L23) **Digital Noise Spectroscopy System and Its Application to Solar Cells.** Armin Mehrabian[1], Raymond Hoheisel[1], David J. Nagel[1], Scott R. Messenger[2], Sergey Maximenko[3]. *[1]The George Washington University, Washington, DC, USA, [2]University of Maryland Baltimore County, Baltimore, MD, USA, [3]Naval Research Laboratory, Washington, DC, USA.*

(538-L26) **Spatially And Spectrally Resolved Temperature Dependence Of Defect Related Luminescence Using Hyperspectral Imaging.** Andreas Fløi, Ingunn Burud, Espen Olsen. *Norwegian University of Life Sciences, Ås, Norway.*

(539-L29) **In Situ PL Imaging Toward Real-Time Plating Process Control.** Jungwoo Z. Lee[1], Joseph T. Sullivan[1], Lynne Michaelson[2], Krystal Munoz[2], Tom Tyson[2], Anthony Gallegos[2], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Technic Inc., Cranston, RI, USA.*

(540-L32) **Accurate and Rapid Measurement of High-Capacitance PV Cells and Modules using a Single Short Pulse Light.** Hisashi Kojima[1], Kaztaka Iwamoto[1], Akio Shimono[1], Junichiro Abe[1], Yoshihiro Hishikawa[2]. *[1]Kyoshin Electric Co., Ltd., Kyoto, Japan, [2]AIST, Ibaraki, Japan.*

(541-M3) **Afterpulse Background Suppression in Time-Correlated Single Photon Counting Lifetime Experiments using Optimized Gate Filter.** Martin W Gerber, Rafael N Kleiman. *McMaster University, Hamilton, ON, Canada.*

(542-M6) **Nanoscale Photovoltaic Performance in Micro/Nanopatterned CdTe-CdS Thin Film Solar Cells.** Yasemin Kutes[1], James L Bosse[1], Brandon A Aguirre[3], Jose L Cruz-Campa[2], Joseph Michael[2], David Zubia[3], Erik D Spoerke[2], Bryan D Huey[1]. *[1]University of Connecticut, Storrs, CT, USA, [2]Sandia National Laboratories, Albaquerque, NM, USA, [3]University of Texas at El Paso, El Paso, TX, USA.*

(543-M9) **Induction of Internal Capacitance Effect of Organic Photovoltaic Device (OPV) by Real-Time One-Sweep Method (RTOSM) in I-V Measurement.** Yean-San Long, Shu-Tsung Hsu, Yu-Tai Li, Teng-Chun Wu. *Center for Measurement Standards, Industrial Technology Research Institute, Hsinchu, Taiwan.*

(544-M12) **Direct Observation of Grain Boundary PN Junction Potentials in CIGS Using Photoemission and Low Energy Electron Microscopy (PELEEM).** Calvin K. Chan[1], Taisuke Ohta[1], Gary L. Kellogg[1], Douglas Pernik[2], Brian Korgel[2], Lorelle Mansfield[3], Rommel Noufi[3], Kannan Ramanathan[3]. *[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]The University of Texas at Austin, Austin, TX, USA, [3]National Renewable Energy Laboratory, Golden, CO, USA.*

Area 10- Posters

8:15 - 9:30 PM **Exhibit Hall D**

Performance Modeling and Validation II

Chair(s): Billy Hayes, Martin Waters

(545-N16) **Critical Voltage Perturbation Size For An Open-loop Perturb-and-Observe (P&O) Maximum Power Point Tracking (MPPT) Grid-Connected Solar Photovoltaic (PV) System.** Emmanuel K. Anto, Philip Y. Okyere, Johnson A. Asumadu., ,, .

(546-N20) **Effect of module temperature and seasonal variation analysis of the outdoor performance of CdTe at composite climate of India.** Birinchi Bora[1], O.S. Sastry[1], A Kumar[1], Y.K Singh[1], K. Yadav[1], R Singh[1], M Bangar[1]. *[1]Solar Energy centre, Gurgaon, India, [2]Solar Energy centre, Gurgaon, India, [3]Solar Energy centre, Gurgaon, India, [4]Solar Energy centre, Gurgaon, India, [5]Solar Energy centre, Gurgaon, India, [6]Solar Energy centre, Gurgaon, India, [7]Solar Energy centre, Gurgaon, India.*

(547-N24) **Complete PV Power Plant Certification: New Standards for Quality Assurance of Large Scale PV Power Plants.** Boris Farnung[1], Peter Bostock[2], Jonas Brückner[3], Klaus Kiefer[1]. *[1]Fraunhofer ISE, Freiburg, Germany, [2]VDE Americas, San Francisco, CA, USA, [3]VDE Testing and Certification Institute, Offenbach, Germany.*

(548-N28) **Spatial Variations in Temperature Across a Photovoltaic Array.** Michaela Farr, Joshua S Stein. *Sandia National Laboratories, Albuquerque, NM, USA.*

(549-N32) **Use of the Suns-Voc for Diagnosing Outdoor Arrays & Modules.** M. Keith Forsyth[1], Matthew Mahaffey[2], Adrienne L. Blum[1], Weston A. Dobson[1], Ronald A. Sinton[1]. *[1]Sinton Instruments, Boulder, CO, USA, [2]Colorado School of Mines, Golden, CO, USA.*

(550-N36) **Validation of Multiple Flat Plate Photovoltaic Modeling Tools Against Measured Data.** Janine Freeman, Jonathan Whitmore, Nate Blair, Aron P. Dobos. *National Renewable Energy Laboratory, Golden, CO, USA.*

(551-N40) **Inverter Induced Photovoltaic System Efficiency Losses.** Fan He, Liang Ji, Tim Zgonena, Christopher Flueckiger, Bengt Jaeckel, Paul Brazis. *UL LLC, Northbrook, IL, USA.*

(552-N44) **An Advance Geometrical Maximum Power Point Trageting Technique for Solar Photovoltaics using Current-Voltage Chracteristic.** Gaurav Kumar[1], Ashish Panchal[2]. *[1]S V N I T, Surat, India, [2]SVNIT, Surat, India.*

(553-N48) **Seasonal quality factor; 60 kWp PV system at north Mexico City.** Yasuhiro Matsumoto[1], Jose Antonio Urbano[1], Oscar Iván Gómez[1], René Asomoza[1], Gabriela López[1], Ramón Peña[1], Claudia López[2]. *[1]Research Center and Advanced Studies of the National Polytechnic Institute, Mexico, Mexico, [2]Fronius SA de CV, Mexico, Mexico.*

(554-O4) **Operational Performance of Grid-Connected PV Systems.** Panagiotis Moriartis, Wilfried G.J.H.M. Van Sark. *Utrecht University, Copernicus Institute, Utrecht, Netherlands.*

(555-O8) **Performance Characterization of Cadmium Telluride Modules Validated by Utility Scale and Test Systems.** Lauren Ngan[1], Nicholas Strevel[1], Kendra Passow[1], Alex F. Panchula[1], D.C. Jordan[2]. *[1]First Solar, San Francisco, CA, USA, [2]National Renewable Energy Lab, Golden, CO, USA.*

(556-O12) **Self-Reported Field Efficiency of Utility-Scale Inverters.** Kendra Passow, Lauren Ngan, Alex Panchula. *First Solar, San Francisco, CA, USA.*

(557-O16) **A Practical Perspective on Grid-tied PV Systems in Low Reliability Grids.** Saad Pervaiz[2], Hassan A Khan[1], Muhammad Ali Qureshi[1]. *[1]Dept of Electrical Engineering, LUMS, Lahore, Pakistan, [2]University of Colorado at Boulder, Denver, CO, USA.*

(558-O19) **Ambient Temperature Correction of Photovoltaic System Performance Data.** Bryson Rupnik, Owen Westbrook. *juwi solar Inc, Boulder, CO, USA.*

(559-O22) **Performance of a 34 kWp Grid-Connected PV System in Indonesia – A Comparison of Tropical and European PV Systems.** Anton J. Veldhuis, Angele H.M.E. Reinders. *University of Twente, Enschede, Netherlands.*

(560-O24) **Uniform and Partial Shading Conditions.** Antony Xenophontos, Ali Bazzi. *University of Connecticut, Storrs, CT, USA.*

Area 12- Posters

8:15 - 9:30 PM **Exhibit Hall D**

Reliability 1

Chair(s): Michelle Propst, Allan Ward, Shubhra Bansal

(561-O47) **Properties of encapsulation materials and their relevance for recent field failures.** Juliane Berghold, Benjamin Frohmann, Simon Koch, Paul Grunow. *PI Berlin AG, Berlin, Germany.*

(562-P1) **Supplemental Methods to Analyze Ageing of PV Modules on Module Level.** Nicolas Bogdanski, Gerhard Mathiak. *TÜV Rheinland Energie und Umwelt, Cologne, Germany.*

(563-P3) **PID Results at low irradiances.** Benoit Braisaz[1], Khalid Radouane[2]. *[1]EDF R&D, Ecuelles, France, [2]EDF EN, La Défense, France.*

(564-P5) **Water Cooking for Backsheet and PV Module Endurance Evaluation.** Maoyi Chang, Haomin Chen, Chienyu Chen, C. H. Hsueh, W. J. Hsieh. *AU Optronics, Taichuang, Taiwan.*

(565-P7) **Optimize Silicon Solar Cell Micro-Structure for Lowering PV Module Power Loss by Thermal Cycling Induced.** Wen-Tai Chung, Chien-Wen Chen. *Motech Industries, Inc., Tainan, Taiwan.*

(566-P9) **A Modeling of Soldering Adhesion Forecast for the Crystalline Silicon Solar Cell.** Wen-Tai Chung, Wei-Cyun Lee, Chi-Kun Wu, Yu-Ting Hung, Chien-Wen Chen. *Motech Industries, Inc., Tainan, Taiwan.*

(567-P11) **Device for Comprehensive Analysis of Leakage Current Paths in Photovoltaic Module Packaging Materials.** Neelkanth G. Dhere, Narendra S. Shiradkar, Eric Schneller. *Florida Solar Energy Center, University of Central Florida, Cocoa, FL, USA.*

(568-P13) **Recovery after potential induced degradation of CuIn1-xGaxSe2 solar cells with CdS and Zn(O,S) buffer layers.** Viktor Fjällström, Bart Vermang, Pedro Salomé, Piotr Szaniawski, Fredrik Rostvall, Uwe Zimmermann, Marika Edoff. *Ångström Solar Center, Solid State Electronics, Uppsala University, Ångström Laboratory, PO Box 534, SE-75121, Uppsala, Sweden.*

(569-P15) **One-Dimensional Reaction-Diffusion Simulation of Cu Migration in Polycrystalline CdTe Solar Cells.** Da Guo[1], Richard Akis[1], Daniel Brinkman[2], Igor Sankin[3], Tian Fang[3], Dragica Vasileska[1], Christian Ringhofer[2]. *[1]School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA, [2]School of Mathematical and Statistical Science, Arizona State University, Tempe, AZ, USA, [3]First Solar, Perrysburg, OH, USA.*

(570-P17) **Establishing the long term moisture barrier performance of the edge seal from accelerated testing.** Kedar Y Hardikar, Dan Vitkavage, Ajay Saproo, Todd Krajewski.

(571-P19) **Solder joint failure modes in crystalline Si PV modules operated in the field for 10 years.** uichi itoh[1], Tetsuro Nishimura[2], Takuro Fukami[2], Kenji Takamura[2], Akira Kita[2], Ryosuke Miyabayashi[3], Hideo Ohkuma[4]. *[1]AIST, Tsukuba, Japan, [2]Nihon Superior Co. LTD, Suita, Japan, [3]Nihon Superior Co. LTD, Suita, Japan, [4]Nihon Superior Co. LTD, Suita, Japan, [5]Nihon Superior Co. LTD, Suita, Japan, [6]NPC Incorporated, Tokyo, Japan, [7]HTO Inc., Yasu, Japan.*

(572-P21) **Prevention of Potential Induced Degradation with Thin Ionomer Film.** Jane Kapur, Katherine M Stika, Craig Westphal, Jennifer L Norwood, Babak Hamzavytehrany, Alison MA Bennett. *E. I. DuPont de Nemours & Co., Inc., Wilmington, DE, USA.*

(573-P23) **Study on the lifetime prediction of multilayer encapsulated organic solar cell under continuously varying environment.** Namsu Kim[1], Samuel Graham[2], Sung Hyun Kim[3], Kyung-Jun Hwang[1], Dajung Kim[1]. *[1]Components & Materials Physics Research Center, Korea Electronics Technology Institute, Seongnam, South Korea, [2]Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA, [3]Energy Nano Materials Research Center, Korea Electronics Technology Institute, Seongnam, South Korea.*

(574-P25) **Laboratory testing and long term performance assessment of various solar lighting systems.** Parimita Mohanty, Arvind Sharma, Richie Brian Stephen. *TERI, India Habitat Centre, Lodhi Road, New Delhi, India.*

(575-P27) **Stability of CZTS Thin Film Solar Cells upon Accelerated Thermal Cycling and Damp Heat Exposure.** Chien-Yi Peng[1,2], Tara P. Dhakal[2,3], Amin Emrani[2,3], Susan Lu[1], Charles R. Westgate[2,3]. *[1]Department of Systems Science and Industrial Engineering, State University of New York at Binghamton, Binghamton, NY, USA, [2]Center for Autonomous Solar Power (CASP), Binghamton University, Binghamton, NY, USA, [3]Department of Electrical and Computer Engineering, State University of New York at Binghamton, Binghamton, NY, USA.*

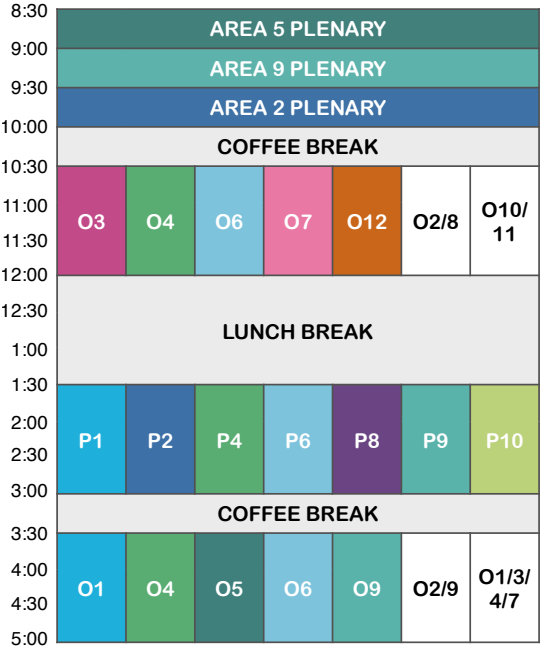
(576-P29) **Mirror Augmented Photovoltaics and Time Series Analytics of the I-V Curve Parameters.** Timothy J Peshek, Shay Mathews, Yang Hu, Roger H French. *Case Western Reserve University, Cleveland, OH, USA.*

(577-P31) **Measuring PV System Series Resistance Without IV Curves.** Joshua S Stein[1], Shawn McCaslin[2], Clifford W Hansen[1], William E Boyson[1], Charles D Robinson[1]. *[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Draker, Burlington, VT, USA.*

(578-P33) **CIGS PV Reliability - Current practices, Challenges and Approaches.** Rajalakshmi Sundaramoorthy, David Metacarpa, Jim R Lloyd, Pradeep Haldar. *US Photovoltaic Manufacturing Consortium (PVMC), SUNY College of Nanoscale Science and Engineering, Albany, NY, USA.*

(579-P35) **Desert Applications of PV Modules.** Karl-Anders Weiss, Michael Koehl, Elisabeth Klimm, Karolina Slamova, Timo Lorenz, Jan Herrmann. *Fraunhofer ISE, Freiburg, Germany.*

WEDNESDAY PROGRAM SUMMARY



	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 5 - Plenary

8:30 - 9:00 AM **Ballroom 3-4**

Thin Film Silicon Based PV Technologies

Chair(s): Franz-Josef Haug

8:30 **(580) Blazing New Paths to High Efficiency Amorphous Silicon Based Solar Modules**
Jun Lin[1], Julian Cashmore[2], Takashi Iwahashi[1], Junpei Sakurai[1], Paolo Losio[2], Jean Baptiste Orhan[3], Jochen Hoetzel[2], Sergej Ristau[2], Yukimasa Saito[1], Akihiro Tsuji[1], Tobias Roschek[2], Johannes Meier[3], Ivan Sinicco[2], Arno Zindel[2], Hiroaki Hayashi[1], Daisuke Matsunaga[1]
[1]Tokyo Electron Ltd., Tokyo, Japan, [2]TEL Solar AG, Trubbach, Switzerland, [3]TEL Solar-Lab SA, Neuchatel, Switzerland

Area 9 - Plenary

9:00 - 9:30 AM **Ballroom 3-4**

PV Modules and Manufacturing

Chair(s): Pierre Verlinden, Joshua Stein

9:00 **(581) Energy Modelling and Rating**
Steve Ransome
SRCL, Kingston upon thames, UK

Area 2 - Plenary

9:30 - 10:00 AM **Ballroom 3-4**

Chalcogenide Thin Film Solar Cells

Chair(s): Susanne Siebentritt

9:30 **(582) Thin Fim Chalcogenide PV: Progress in Research Breakthroughs and Industrial Developments**
Ayodhya N. Tiwari[1,2]
[1]Empa, Swiss Federal Laboratories for Materials Science and Technology, Duebendorf, Switzerland, [2]Flisom, Duebendorf, Switzerland

10:00 - 10:30 AM **Exhibit Hall D**

Coffee Break

Joint Session: Areas 2,8 - Orals

10:30 - 12:00 PM **MR 502-504**

Characterisation Methods for CIGS Solar Cells

Chair(s): Wyatt Metzger, Alex Redinger

10:30 **(583) Characterization of internal interfaces in Cu(In,Ga)Se2 thin-film solar cells using correlative microscopies (special invited speaker)**
Oana Cojocaru-MIrédin[1], Daniel Abou-Ras[2], Roland Wuerz[3], Rodrigo Saez-Araoz[2], Christian-Herbert Fischer[2], Dierk Raabe[1]
[1]Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany, [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany, [3]Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, Stuttgart, Germany

11:00 **(584) Quantitative micrometric imaging of thin films solar cells properties using Cu(In,Ga)Se2 microcells**
Laurent Lombez[1,2,3], Myriam Paire[1,2,3], Amaury Delamarre[1,2,3], Gilbert El-Hajje[1,2,3], Daniel Ory[1,2,3], Daniel Lincot[1,2,3], jean-françois Guillemoles[1,2,3]
[1]Institute for Research and Development on Photovoltaic Energy (IRDEP), EDF R&D, chatou, France, [2]IRDEP, CNRS, Chatou, France, [3]IRDEP-Chimie Paristech, Paris, France

11:15 **(585) Electroluminescence intensity analysis of neutral bulk and space charge region collection effects on large area CIGS module performance**
Guozhen Yue, Dingyuan Lu, Bernie Cheng, Baosheng Sang, B.J. Stanbery
HelioVolt Corporation, 6301-8 Stassney Lane, Austin, TX, USA

11:30 **(586) Real Time Spectroscopic Ellipsometry Analysis of the Three-Stages of $CuIn_{1-x}Ga_xSe_2$ co-Evaporation**
Puja Pradhan[1], Puruswottam Aryal[1], Abdel R Ibdah[1], Krishna Aryal[2], Jian Li[1], Nikolas J Podraza[1], Sylvain Marsillac[2], Robert W Collins[1]
[1]The University of Toledo, Toledo, OH, USA, [2]Old Dominion University, Norfolk, VA, USA

11:45 **(587) Charge Carrier Mobilities and Dynamics in Thin Film Compound Semiconductor Materials from Transient Thz Absorption**
Hannes Hempel, Christian Strothkämper, Christian Kaufmann, Justus Just, Rainer Eichberger, Thomas Unold
Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

Joint Session: Areas 10,11 - Orals

10:30 - 12:00 PM **MR 505-507**

System Grid Integration

Chair(s): Michael Coddington, Chris Barker

10:30 **(588) The Economic Value of Forecasts for Optimal Curtailment Strategies to Comply with Ramp Rate Rules**
Daniel Cormode, Antonio Lorenzo, William Holmgren, Sophia Chen, Alex Cronin
University of Arizona, Tucson, AZ, USA

10:45 **(589) Clustering Distribution Feeders in the Arizona Public Service Territory**
James Cale[1], Bryan Palmintier[1], Dave Narang[2], Kevin Carroll[2]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Arizona Public Service, Phoenix, AZ, USA

11:00 **(590) Examining System-Wide Impacts of Solar PV Control Systems with a Power Hardware-in-the-Loop Platform**
Tess Williams[1], Jason Fuller[1], Kevin Schneider[1], Bryan Palmintier[2], Blake Lundstrom[2], Sudipta Chakraborty[2]
[1]Pacific Northwest National Laboratory, Richland, WA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

11:15 **(591) Feeder Model Validation and Simulation for High-Penetration PV Deployment in the Arizona Public Service System**
Murali Baggu[1], Raja Ayyanar[2], David Narang[3]
[1]National Renewable Energy Laboratory, Golden, CA, USA, [2]Arizona State University, Phoenix, AZ, USA, [3]Arizona Public Service, Phoenix, AZ, USA

11:30 **(592) Evaluation of Reactive Power Control Capabilities of Residential PV in an Unbalanced Distribution Feeder**
John Seuss[1], Matthew J Reno[1,2], Ronald G Harley[1], Robert J Broderick[2]
[1]Georgia Institute of Technology, Atlanta, GA, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA

11:45 **(593) Verification of Protective Device Coordination in Distribution Systems with Photovoltaic Generation**
Yingying Tang, Raja Ayyanar
Arizona State University, Tempe, AZ, USA

Area 3 - Orals

10:30 - 12:00 PM **Ballroom 1CD**

Low Concentration Solar Cells and Receivers

Chair(s): Adam Plesniak, Pablo Garcia-Linares

10:30 **(594) Industrially Feasible All-Purpose Metal-Wrap-Through Concentrator Solar Cells**
Tobias Fellmeth[1], Raphael Efinger[1], Matthieu Ebert[1], Ingrid Hädrich[1], Florian Clement[1], Daniel Biro[1], Pablo Noriega[2], sebastian Caparros[2], Fernando Castano[2]
[1]Fraunhofer ISE, Heidenhofstr. 2, 79110 Freiburg im Breisgau, Germany, [2]Abengoa Solar New Technologies, Soland Center, Sanlucar la Mayor, 41800 Sevilla, Spain

10:45 **(595) A Low Concentration Receiver Concept for Cost Effective Crystalline Back Contact Cells**
Matthieu Ebert[1], Tobias Dörsam[1], Tobias Fellmeth[1], Ingrid Hädrich[1], Ulrich Eitner[1], Daniel Biro[1], Maike Wiesenfarth[1], Pablo Noriega[2], Sebastian Caparros[2], Fernando Castano[2]
[1]Fraunhofer ISE, Freiburg, Germany, [2] Abengoa Solar New Technologies, Sevilla, Spain

11:00 **(596) Ultra-Thin Defect-Tolerant High Efficiency III-V Tandems for Development of Low-Cost Photovoltaics.**
Alex Freundlich, Akhil Mehrotra, Manori V. Gunasekera, Gopi K. Vijaya
University of Houston, Houston, TX, USA

11:15 **(597) Hybrid Micro-scale CPV/PV Architecture**
Michael W. Haney, Tian Gu, Gautam Agrawal
University of Delaware, Newark, DE, USA

11:30 **Best Student Presentation Award Finalist**
(598) Epitaxial lift-off processed GaAs thin-film solar cells integrated with low-cost plastic mini-compound parabolic concentrators
Kyusang Lee[1], Jaesang Lee[1], Bryan A. Mazor[2], Stephen R. Forrest[1,2,3]
[1]Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA, [2]Department of Physics, University of Michigan, Ann Arbor, MI, USA, [3]Department of Material Science and Engineering, University of Michigan, Ann Arbor, MI, USA

11:45 **(599) Analysis of GaAs Solar Cells at High MOCVD Growth Rates**
Kenneth J Schmieder[1], Michael K Yakes[1], Christopher G Bailey[1], Ziggy Pulwin[2], Louise C Hirst[1], Matthew P Lumb[3], Maria Gonzalez[4], Seth M Hubbard[5], Chris Ebert[2], Robert J Walters[1]
[1]U.S. Naval Research Laboratory, Washington, DC, USA, [2]Veeco MOCVD, Somerset, NJ, USA, [3]George Washington University, Washington, DC, USA, [4]Sotera Defense Solutions, Annapolis Junction, MD, USA, [5]Nanopower Research Labs, Rochester Institute of Technology, Rochester, NY, USA

Area 4 - Orals

10:30 - 12:00 PM **Ballroom 1EF**

Advanced Cell Structures

Chair(s): James Gee, Rolf Brendel

10:30 **(600) Understanding Manufacturing Cost Influence on Future Trends in Silicon Photovoltaics**
Paul A Basore
pvspecialist@gmail.com, San Mateo, CA, USA

11:00 **(601) Towards the Practicl Limits of Silicon Solar Cells**
David D. Smith, Peter Cousins, Staffan Westerberg, Russelle De Jesus-Tabajonda, Gerly Aniero, Yu-Chen Shen
SunPower Corp., San Jose, CA, USA

11:30 **(602) 20.63 % nPERT Cells and 20% PR Gain Bifacial Module**
Shu-Hung Yu, Chih-Jeng Huang, Po-Tsung Hsieh, Hung-Chih Chang, Wei-Cheng Mo, Chi-Chun Li
Motech Industries, Inc, Tainan, Taiwan, Taiwan

11:45 **(603) The BSK cell concept - bifacial operation with double-sided collection**
Fabian Fertig, Karin Krauß, Johannes Greulich, Florian Clement, Daniel Biro, Ralf Preu, Stefan Rein
Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany

Area 6 - Orals

10:30 - 12:00 PM **Ballroom 2A**

OPV Stability

Chair(s): Jan Gilot, Moritz Riede

10:30 **(604) Degradation Mechanisms of Polymer-Based Organic Solar Cells**
Hans-Joachim Egelhaaf
Belectric OPV GmbH, Nuremberg, Germany

11:00 **(605) The Effect of Side-Chains on Polymer Solar Cell Stability**
Graham E. Morse[1], Aurélien Tournebize[2], Agnès Rivaton[2], Nicolas Blouin[1], Steven Tierney[1]
[1]Merck Chemicals Ltd., Southampton, UK, [2]ICCF, Equipe Photochimie, CNRS, Aubière, France

11:15 **(606) Polaron stability in semiconducting polymer neat films**
Daniel S Beatrup[1], James R Durrant[1], Iain McCulloch[1], Hugo Bronstein[2], Bob Schroeder[1]
[1]Imperial College London, London, UK, [2]University College London, London, UK

11:30 **(607) The Stability of Organic Solar Cells Under Highly Damp Conditions – Normal vs. Inverted Cells**
Seunghyup Yoo, Donggeon Han
KAIST, Daejeon, Korea

Area 7 - Orals

10:30 - 12:00 PM **Ballroom 1AB**

Space PV Systems

Chair(s): Claus Zimmermann, Justin Likar

10:30 **(608) Effect of irradiation on Gallium Arsenide solar cells with multi quantum well structures**
Sergey maximenko[1], Matt Lumb[2], Raymond Hoheisel[2], Maria Gonzalez[3], David Scheiman[1], Scott Messenger[4], Tom Tibbits[5], M Imaizumi[6], T Ohshima[7], S.-i. Sato[7], Philip Jenkins[1], Robert Walters[1]
[1]Naval Research Laboratory, Washington, DC, USA, [2]The George Washington University, Washington, DC, USA, [3]Sotera Defense Solutions, Annapolis Junction, MD, USA, [4]University of Maryland Baltimore County, Baltimore, MD, USA, [5]formerly QuantaSol Ltd, Kingston-upon-Thames, UK, [6]Japan Aerospace Exploration Agency (JAXA), Tsukuba, Japan, [7]Japan Atomic Energy Agency (JAEA), Takasaki, Japan

10:45 **(609) First Flight Demonstration of Glass-Type Space Solar Sheet**
Kazunori Shimazaki[1], Yuki Kobayashi[1], Masato Takahashi[1], Mitsuru Imaizumi[1], Mio Murashima[2], Yu Takahashi[2], Hiroyuki Toyota[2], Akio Kukita[2], Takeshi Ohshima[3], Shin-ichiro Sato[3], Tatsuya Takamoto[4], Hiroaki Kusawake[1]
[1]Japan Aerospace Exploration Agency (JAXA), Tsukuba Space Center, Tsukuba, Japan, [2]Japan Aerospace Exploration Agency (JAXA), ISAS, Sagamihara, Japan, [3]Japan Atomic Energy Agency (JAEA), Takasaki, Japan, [4]SHARP Corporation, Yamatokoriyama, Japan

11:00 **(610) Predicting the Solar Probe Plus Solar Array Output**
Edward M Gaddy[1], Michael H Butler[1], Mary Kae Lockwood[1], Gayle K Martin[2], Cristina T Vigil[2], Andreea Boca[2], Benjamin Richards[2]
[1]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA, [2]Emcore Corporation, Albuquerque, NM, USA

11:15 **(611) Realisation of Mars Orbiter Mission (MOM) Solar Array**
Uma B R, Nukaraju R, Krishnapriya G, Sankaran M
Power Systems Group, ISRO Satellite Centre, Bangalore, India

11:30 **(612) On-orbit Performance Analysis on Solar Array Paddle of X-ray Astronomy Satellite "Suzaku"**
Takanobu Shimada, Hiroyuki Toyota, Kazuyuki Hirose, Yoshitomo Maeda, Kazuhisa Mitsuda
Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA), Sagamihara, Japan

11:45 **(613) Low Cost Automated Manufacture of High Specific Power Photovoltaic Solar Arrays for Space**
Nicholas Walmsley, Matthew Wrosch, Theodore Stern
Vanguard Space Technologies, Inc., San Diego, CA, USA

Area 12 - Orals

10:30 - 12:00 PM **Ballroom 2B**

Correlation of Accelerated Testing with Field Experience

Chair(s): Jeff Newmiller, Bengt Jaeckel

10:30 **(614) Evaluation of the Uncertainty in Accelerated Stress Testing**
Michael D. Kempe
National Renewable Energy Laboratory, Golden, CO, USA

10:45 **Best Student Presentation Award Finalist**
(615) Data Science Study Protocols for Investigating Lifetime and Degradation of PV Technology Systems
Nicholas R Wheeler[1], Abdulkerim Gok[2], Yifan Xu[3], Ian Kidd[2], Laura S Bruckman[2], Jiayang Sun[3], Roger H French[1,2]
[1]Department of Macromolecular Science and Engineering, Case Western Reserve University, Cleveland, OH, USA, [2]Department of Material Science, Case Western Reserve University, Cleveland, OH, USA, [3]Department of Epidemiology and Biostatistics, Case Western Reserve University, Cleveland, OH, USA

11:00 **(616) Assessment of PV Module Durability Using Accelerated and Outdoor Performance Analysis and Comparisons**
William J. Gambogi[1], Yushi Heta[2], James G. Kopchick[1], Thomas Felder[1], Steven W. MacMaster[1], Alexander Z. Bradley[1], Babak Hamzavytehrany[1], Bao-Ling Yu[1], Katherine M. Stika[1], T. John Trout[1], Lucie Garreau-Iles[3], Oakland Fu[4], Hongjie Hu[4]
[1]DuPont, Wilmington, DE, USA, [2]DuPont K. K., Utsunomiya, Japan, [3]Du Pont de Nemours International S.A., Meyrin, Switzerland, [4]DuPont (China) R&D Center, Shanghai, China

11:15 **(617) Trial Run of a Junction-Box Attachment Test for Use in Photovoltaic Module Qualification**
David M Miller, Scott L Deibert, John H Wohlgemuth
National Renewable Energy Laboratory, Golden, CO, USA

11:30 **(618) A Comparison of Accelerated Degradation Test by a UV Pulse Laser and Fluorescence Tubes for EVA Films**
Yu-Tai Li[1], Bo-Fang Wang[2], Yu-Hsien Lee[1], Cho-Fan Hsieh[1], Hung-Sen Wu[1], Der-ray Huang[2]
[1] Industrial Technology Research Institute, HsinChu, Taiwan, [2]Department of Opto-Electronic Engineering, National Dong Hwa University, Hualien, Taiwan

11:45 **(619) Development of Comparative Tests of PV Modules by the International PV Module QA Task Force**
John H Wohlgemuth[1], Sarah R. Kurtz[1], Tony Sample[2], Masaaki Yamamichi[3], Michio Kondo[3]
[1]NREL, Golden, CO, USA, [2]JRC, Ispra, Italy, [3]AIST, Tsukuba, Japan

Area 1 - Posters

1:30 - 3:00 PM **Exhibit Hall D**

Light Management for Enhanced Solar Cell Performance

Chair(s): Albert Polman, Jacob J. Krich, Gregory Nielson

(620-A3) **Broad Band Absorption Silicon Nanowire Array Using Diverse Radii for Photovoltiac Applications.** OMAR AL Zoubi[1], Hameed Naseem[1,2]. *[1]Department of Electrical Engineering, Fayetteville, AR, USA, [2]Arkansas GREEN Research Center for Solar Cells, Fayetteville, AR, USA.*

(621-A6) **Nanostructured Window Layer – A New Approach to Design Nanostructured Solar Cells.** Yusi Chen[1], Yangsen Kang[1], Yijie Huo[1], Dong Liang[2], Li Zhao[3], Jieyang Jia[1], Jeremy Kim[1], Leon Yao[1], Jeremy Bregman[1], James S. Harris[1,3,4]. *[1]Department of Electrical Engineering, Stanford University, Stanford, CA, USA, [2]Department of Physics, Stanford University, Stanford, CA, USA, [3]Department of Material Science and Engineering, Stanford University, Stanford, CA, USA, [4]Department of Applied Physics, Stanford University, Stanford, CA, USA.*

(622-A9) **Silicon nano-fabrication by using silica nanosphere lithography technique for enhanced light management.** Jeayoung Choi, Christiana. B. Honsberg. *Arizona State University, Tempe, AZ, USA.*

(623-A12) **Efficiency Enhancement in Thin-Film c-Si HIT Cells using Luminescent 2.85 nm Silicon Nanoparticles.** Farsad I. Chowdhury, Aaesha Alnuaimi, Kazi Islam, Ammar Nayfeh. *Institute Center for Future Energy Systems (iFES), Masdar Institute of Science and Technology, P.O. Box 54224, Abu Dhabi, United Arab Emirates.*

(624-A15) **Spectrum Splitting Double-Cell Scheme for Solar Photovoltaics.** Alexander Dorodnyy[1], Valery Shklover[2], Leonid Braginsky[2,3], Christian Hafner[1], Juerg Leuthold[1]. *[1]Institute of Electromagnetic Fields, ETH, Zurich, Switzerland, [2]Laboratory of Crystallography, ETH, Zurich, Switzerland, [3]Institute of Semiconductor Physics, Novosibirsk State University, Novosibirsk, Russia.*

(625-A18) **Hybrid Approach Simulations for Light Propagation Problems.** Alexander Dorodnyy[1], Valery Shklover[2], Christian Hafner[1], Juerg Leuthold[1]. *[1]Institute of Electromagnetic Fields, ETH, Zurich, Switzerland, [2]Laboratory of Crystallography, ETH, Zurich, Switzerland.*

(626-A21) **Design Improvements for Polyhedral Specular Reflector Spectrum-Splitting Module for Ultra-High Efficiency (>50%).** Carissa N. Eisler, Emily D. Kosten, Emily C. Warmann, Harry A. Atwater. *Caltech, Pasadena, CA, USA.*

(627-A24) **A Study into Sensitizing Cerium with Silicon Nanocrystals for Down Shifting Applications.** Daniel R Frisina[1], Ahmed M Gabr[2], Justin Sacks[1], Karen Hinzer[2], Peter Mascher[1], Rafael, N Kleiman[1]. *[1]McMaster University, HAMILTON, ON, Canada, [2]SUNLAB, OTTAWA, ON, Canada.*

(628-A27) **Optimization of Bifacial Cells for Upconversion Applications.** Ahmed M Gabr[1], Anna H. Trojnar[1], Matthew Wilkins[1], Trevor J Hall[1], Rafael N. Kleiman[2], Karin Hinzer[1]. *[1]University of Ottawa, Ottawa, ON, Canada, [2]McMaster University, Hamilton, ON, Canada.*

(629-A30) **Texturing Low Reflecting Surface of Random Double Inverted Pyramids Using N-fluoropyridinium Salt.** Tatsuya Kumada[1], Kentaro Kawai[1], Masaki Otani[1], Toshinori Hirano[1], Takabumi Nagai[2], Kenji Adachi[2], Kenta Arima[1], Mizuho Morita[1]. *[1]Osaka University, Osaka, Japan, [2]Daikin Industries, Ltd., Osaka, Japan.*

(630-A33) **Integrated Optical Nanostructures for Wide-angle Antireflection and Light Trapping in III/V Solar Cells.** Xiaohan Li[1], Ping-Chun Li[1], Dongzhi Hu[2], Daniel Schaadt[2], Chris Stender[3], Clay McPheeters[3], Rao Tatavarti[3], Kimberly Sablon[4], Edward T Yu[1]. *[1]University of Texas at Austin, Austin, TX, USA, [2]Technische Universität Clausthal, Clausthal-Zellerfeld, Germany, [3]Microlink Devices, Inc., Niles, IL, USA, [4]U. S. Army Research Laboratory, Adelphi, MD, USA.*

(631-A36) **Theoretical Modeling on Luminescent Down-Shifting Process: A Discussion on Luminescent Molecule Design.** Yilin Li, Wen-Ji Dong. *School of Chemical Engineering and Bioengineering, Washington State Univeristy, Pullman, WA, USA.*

(632-A39) **Ray Trace Optimization of Light Trapping Filtered Concentrator.** John V. Lloyd, Emily D. Kosten, Emily C. Warmann, Cristofer A. Flowers, Harry A. Atwater. *California Institute of Technology, Pasadena, CA, USA.*

(633-A42) **Irregular Metal Nanocavity for Efficient Near Band-edge Light-trapping in Organic and Inorganic Photovoltaic Materials.** Zingway Pei[1,2,3], B. Parvathy Devi[1], Subramani Thiyagu[1]. *[1]Department of Electrical Engineering, National Chung Hsing University, Taichung, Taiwan, [2]Graduate Institute of Optoelectronic Engineering, National Chung Hsing University, Taichung, Taiwan, [3]Nanoscience and Nanotechnology Research Center, National Chung Hsing University, Taichung, Taiwan.*

(634-A45) **Comparison of Dispersive and Non-Dispersive Spectrum Splitting Techniques for Photovoltaic Systems.** Juan M Russo[1], Shelby D Vorndran[2], Yuechen Wu[1], Raymond K Kostuk[1,2]. *[1]University of Arizona Dept. of Electrical Computer Engineering, Tucson, AZ, USA, [2]University of Arizona College of Optical Sciences, Tucson, AZ, USA.*

(635-A48) **Proof of Down-Conversion by CdSe/ZnS Quantum Dots on Silicon Solar Cells.** Bahareh Sadeghimakki[1,2], Siva Sivoththaman[1,2]. *[1]Centre for Advanced Photovoltaic Devices and Systems, Waterloo, ON, Canada, [2]Electrical and Computer Engineering Department, Waterloo, ON, Canada.*

(636-B3) **Plasmonic Light Trapping in Ultrathin Single Crystal Silicon Membrane for Solar Cells Application.** Manisha Sharma, Pushpa Raj Pudasaini, Arturo A Ayon. *The University of Texas at San Antonio, San Antonio, TX, USA.*

(637-B6) **Surface Plasmon Polariton Enhanced Upconversion in Rare Earth Doped Nano Crystals on Plasmonic Substrates.** Steve Smith. *South Dakota School of Mines and Technology, Rapid City, SD, USA.*

(638-B9) **Investigation of Moth-Eye Antireflection Coatings for Photovoltaic Cover Glass Using FDTD Modeling Method.** Corey S. Thompson, Min Zou. *University of Arkansas, Fayetteville, AR, USA.*

(639-B12) **Luminescent Solar Concentrators: the route to 10% efficiency.** Wilfried G.J.H.M. van Sark[1], Zachar Krumer[2], Celso de Mello Donegá[2], Ruud E.I. Schropp[3,4]. *[1]Utrecht University, Copernicus Institute, Utrecht, Netherlands, [2]Condensed Matter and Interfaces, Debye Institute, Utrecht, Netherlands, [3]Solar Energy, Energy Research Center of the Netherlands, Eindhoven, Netherlands, [4]Plasma & Materials Processing, Department of Applied Physics, Eindhoven University of Technology, Eindhoven, Netherlands.*

(640-B15) **Cylindrical and Square Fibre Luminescent Solar Concentrators: Experimental and Simulation Comparisons.** Jose J.H. Videira[1], Amanda J. Chatten[1], Emiliano Bilotti[2]. *[1]Imperial College London, London, UK, [2]Queen Mary University of London, London, UK.*

(641-B18) **Buried PN Junction Nanopillar Solar Cell: A Novel Approach to Suppress Recombination Loss in Surface Nanostructure.** Keiji Watanabe, Mieko Matsumura, Takashi Hattori, Taro Osabe, Yasuhiro Shimamoto. *Central Research Laboratory, Hitachi Ltd., Tokyo, Japan.*

Area 2 - Posters

1:30 - 3:00 PM **Exhibit Hall D**

CdTe and CZTS

Chair(s): Hugh Hillhouse, Edgardo Saucedo, Sylvain Marsillac

(642-B28) **High Efficiency Flexible CdTe Superstrate Devices.** Teresa M. Barnes[1], Will L. Rance[1], James M. Burst[1], Matthew O. Reese[1], Daniel M. Meysing[2], Colin A. Wolden[2], Timothy A. Gessert[1], Sean M. Garner[3], Pat Cimo[3], Wyatt K. Metzger[1]. *[1]NREL, Golden, CO, USA, [2]Colorado School of Mines, Golden, CO, USA, [3]Corning, Inc., Corning, NY, USA.*

(643-B31) **Performance of Nanocrystalline Iron Pyrite as the Back Contact to CdS/CdTe Solar Cells.** Khagendra P. Bhandari, Rajendra R. Khanal, Naba R. Paudel, Prakash Koirala, Tyler Kinner, Yanfa Yan, Robert W. Collins, Michael J. Heben, Randy J. Ellingson. *Wright Center for Photovoltaics Innovation and Commercialization, Department of Physics and Astronomy, The University of Toledo, Toledo, OH, USA.*

(644-B34) **Junction Formation and Interface Studies in CZTSe Solar Cells.** Brion Bob[1], Jian V. Li[2], Carolyn Beall[2], Jeff Carapella[2], Clay DeHart[2], Yang Yang[1], Ingrid L. Repins[2]. *[1]University of California, Los Angeles, Los Angeles, CA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(645-B37) **Congruent Evaporation of Tin (II) Sulfide for Solar Cell Applications.** Rupak Chakraborty[1], Vera Steinmann[1], Rafael Jaramillo[1], Katy Hartman[1], Riley E. Brandt[1], Helen Hejin Park[2], Jeremy Poindexter[1], Yun Seog Lee[1], Roy G. Gordon[2], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Harvard University, Cambridge, MA, USA.*

(646-B40) **Two Ideal Compositions for Kesterite-Based Solar Cell Devices: Maximizing Independently VOC and JSC.** Mirjana Dimitrievska[1], Andrew Fairbrother[1], Alejandro Perez-Rodriguez[1, 2], Victor Izquierdo-Roca[1], Edgardo Saucedo[1]. *[1]IREC, Barcelona, Spain, [2]IN2UB, Barcelona, Spain.*

(647-B43) **CdTe Single-Crystal Wafer Heterojunction Photovoltaic Cells.** Joel N. Duenow, James M. Burst, David S. Albin, Anna Duda, Clay M. DeHart, Wyatt K. Metzger. *National Renewable Energy Laboratory, Golden, CO, USA.*

(648-B46) **CZTS solar cells fabricated by fast sulfurization of sputtered Sn/Zn/Cu precursors under H2S atmosphere.** Amin Emrani, Tara P. Dhakal, Charles R. Westgate. *Center for Autonomous Solar Power (CASP), SUNY-Binghamton, Binghamton, NY, USA.*

(649-C1) **Rapid thermal processing of Cu2ZnSnSe4 thin films.** Andrew Fairbrother[1], Lionel Fourdrinier[2], Xavier Fontané[1], Victor Izquierdo-Roca[1], Mirjana Dimitrievska[1], Fabrizio Maseri[2], Alejandro Pérez-Rodríguez[1,3], Edgardo Saucedo[1]. *[1]Catalonia Institute for Energy Research (IREC), Sant Adrià del Besòs-Barcelona, Spain, [2]AC&CS – CRM Group, Liege, Belgium, [3]IN2UB, Universitat de Barcelona, Barcelona, Spain.*

(650-C4) **ZnTe:Cu Film Properties and Their Impact on CdS/CdTe Devices.** Brooke R Faulkner[1], James M Burst[2], Timothy R Ohno[1], Craig L Perkins[2], Bobby To[2], Timothy A Gessert[2]. *[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(651-C7) **Study of RF sputtered Cu3SbS4 Thin-film Solar Cells.** Nicholas D. Franzer, Naba R. Paudel, Chuanxiao Xiao, Yanfa Yan. *University of Toledo, Toledo, OH, USA.*

(652-C10) **Analysis of ZnTe:Cu/Ti Contacts for Crystalline CdTe.** Timothy A. Gessert, Joel N. Duenow, Scott Ward, Bobby To. *National Renewable Energy Laboratory, Golden, CO, USA.*

(653-C13) **Study of recombination process in Cu2ZnSnS4 thin film using two-wavelength excited photoluminescence.** Mohammad Abdul Halim[1], Muhammad Monirul Islam[1], Xianjia Luo[1], Chong Xu[1], Takeaki Sakurai[1], Noriyuki Sakai[2], Takuya Katou[2], Hiroki Sugimoto[2], Hitoshi Tampo[3], Hajime Shibata[3], Shigeru Niki[3], Katsuhiro Akimoto[1]. *[1]Tsukuba University, Tsukuba, Japan, [2]Showa Shell Sekiyu KK, Minato, Japan, [3]National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan.*

(654-C16) **Heteroepitaxial Growth of CZTS.** Steven P Harvey[1], Craig Perkins[1], Matthew Young[1], helio moutinho[1], Andrew Norman[1], Samual Wilson[2], Glenn Teeter[1]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]University of Florida, Gainesville, FL, USA.*

(655-C19) **Controlled electrodeposition of Cu-Zn-Sn thin films for highly efficient CZTSSe thin films solar cells.** Jong-Ok Jeon[1,2], Jin Young Kim[1,2,3]. *[1]Photo-electronic Hybrids Research Center, Korea Institute of Science and Technology (KIST), Seoul, South Korea, [2]Department of Nanomaterials Science and Engineering, University of Science and Technology (UST), Daejeon, South Korea, [3]Green School, Korea University, Seoul, South Korea.*

(656-C22) **Stoichiometric Effects in Polycrystalline CdTe.** Md Imran Khan[1], Vamsi Evani[1], Shamara Collins[1], Prasad Bane[1], Sara Bakhshi[1], Vishal Kendre[1], Vasilis Palekis[1], Sergiu Vatavu[2], Don Morel[1], Chris Ferekides[1]. *[1]University of South Florida, Tampa, FL, USA, [2]Moldova State University, Chisinau, Moldova.*

(657-C25) **Semiconducting Carbon Single-walled Nanotubes as a Cu-Free, Barrier-Free Back Contact for CdTe Solar Cell.** Rajendra R Khanal[1], Adam B Phillips[1], Zhaoning Song[1], Victor V Plotnikov[2], Chad W Carter[2], John M Stayancho[2], Michael J Heben[1]. *[1]1Wright Center for Photovoltaics Innovation and Commercialization, Department of Physics and Astronomy, School of Solar and Advanced Renewable Energy, University of Toledo, Toledo, OH, USA, [2]2Lucintech Incorporated, Toledo, OH, USA.*

(658-C28) **Investigation of Passivation Treatment of Cd1-xMgxTe Thin Films for Possible Application in High Efficiency Cells.** Pavel S. Kobyakov[1], Drew E. Swanson[1], Carey Reich[1], Jennifer Drayton[2], W.S. Sampath[1]. *[1]Department of Mechanical Engineering, Colorado State University, Fort Collins, CO, USA, [2]Department of Physics, Colorado State Univeristy, Fort Collins, CO, USA.*

(659-C31) **Doped a-Si1-xCx:H as a Novel Back Contact Material for CdTe Solar Cells.** Prakash Koirala[1], Zhiquan Huang[1], Xinxuan Tan[1], Maxwell Junda[1], Nikolas J Podraza[1], Sylvain Marsillac[2], Anjus A Rockett[3], Robert W Collins[1]. *[1]The University of Toledo, Toledo, OH, USA, [2]Old Dominion University, Norfolk, VA, USA, [3]University of Illinois Urbana-Champaign, Urbana, IL, USA.*

(660-C34) **Rapid thermal processing of ZnTe:Cu contacted CdTe solar cells.** Jiaojiao Li, Colin Wolden. *Colorado School of Mines, Golden, CO, USA.*

(661-C37) **Photocapacitance Measurements and Photocarrier Mobilities in CdTe Thin Film Solar Cells.** Qi Long[1], Daniel A. Goldman[1], Steluta A. Dinca[1], Eric A. Schiff[1], Jeremy Theil[2], Ming Yu[2]. *[1]Syracuse University, Syracuse, NY, USA, [2]First Solar Inc., Santa Clara, CA, USA.*

(662-C40) **Defect Studies of Cu2ZnSn(S,Se)4 Thin Film Solar Cells with Different Cu/Sn Ratios by Admittance Spectroscopy.** Xianjia Luo[1], Muhammad Monirul Islam[1], Mohammad Abdul Halim[1], Chong Xu[1], Takeaki Sakurai[1], Noriyuki Sakai[2], Takuya Kato[2], Hiroki Sugimoto[2], Hitoshi Tampo[3], Hajime Shibata[3], Shigeru Niki[3], Katsuhiro Akimoto[1]. *[1]Institute of Applied Physics, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki, 305-8573, Japan, [2]Energy Solution Business Center, Showa Shell Sekiyu K.K., 2-3-2 Daiba, Minato-ku, Tokyo 135-8074, Japan, [3]National Institute of Advanced Industrial Science and Technology (AIST), 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan.*

(663-C43) **Impact of Humidity Exposure during Device Fabrication on CZTSSe Solar Cell Performance.** Irina Malajovich, Yanyan Cao, Jonathan V. Caspar, Qijie Guo, Lynda K. Johnson, Boheng Ma, Kaushik Roy Choudhury, Dennis J. Walls, Wei Wu. *E. I. DuPont de Nemours, Wilmington, DE, USA.*

(664-C46) **A Path to 10 % Efficiency in Tin Sulfide Solar Cells.** Niall Mangan[1], Riley E. Brandt[1], Vera Steinmann[1], Rafael Jaramillo[1], Jian V. Li[2], Helen Hejin Park[3], Leizhi Sun[3], Roy G. Gordon[3], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]Harvard University, Cambridge, MA, USA.*

(665-D1) **Epitaxial Growth of CZTS on Si Substrates Investigated with Electron Backscattered Diffraction.** Helio Moutinho, Matthew Young, Steve Harvey, Chun-Sheng Jiang, Craig Perkins, Samual Wilson, Mowafak Al-Jassim, Ingrid Repins, Glenn Teeter. *National Renewable Energy Laboratory, Golden, CO, USA.*

(666-D4) **Calculation of Defect Concentrations in Cu2ZnSnS4 from Stoichiometry.** Daniel Mutter, Scott T. Dunham. *University of Washington, Department of Electrical Engineering, Seattle, WA, USA.*

(667-D7) **Formation Energies of Carbon related Defects in Cu2ZnSnS4.** Daniel Mutter, Scott T. Dunham. *University of Washington, Department of Electrical Engineering, Seattle, WA, USA.*

(668-D10) **Effect of band gap grading on the performance characteristics of Cu2ZnSnS4 solar cell.** Muteeu A. Olopade, Adeyinka D. Adewoyin, Deborah O. Olorode, Michael A. Chendo. *Department of Physics, University of Lagos, Akoka, Lagos, Nigeria.*

(669-D13) **High Throughput Laser Processing for the Formation of Ohmic Contacts to CdTe Solar Cells.** Vasilios Palekis[1], Brian J. Simonds[2], Md Khan[1], Vamsi Evani[1], Michael A. Scarpulla[2], Chris Ferekides[1]. *[1]University of South Florida, Tampa, FL, USA, [2]University of Utah, Salt Lake City, UT, USA.*

(670-D16) **Valence Band Offset at MoO3/CdTe Interface Probed by X-ray Photoelectron Spectroscopy.** Naba R Paudel, Yanfa Yan. *Department of Physics & Astronomy, University of Toledo, Toledo, OH, USA.*

(671-D19) **Thin Film Iron Pyrite Synthesized by Sulfurization of Iron Oxide for Application in Photovoltaics.** Pravakar P Rajbhandari[1,3], Tara P Dhakal[1,3], Anju Sharma[2,3], Charles R Westgate[1,3]. *[1]Center for Autonomous Solar Power, Binghamton, NY, USA, [2]Small Scale Systems Integration and Packaging (S3IP) Center, Binghamton, NY, USA, [3]Binghamton University, State University of New York, Binghamton, NY, USA.*

(672-D22) **Nitrogen Doped Chalcopyrites as Contacts to CdTe Photovoltaics.** Angus Rockett[1], Thomas Erickson[1], Zhengfeng Wang[1], Krishna Aryal[2], Sylvain Marsillac[2], Prakash Koirala[3], Robert Collins[3]. *[1]University of Illinois Urbana-Champaign, Urbana, IL, USA, [2]Dept. of Electrical & Computer Engineering, Old Dominion Univ., Norfolk, VA, USA, [3]Dept. of Physics & Astronomy, University of Toledo, Toledo, OH, USA.*

(673-D25) **Te-rich CdTe Surface by Pulsed UV Laser Treatment for Ohmic Back Contact Formation.** Brian J. Simonds[1], Vasilios Palekis[2], Brian Van Devener[3], Christos Ferekides[2], Michael A. Scarpulla[1]. *[1]Materials Science and Engineering, University of Utah, Salt Lake City, UT, USA, [2]Electrical Engineering, University of South Florida, Tampa, FL, USA, [3]University of Utah, Salt Lake City, UT, USA.*

(674-D28) **Exploring the Potential for High-quality Epitaxial CdTe Solar Cells.** Tao Song[1,2], Ana Kanevce[2], James R. Sites[1]. *[1]Department of Physics, Colorado State University, Fort Collins, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(675-D31) **Epitaxial Growth of Cu2ZnSnS4 by Radio Frequency Magnetron Sputtering.** Ning Song[1], Xiaojing Hao[2], Martin Green[3]. *[1]SPREE, UNSW, Sydney, Australia, [2]SPREE, UNSW, Sydney, Australia, [3]SPREE, UNSW, Sydney, Australia.*

(676-E2) **Characterization of Nanocrystal-Ink based CZTSSe and CIGSSe Solar Cells using Voltage-dependent Admittance Spectroscopy.** Xingshu Sun[1], Charles J. Hages[2], Nathaniel J. Carter[2], James E. Moore[1], Rakesh Agrawal[2], Mark Lundstrom[1]. *[1]Purdue University School of Electrical and Computer Engineering, West Lafayette, IN, USA, [2]Purdue University School of Chemical Engineering, West Lafayette, IN, USA.*

(677-E5) **Study of defects in CdTe heterostructures using imaging confocal photoluminescence and photoluminescence intensity measurements.** Craig H. Swartz[1], Odille C. Noriega[1], Pathiraja A Jayathilaka[1], Madhavie Edirisooriya[1], Xin-Hao Zhao[2], Michael J. DiNezza[2], Shi Liu[2], Yong-Hang Zhang[2], Thomas H. Myers[1]. *[1]Texas State University, San Marcos, TX, USA, [2]Arizona State University, Tempe, AZ, USA.*

(678-E8) **Crystallization behavior of Cu2ZnSn(Sx,Se1-x)4 absorbers processed from sputtered Cu2ZnSnS4 precursors under different selenization conditions.** Solange Temgoua, Romain Bodeux, Sebastien Delbos, Negar Naghavi. *Institute of Research and Development on Photovoltaic Energy, Chatou, France.*

(679-E11) **CdTe solar cells using combined ZnS/CdS window layers.** Chuanxiao Xiao, Naba. R Paudel, Corey. R Grice, Yue Yu, Yanfa Yan. *The University of Toledo, Toledo, OH, USA.*

(680-E14) **The Effect of Secondary phases on Cu2ZnSn(S,Se)4 based Solar Cell.** Hyesun Yoo[1], Robert Lechner[2], Stefan Jost[2], Jörg Palm[2], Arnaud Verger[3], Anne Lelarge[3], Virginie Moreau[3], Corinne Papret[3], Rainer Hock[1]. *[1]University of Erlangen-Nürnberg, Erlangen, Germany, [2]AVANCIS GmbH, München, Germany, [3]Saint-Gobain Recherche, Aubervilliers, France.*

(681-E17) **Comparison of Cu-Sn-S and Cu-Sb-S as potential solar cell absorbers.** Andriy Zakutayev[1], Lauryn L. Baranowski[1,2], Adam W. Welch[1,2], Colin A. Wolden[2], Eric S. Toberer[1,2]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado School of Mines, Golden, CO, USA.*

(682-E18) **Towards Model-Guided Defect Reduction in Cd1-xZnxTe/CdS Solar Cells: Development of Molecular Dynamics Models.** Xiaowang Zhou[1], Jose Juan Chavez[2], Jose Luis Cruz-Campa[1], David Zubia[2]. *[1]Sandia National Laboratories, Livermore, CA, USA, [2]University of Texas at El Paso, El Paso, NM, USA.*

Area 4 - Posters

1:30 - 3:00 PM **Exhibit Hall D**

Contacts and Analysis

Chair(s): Keith Mcintosh, Kyumin Lee, Kirsten Cabanas-Holmen

(683-G1) **A simplified expression for optical absorbance in Si solar cells.** Luigi Abenante. *ENEA, ROMA, Italy.*

(684-G5) **Enhanced performance core-sell Si/CdS nanowires heterojunction solar cell device.** Alaa A. AL-Hilo[1,2], Muatez Z. Mohammed[1], Johnathan C. Armstrong[1], Tar-Pin Chen[1]. *[1]University of Arkansas at Little Rock and Green Solar cell Research Center, Little Rock, AR, USA, [2]University of Basrah, Basrah, Iraq.*

(685-G9) **Fine Texture for Front Surface Fine Lines with Screen Printing.** Mari Aoki[1], Kyotaro Nakamura[2], Isao Sumita[1], Tomihisa Tachibana[1], Yasushi Kawata[3], Hironori Sato[3], Yoshio Ohshita[1]. *[1]Toyota Technological Institute, Nagoya, Japan, [2]Meiji University, Kawasaki, Japan, [3]Y.A.C. Co., Ltd., Akishima, Japan.*

(686-G13) **A Critical Analysis on the Role of Back Surface Passivation for a-Si/c-Si Heterojunction Solar Cells.** Nithin Chatterji[1], Sanchit Khatavkar[1], Cristobal Voz[2], A. Morales Vilches[2], J. Puigdollers[2], B. M. Arora[1], Aldrin Antony[3], Pradeep R Nair[1]. *[1]Dept. of Electrical Engineering, IIT Bombay, Mumbai, India, [2]2Grup de Recerca en Micro I Nanotechnologies, Dept d'Enginyeria Electronica, Universitat Politecnica De Catalunya, Barcelona, Spain, [3]Dept. of Energy Science and Engineering, IIT Bombay, Mumbai, India.*

(687-G17) **Investigation of Rear SiOx/SiNx Passivated Solar Cells Under Low Irradiance Intensities.** Wei-Chih Cheng, Jun-Rui Huang, Kuo-Yi Yen, Chi-Yu Hsieh, Chih-Ming Kang, Sean Huai Chung Chen, Li-Wei Cheng. *Topcell Solar International Co., Ltd., Taoyuan County, Taiwan.*

(688-G21) **Impact of the bias on the temperature of silicon solar cells under operating conditions.** Romain Couderc[1,2], Mustapha Lemiti[2], Mohamed Amara[1]. *[1]Centre de thermique CETHIL-UMR5008 CNRS, Villeurbanne, France, [2]Institut de Nanotechnologies INL-UMR5270 CNRS, Villeurbanne, France.*

(689-G25) **"Thin Silicon Solar Cells: A Path to 35% Shockley-Queisser Limits", a DOE funded FPACE II project.** Laura Ding, Mathieu Boccard, Joshua Williams, April Jeffries, Srikanth Gangam, Kunal Ghosh, Christiana Honsberg, Mariana Bertoni, Zachary Holman, Stuart Bowden. *School of Electrical, Computer & Energy Engineering, Arizona State University, Tempe, AZ, USA.*

(690-G29) **Evaluation of Recombination Losses in Bifacial n+-p-p+ and p+-n-n+ Si Solar Cells Fabricated Using B Ion Implantation.** Ygal Eisenberg[1], Iev Kreinin[1], Ninel Bordin[1], Galina Grigorieva[2], Marlen Kagan[2], Kira Zviagina[2], Naftali Eisenberg[1], Shlomo Hava[3]. *[1]Jerusalem College of Technology, Jerusalem, Israel, [2]KVANT Research and Production Enterprise, Moscow, Russia, [3]Ben-Gurion University of the Negev, Beer Sheva, Israel.*

(691-G33) **Role of the Interfacial Inversion Layer with Reduced Bandgap Narrowing in the Improvement of the Open Circuit Voltage of Amorphous Silicon/Crystalline Silicon Heterojunction [HIT] Solar Cell.** Moustafa Y Ghannam[1], Ghadah Shehadah[1], Yaser Abdulraheem[1], Jef Poortmans[2]. *[1]EE Department, College of Emgineering and Petroleum, Kuwait University, Kuwait, Kuwait, [2]IMEC, Kapeldreef 75, 3001, Leuven, Belgium.*

(692-G37) **Topology Optimization: An effective method for designing front metallization patterns of solar cells.** Deepak K. Gupta[1], Matthijs Langelaar[1], Marco Barink[2], Fred van Keulen[1]. *[1]Precision and Microsystems Engineering, Delft University of Technology, Delft, Netherlands, [2]TNO, Eindhoven, Netherlands.*

(693-H1) **Hydrogen Passivation of Laser-Induced Defects for Silicon Solar Cells.** Brett J Hallam[1,2], Adeline Sugianto[1], Ly Mai[1], GuangQi Xu[1], Catherine E Chan[1], Malcolm D Abbott[1], Stuart R Wenham[1], Angel Uruena[3], Monica Aleman[3], Jef Poortmans[2,3,4]. *[1]School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Kensington, Australia, [2]KU Leuven, Leuven, Belgium, [3]imec, Leuven, Belgium, [4]UHasselt, Hasselt, Belgium.*

(694-H5) **Zn as the Protective Layer for Cu Electrode in Wafer-Si Solar Cells.** Xiaofei Han[1], Bin Zhou[1], Deren Yang[2], Meng Tao[1]. *[1]Arizona State University, Tempe, AZ, USA, [2]Zhejiang University, Hangzhou, China.*

(695-H9) **A simplified process flow for silicon heterojunction interdigitated back contact solar cells: using shadow masks and tunnel junctions.** Stanislau Y Herasimenka, Clarence J Tracy, Jongwon Lee, William J Dauksher, Christiana B Honsberg, Stuart Bowden. *Arizona State University, Tempe, AZ, USA.*

(696-H13) **Micro Cold Spray Printed Top Metallization Layer for Solar Cells.** Justin M Hoey, Michael J Robinson, Robert A Sailer. *North Dakota State University, Fargo, ND, USA.*

(697-H17) **a-Si:H/TCO Contact Resistance Measurement Using a Kelvin Cross Bridge Resistor.** Priyaranga L Koswatta, Zachary C Holman. *Arizona State University, Tempe, AZ, USA.*

(698-H21) **Patterning and Metallization of Silicon Solar Cells by Inkjet-Printed Functional Ink on a Photoresist Layer.** Zhongtian Li, Ran Chen, Yu Yao, Aliosn Lennon. *The University of New South Wales, Sydney, Australia.*

(699-H25) **Process optimization of localized BSF formation for solar cells with over 20% energy conversion efficiency.** Dong Lin, Malcolm Abbott, Pei Hsuan Lu, Bo Xiao, Stuart Wenham. *University of New South Wales, Sydney, Australia.*

(700-H29) **Analysis of Small Area Interdigtiated Back Contact Silicon Solar Cells: The Influence of Boron Diffusion Process on Cell Performances.** Shu Yen Liu, Yun Kuo Tsao, Zong Liang Yao, Bo Shen Lee, Kuang Chieh Lai, Yu Pan Pai. *Motech Industries, Tainan, Taiwan.*

(701-H33) **Novel High-Efficiency c-Si Compound Heterojunction Solar Cells: HCT (Heterojunction with Compound Thin-layer).** Yiming Liu[1,2], Yun Sun[1], Wei Liu[1], Zhiqiang Zhou[1], Jianghong Yao[2]. *[1]Institute of Photo-electronic Thin Film Devices and Technology, Nankai University, Tianjin, China, [2] Department of Physics, Nankai University, Tianjin, China.*

(702-H37) **HELICS Cell, Laser-cut grooves to create a high-efficiency, low-cost IBC solar cell.** Wassim J. Mughal[1], Humayun A. Mughal[2], Alan G. Laffoley[2], Antulio Tarazona[3], Sergei Simdyankin[4], Darren M. Bagnall[5], Stuart A. Boden[1], Nick E. B. Cowern[4]. *[1]University of Southampton, Southampton, UK, [2]Silicon CPV plc, Harlow, UK, [3]EcherKon Technologies Ltd, Crawley, UK, [4]Newcastle University, Newcastle, UK, [5]University of New South Wales, Sydney, Australia.*

(703-I1) **Hot Hole Transport in a-Si/c-Si Heterojunction Solar Cells.** Pradyumna Muralidharan, Kunal Ghosh, Dragica Vasileksa, Stephen M Goodnick. *Arizona State University, Tempe, AZ, USA.*

(704-I5) **New Cu paste with high bonding strength---nano composite alloy particles synthesized by nanomized method.** Shigenobu Sekine[1], Uichi Itoh[2], Ryuji Kimura[1], Keiji Okada[1], Hiroaki Shindo[1], Tatsuya Ooi[1], Manabu Yoshida[2], Hideo Tokuhisa[2]. *[1]Napra Corporation, Katsushika-ku, Japan, [2]AIST, Tsukuba, Japan.*

(705-I9) **Advances in screen printing metallization for a-Si:H/c-Si heterojunction solar cells.** Luca Serenelli[1], Michele Miliciani[2], Massimo Izzi[1], Rosa Chierchia[1], Mario Tucci[1]. *[1]ENEA, Rome, Italy, [2]CHIMET SpA, Arezzo, Italy.*

(706-I13) **Non-Vacuum Electroplated Al for n-Side Electrode in Si Solar Cells.** Wen-Cheng Sun, Xiaofei Han, Meng Tao. *Arizona State University, Tempe, AZ, USA.*

(707-I17) **Optimization of Local Contact Formation on Screen-printed Al2O3 passivated Solar Cells.** Xusheng Wang[1,2], Jian Wu[1,2], Lingjun Zhang[1,2]. *[1]Canadian Solar Inc, Suzhou, China, [2]Photovoltaic Research Center of Soochow University, Suzhou, China.*

(708-I19) **Field-Effect Ferroelectric-Semiconductor Solar Cells.** Wentao Wang[1], Fude Liu[1], Chor Man Lau[1], Lei Wang[1], Guandong Yang[1], Dawei Zheng[1], Zhigang Li[2]. *[1]The University of Hong Kong, Hong Kong, Hong Kong, [2]The Hong Kong University of Science and Technology, Hong Kong, Hong Kong.*

(709-I21) **Metallization of Crystalline Silicon Solar Cells with Very Narrow Gridlines and Multi-Busbars.** Baomin Xu, Scott Solberg, Scott Limb, Sean Garner. *Palo Alto Research Center Inc., 3333 Coyote Hill Road, Palo Atlo, CA, USA.*

(710-I23) **Development of a Self-aligned Etch-back Process for Selectively Doped Silicon Solar Cells.** Di Yan, James Bullock, Yimao Wan, Andres Cuevas. *Australian National University, canberra, Australia.*

(711-I25) **Design and Characterization of an Adhesion Strength Tester for Evaluating Metal Contacts on Silicon Solar Cells.** Trevor L. Young[1], Kenneth Hee[1], Alison J. Lennon[2], Renate J. Egan[1], Oscar Wilkie[2], Yu Yao[2]. *[1]Suntech R&D Australia Pty Ltd, Sydney, Australia, [2]School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, Australia.*

Area 6 - Posters

1:30 - 3:00 PM **Exhibit Hall D**

Organic PV II: Interfaces, Stability and Fabrication

Chair(s): Jan Gilot, Graham Morse, Dana Olson

(712-J28) **Surface Plasmon Enhanced Infrared Absorption in the Sensitized Polymer Solar Cell.** Sungmo Ahn[1], Devin Rourke[2], Alexandre M. Nardes[3], Jao van de Lagemaat[3], Nikos Kopidakis[3], Wounjhang Park[1]. *[1]Department of Electrical, Computer and Energy Engineering, University of Colorado, Boulder, CO, USA, [2]Department of Physics, University of Colorado, Boulder, CO, USA, [3]National Renewable Energy Laboratory, Golden, CO, USA.*

(713-J30) **Improving P3HT:PCBM Based Polymer Solar Cell: Role of Doped PEDOT:PSS Hole Extracting Layer Towards Degradation.** Swati Arora[1], Vinamrita Singh[2], Manoj Arora[3], Ram Pal Tandon[2]. *[1]Department of Physics, Zakir Husain College, University of Delhi, Delhi, India, [2]Department of Physics & Astrophysics, University of Delhi, Delhi, India, [3]Department of Physics, Ramjas College, University of Delhi, Delhi, India.*

(714-J32) **PBDTTPD-based polymer solar cells fabricated under up-scalable conditions.** Anna Calabrese, Riccardo Po, Gianni Corso, Riccardo Barbieri. *Centro Ricerche per le Energie non Convenzionali – Istituto eni Donegani, eni SpA, Novara, Italy.*

(715-J34) **Plasmonic-electrical Effect and Carrier Accumulation Effects of Metal Nanomaterials for High Performance Organic Solar Cells.** Wallace Choy. *Department of Electrical and Electronic Engineering, the University of Hong Kong, Hong Kong, Hong Kong.*

(716-J36) **Reversing Degradation of Organic Solar cells.** Virkam Dalal, Joydeep Bhattacharya, Pranav Joshi, Robert Mayer. *Iowa State University, Ames, IA, USA.*

(717-J38) **The role of temperature in the triplet-fusion induced low-energy photon up-converted delayed luminescence of a solid state composite.** Hossein Goudarzi, Panagiotis E. Keivanidis. *Centre for Nano Science and Technology @Polimi, Istituto Italiano di Tecnologia, Milan, Italy.*

(718-J40) **Micro-Scale Textures for Enhanced Peformance of Organic Solar Cells.** Benjamin Lipovsek, Janez Krc, Marko Topic. *University of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia.*

(719-K2) **Current Voltage Analysis of Silver Nanoparticle Doped Organic Photovoltaic Devices.** Roy Murray, Nopporn Rujisamphan, Hailey Cramer, S. Ismat Shah. *University of Delaware, Newark, DE, USA.*

(720-K4) **Thermal annealing affects vertical morphology, doping and defect density in BHJ OPV devices.** Alexandre M Nardes. *NREL, Golden, CO, USA.*

(721-K6) **Extrusion as Plausible Processing Method for Production of Organic PhotoVoltaic Solar Cells.** Ali Nourdine, Lara Perrin, Nicole Albérola, Lionel Flandin. *LEPMI, UMR 5279, CNRS-Grenoble INP-Université de Savoie-Université J. Fourier LMOPS-INES Bâtiment Hélios, Campus de Savoie-Technolac, F-73376 Le Bourget-du-Lac Cedex, France.*

(722-K8) **Fabrication and encapsulation of perovskites sensitized solid state solar cells.** F. Javier Ramos[1], David Cortes[2], Aranzazu Aguirre[2], Fernando J. Castano[1,2], Shahzada Ahmad[1]. *[1]Abengoa Research, Campus palmas altas, Spain, [2]Abengoa Solar, Soland center, Spain.*

(724-K12) **Oxygen Diffusion in Organic Polymers.** Safa Sahoee[1,2], Ying Soon[1], Fernando Castro[2], James R. Durrant[1]. *[1]Imperial College London and National Physical Laboratory, London, UK, [2]National Physical Laboratory, London, UK.*

Area 8 - Posters	
1:30 - 3:00 PM	**Exhibit Hall D**
Characterization III	

Chair(s): Chris Fell, Keith Emery

(725-K31) **SunsPZ© : Real Time Spatially Resolved Solar Cell Parameter Visualizer.** Pooja Chaturvedi, Ziv Hameiri, Bram Hoex. *Solar Energy Research Institute of Singapore, National University of Singapore, Singapore, Singapore.*

(726-K34) **Characterization of Solar Cells in Transportation.** Shu-Tsung Hsu[1], Yean-San Long[2], Yu-Tai Li[3]. *[1]1, HsinChu, Taiwan, [2]2, HsinChu, Taiwan, [3]3, HsinChu, Taiwan.*

(727-K37) **Influence of Soiling Layer on Quantum Efficiency and Spectral Reflectance on Crystalline Silicon PV Modules.** Jim Joseph John[1,2], Sai Tatapudi[2], Govindasamy Tamizhmani[2]. *[1]Indian Institute of Technology, Mumbai, India, [2]Arizona State University, Mesa, AZ, USA.*

(728-K40) **An Experimental Procedure to Check the Performance Degradation On-Site in Grid-Connected Photovoltaic Systems.** Filippo Spertino, Fabio Corona, Paolo Di Leo, Fabio Papandrea. *Politecnico di Torino, Torino, Italy.*

(729-L3) **Reliability evaluation of anti-reflection coated glass for photovoltaic modules.** Tony Tang, Ruirui Lv, Jing Tang, Lixia Peng, Albert Fu, Lingjun Zhang. *Canadian Solar Inc., Suzhou, China.*

(730-L6) **The study of dependency of external quantum efficiency of triplejunction solar cells on measurement condition.** Mitusnobu Sugai[1], Jiro Harada[1], Tetsuya Nakamura[2], Mitusru Imaizumi[2], Takeshi Ohshima[3]. *[1]Advanced Engineering Services Co., Ltd., Ttsukuba, Japan, [2]Japan Aerospace Exploration Agency, Ttsukuba, Japan, [3]Japan Atomic Energy Agency, Takasaki, Japan.*

(731-L9) **High-Speed Multi-Channel System for Solar Simulator Irradiance Non-Uniformity Measurement.** Davide Rivola, Sebastian Dittmann, Mauro Pravettoni, Gabi Friesen, Domenico Chianese. *University of Applied Sciences and Arts of Southern Switzerland, Institute for Applied Sustainability to the Built Environment, Canobbio, Switzerland.*

(732-L12) **Empirical Procedure to Correct Concentrator Cell Efficiency Measurement Errors Caused by Unfiltered Xenon Flash Solar Simulators.** Carl R Osterwald[1], Mark W Wanlass[2], Tom Moriarty[1], Myles A Steiner[1], Keith A Emery[1]. *[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Wanlass Consulting, Golden, CO, USA.*

(733-L15) **Fast Electrical Modeling for Spatially-Resolved Characterization of Amorphous Silicon Photovoltaic Cells.** Xiaofeng Wu, Martin Bliss, Jiang Zhu, Thomas R Betts, Ralph Gottschalg. *CREST, Loughborough University, Loughborough, UK.*

(734-L18) **Effects of light-soaking and temperature on different PV technologies.** Sandra B. Schujman, Jonathan R. Mann, Christopher Hull, John Wax, Linda M. LaQue, Gary Dufresne, Crispin Rice, David Taylor, Milo Tallon, Alex Bialy, Alex Novicki, David J. Metacarpa, Pradeep Haldar. *US Photovoltaic Manufacturing Consortium (PVMC), SUNY College of Nanoscale Science and Engineering, Albany, NY, USA.*

(735-L21) **Influence of Spectral Composition on the Temperature Coefficients of Solar Cells from Elkem Solar.** Muhammad Tayyib[1], Jan Ove Odden[2], Tor Oskar saetre[3]. *[1]Teknova AS Gimlemoen 19, 4630, Krisitiansand S, Norway, [2]Elkem Solar AS. P.O. Box 8040 Vaagsbygd. NO-4675, Krisitiansand S, Norway, [3]University of Agder. Postboks 509. NO-4898, Grimstad, Norway.*

(736-L24) **Scaling Error of Quantum Efficiency Measurements for Heavily Shunted Cells in Reliability Research.** Jaewon Oh[1], GovindaSamy TamizhMani[2], Stuart Bowden[1]. *[1]Solar Power Laboratory, Arizona State University, Tempe, AZ, USA, [2]Photovoltaic Reliability Laboratory, Arizona State University, Mesa, AZ, USA.*

(737-L27) **Current-Soaking and Dark Storage Effects of Polycrystalline Thin Film Solar Modules.** Sebastian Dittmann, Alessandro Virtuani, Gabi Friesen, Flavio Serrano. *University of Applied Sciences and Art of Southern Switzerland, Canobbio, Switzerland.*

(738-L30) **Compact Accelerated Life Testing with Expanded Measurement Suite.** John M. Raguse, Russell Geisthardt, Jennifer Drayton, James R. Sites. *Colorado State University, Fort Collins, CO, USA.*

(739-M1) **Mapping Chemical and Mechanical Property Degradation in Photovoltaic Modules.** Katherine M Stika, Craig S Westphal, Jane Kapur, Gail Raty, Jing Li, James G Kopchick, William J Gambogi, Babak Hamzavytehrany, Alexander Z Bradley, James R Marsh, Benjamin W Foltz. *E.I. DuPont de Nemours & Co, Wilmington, DE, USA.*

(740-M4) **Correcting Bias in Measured Module Temperature Coefficients.** Clifford W Hansen[1], Michaela Farr[1], Larry Pratt[2]. *[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]CFV Solar Test Lab, Albuquerque, NM, USA.*

(741-M7) **Stochastic Analysis of Advanced Photovoltaic Devices.** Daniel P Heinzel, Hongyi M Wu, Angus Rockett. *Department of Material Sciences and Engineering, University of Illinois, Urbana, IL, USA.*

(742-M10) **Impact of Incidence-Angle Dependence on Solar Radiometric Calibration.** Mike Dooraghi, Aron Habte, Ibrahim Reda, Manajit Sengupta, Peter Gotseff, Afshin Andreas. *National Renewable Energy Laboratory, Golden, CO, USA.*

(743-M13) **Data Acquisition System for PV System Outdoor Performance Evaluation.** Severine Busquet. *UH-HNEI, Honolulu, HI, USA.*

(744-M15) **Outdoor Calibration System for Solar Cell/Module.** Chen Jiangong, Li Jie. *Fujian Metrology Institute/National PV Industry Measurement and Testing Center, Fuzhou, China.*

(745-M16) **Assessing Solar PV Inverters' Anti-Islanding Protection.** Richard J Bravo[1], Steven A Robles[1], Eduard Muljadi[2]. *[1]Southern California Edison, Westminster, CA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA.*

(746-M17) **VAr Support from Solar PV Inverters.** Richard J Bravo[1], Steven A Robles[1], Tom Bialek[2]. *[1]Southern California Edison, Westminster, CA, USA, [2]San Diego Gas and Electric, San Diego, CA, USA.*

Area 9 - Posters

1:30 - 3:00 PM **Exhibit Hall D**

Module Technology and Manufacturing

Chair(s): Keith McIntosh, Michael Kempe, Yifeng Chen

(747-M19) **Metal Wrap-Through Cell and Module Design Optimization.** Ian J Bennett, Evert E Bende, Wilma Eerenstein. *Energy Research Centre of the Netherlands, Solar Energy, Petten, Netherlands.*

(748-M21) **The Effect of soldering process on performance of crystalline silicon solar module.** dingyue cao, hong yang, he wang. *xi'an jiaotong university, xi'an, China.*

(749-M23) **A High Voltage MWT Module with Improved Shadow Performance.** Anna J. Carr, Mark J. Jansen, Maarten de Bruijne, Lars A. G. Okel, Mario J. H. Kloos, Wilma Eerenstein. *ECN Solar Energy, Petten, Netherlands.*

(750-M25) **Light Capturing Film for Power Gain of Crystalline Silicon PV modules.** Indeok Chung, Won-jae Lee, Eun-Chel Cho, In-Sik Moon. *Hyundai heavy industries, Yongin-si, South Korea.*

(751-M27) **Statistical Methods and Experiment Designs for Bulk Factor Screening in Manufacturing – In the Style of Evolutionary Operations.** Jeffrey Cotter. *Arizona State University, Tempe, AZ, USA.*

(752-M29) **Data mining photovoltaic cell manufacturing data.** Rhett Evans[1,3], Eric Van Voorthuysen[2], Jingbing Zhu[4], Martin Green[1]. *[1]Australian Centre for Advanced Photovoltaics, UNSW, Sydney, Australia, [2]School of Mechanical and Manufacturing Engineering, UNSW, Sydney, Australia, [3]Suntech R&D Australia, Sydney, Australia, [4]Wuxi Suntech Power Co, Wuxi, China.*

(753-M31) **Proposed Photovoltaic Module Form Factor to Reduce Levelized Cost of Energy.** Kurt Lyell[1], John Hoffner[1], David Krick[2], Frank McIntire[3], Scott Stibrich[4], Craig Brooker[4], Jaya Jackson[5], Jack Whittier[4], Richard Campbell[4], Beth Dart[6]. *[1]CH2M Hill, Austin, TX, USA, [2]CH2M Hill, Pittsburgh, PA, USA, [3]CH2M Hill, Spartanburg, SC, USA, [4]CH2M Hill, Englewood, CO, USA, [5]CH2M Hill, Dallas, TX, USA, [6]CH2M Hill, Oakland, CA, USA.*

(754-N1) **Integrated Approach for Economic PV Waste Recycling.** Jens Wolfram Palitzsch, Ulrich Maria Loser, Petra Schönherr. *Loser Chemie GmbH, Langenweißbach, Germany.*

(755-N3) **From Grey Glass to Green Glass – an Offbeat Recycling Idea for Photovoltaic Production Waste.** Jens Wolfram Palitzsch[1], Ulrich Maria Loser[1], Petra Schönherr[1], Dirk Herfurth[2]. *[1]Loser Chemie GmbH, Langenweißbach, Germany, [2]Mounting Systems, Inc, Sacramento, CA, USA.*

(756-N5) **A Highly Abrasive-Resistant, Long-Lasting Anti-Reflective Coating for PV Module Glass.** Sergiu C. Pop[1], Venkata Abbaraju[1], Brenor Brophy[2], Y. Sam Yang[2], Sina Magshoodi[2], Peter Gonsalvez[2]. *[1]Yingli Green Energy Americas, San Francisco, CA, USA, [2]Enki Technology, San Jose, CA, USA.*

(757-N7) **HCPV Modules of SMALFOC Design in Versions for PV and PV/T Operation.** Valery D. Rumyantsev[1], Viacheslav M. Andreev[1], Alexander V. Chekalin[1], Nikolai Yu. Davidyuk[2], Nikolai A. Sadchikov[1]. *[1]Ioffe Physical Technical Institute, St.-Petersburg, Russia, [2]St Petersburg Academic University, St.-Petersburg, Russia.*

(758-N9) **The research on a new type of BIPV modules constructed by Thin-film Photovoltaic Panel(or Module)/ PU/Color organic-coated Steel Plate.** Huacong Yu[1,2], Qi Wang[2], Chuanda Lu[2], Chenggang Wei[2]. *[1]Hanergy PV Science & Technology Co., Ltd, Beijing, China, [2]Nanjing Hanergy Solar PV Co.,ltd, Nanjing, China.*

Area 10 - Posters

1:30 - 3:00 PM **Exhibit Hall D**

PV System Design and Protection

Chair(s): Adrian Haering

(759-N17) **Development of a Grid-Connected Photovoltaic-Storage System using Novel Bidirectional Intelligent Conversion and Connection.** Antonia Sonia A. C. Diniz[1], Lauro V. B. Machado Neto[1], Suellen C. S. Costa[1], Marcio E. M. Souza[2], Wilton de C. Padrão[3], Delly Oliveira Filho[4]. *[1]Pontifical Catholic University of Minas Gerais, Belo Horizonte, Minas Gerais,, Brazil, [2]Energetic Company of Minas Gerais, Belo Horizonte, Minas Gerais,, Brazil, [3]Engetron Ltda., Belo Horizonte, Minas Gerais,, Brazil, [4]Federal University of Viçosa, Vicosa, Minas Gerais,, Brazil.*

(760-N21) **Design and Implementation of a Management System of Surplus Energy Generated By a Distributed Generation System, Case Study GCPVS.** Johann Hernández, Carolina Korez, David Avila, Jose Antonio Murillo. *Universidad Distrital Francisco José de Caldas, Bogotá, Columbia.*

(761-N25) **Cost and Market Analysis of Integrative Lightweight PV Systems for Low-Slope Commercial Rooftops.** Eric Holton, Ankush Halbe, Adam Garney, Jake Whitbeck, Kevin Sharpe, David Metacarpa, Pradeep Haldar. *SUNY College of Nanoscale Science and Engineering, Albany, NY, USA.*

(762-N29) **Design and Implementation of 59 kWp Solar Hybrid Mini-Grid in Solab, Ras Al Khaimah.** Zaki Iqbal[1], Gorkem Soyumer[2], Waqarullah Kazim[1]. *[1]CSEM UAE Innovation Center LLC, Ras Al Khaimah, United Arab Emirates, [2]École polytechnique fédérale de Lausanne (Middle East), Ras Al Khaimah, United Arab Emirates.*

(763-N33) **A New Real Time Reconfiguration Approach Based on Neural Network in Partial Shading for PV Arrays.** Mehmet KARAKOSE[1], Mehmet BAYGIN[1], Koray Sener PARLAK[2]. *[1]Firat University Computer Engineering, Elazig, Turkey, [2]Firat University Vocational School of Technical Sciences, Elazig, Turkey.*

(764-N37) **Stand-Alone Solar Generator with LED Floodlights for Outdoor Sign Illumination.** Daniel L. Meier. *Lightdrop Harvest, LLC, St. Marys, PA, USA.*

(765-N41) **Integrating Rule Base-Disturbance Estimation based fault diagnosis with Graphical User Interface for Grid Connected PV System.** MANIKANDAN PANDIYAN[1], JOVITHA JEROME[2]. *[1]Student Scholar, Dept. of Instrumentation and Control Systems Engg, PSG College of Technology, Coimbatore, India, [2]Professor, Dept. of Instrumentation and Control Systems Engg, PSG College of Technology, Coimbatore, India.*

(766-N45) **An Efficient Reconfiguration Method based on Standard Deviation for Series and Parallel Connected PV Arrays.** Koray Sener Parlak[1], Mehmet Karakose[2]. *[1]Firat University, Elazig, Turkey, [2]Firat University, Elazig, Turkey.*

(767-O1) **A Novel Strategy for Connecting Battery in Standalone Solar Photovoltaic Converter System.** Sachin Parsekar, Kishore Chatterjee. *Indian Institute of Technology Bombay, Mumbai, India.*

(768-O5) **Fire at a PV Installation.** Finley R. Shapiro. *Finley Shapiro Consulting, Inc., Philadelphia, PA, USA.*

(769-O9) **A Power Generation Estimate of Cylindrically-shaped Flexible PV Cell Systems for Off-grid Use.** Mamoru Shibasaki, Toshiaki Yachi. *Tokyo University of Science, Tokyo, Japan.*

(770-O13) **The expansion opportunity for off-grid PV to go mainstream: multiple case studies for village electrification and telecom power-up in India.** Andrew Skumanich[2], Prabhakar Loka[1], Karthik Polsani[1], Shekar Reddy[2]. *[1]Premier Solar, Hyderabad, India, [2]SolarVision Co, Los Gatos - Silicon Valley, CA, USA.*

3:00 - 3:30 PM **Exhibit Hall D**

Coffee Break

Joint Session: Areas 2,9 - Orals

3:30 - 5:00 PM **MR 502-504**

Manufacturing of Thin Film Chalcogenide Modules

Chair(s): Eray Aydil, Shogo Ishizuka

3:30 **(771) High efficiency and large volume production of CIS-based modules**
Hiroki Sugimoto[1,2]
[1]Showa Shell Sekiyu K.K., Atsugi, Japan, [2]Solar Frontier K.K., Atsugi, Japan

4:00 **(772) Evaluation of Micro- and Nanoscale Uniformity in All-PVD Cu(In,Ga)Se$_2$ Solar Cells**
Gregory M Kimball, Neil Mackie, Magdalena Parker, Atiye Bayman
MiaSole Hi-Tech Corp, Santa Clara, CA, USA

4:15 **(773) CIGS Module Manufacturing with High Deposition Rates and Efficiencies**
Dirk Herrmann[1], Philipp Kratzert[1], Stefan Weeke[1], Martin Zimmer[1], Jovana Djordjevic-Reiss[1], Ralf Hunger[1], Lars Bach[1], Peter Lindberg[2], Erik Wallin[2], Olle Lundberg[2], Lars Stolt[1,2]
[1]Solibro GmbH, Bitterfeld-Wolfen, Germany, [2]Solibro Research AB, Uppsala, Sweden

4:30 **(774) Broadband Anti-Reflection coatings for Thin Film Photovoltaics**
Piotr M Kaminski, Gerald Womack, John M Walls
CREST (Centre for Renewable Energy Systems and Technology), School of Electronic, Electrical and Systems Engineering, Loughborough University, Loughborough, UK

4:45 **(775) Recent developments toward a one step thin-film PV interconnection process using laser scribing and inkjet printing.**
Mickey L. Crozier[1,2], Phillip Adamson[1], Adam Brunton[1], Simon Henley[1], Meng Jiang[1], Piotr M. Kaminski[3], Jonathan D. Shephard[2], John M. Walls[2]
[1]M-Solv, Oxford, UK, [2]Heriot-Watt, Edinburgh, UK, [3]CREST, Loughborough, UK

Joint Session: Areas 1,3,4,7 - Orals

3:30 - 5:00 PM **MR 505-507**

III-V on Silicon Solar Cells

Chair(s): Mitsuru Imaizumi, Steven Ringel

3:30 **(776) Progress Toward a Si-Plus Architecture: *Epitaxially-Integrable Si Sub-Cells for III-V/Si Multijunction Photovoltaics***
Tyler J Grassman[1,2], John A Carlin[3], Santino D Carnevale[2], Ibraheem Al Mansouri[4], Hamid Mehrvarz[4], Stephen Bremner[4], Anita Ho-Baillie[4], Elisa García-Tabarés[5], Ignacio Rey-Stolle[5], Martin A Green[4], Steven A Ringel[2,3]
[1]Dept. of Materials Science and Engineering, The Ohio State University, Columbus, OH, USA, [2]Dept. of Electrical and Computer Engineering, The Ohio State University, Columbus, OH, USA, [3]Institute for Materials Research, The Ohio State University, Columbus, OH, USA, [4]School of Photovoltaic and Renewable Energy Engineering, University of New South Wales, Sydney, Australia, [5]Instituto de Energía Solar, Universidad Politécnica de Madrid, Madrid, Spain

4:00 **(777) Direct Epitaxial Growth of Silicon on GaAs by Low Temperature Epitaxy**
Romain Cariou[1,2], Jean-Luc Maurice[2], Jean Decobert[1], Pere Roca i Cabarrocas[2]
[1]III-V Lab, joint laboratory between Alcatel-Lucent Bell Labs France, Thales Research and Technology and CEA-LETI, Marcoussis, France, [2]LPICM-CNRS, Ecole Polytechnique, Palaiseau, France

4:15 **(778) III-V-N/Si heteroepitaxy for multijunction solar cells**
Akihiro Wakahara, Noriyuki Urakami, Hiroto Sekiguchi, Keisuke Yamane
Toyohashi University of Technology, Toyohashi, Japan

4:30 **(779) An Experimental-Theoretical Atomic-Scale Study - *In Situ* Analysis of III-V on Si(100) Growth for Hybrid Solar Cells**
Oliver Supplie[1,2], Sebastian Brueckner[1,2], Oleksandr Romanyuk[3], Matthias M. May[2], Henning Doescher[4], Peter Kleinschmidt[1,2], Helena Stange[2], Anja Dobrich[1,2], Christian Hoehn[2], Hans-Joachim Lewerenz[5], Frank Grosse[6], Thomas Hannappel[1,2]
[1]Ilmenau University of TechnologyTechnical, Ilmenau, Germany, [2]Helmholtz-Zentrum Berlin, Berlin, Germany, [3]Academy of Sciences of the Czech Republic, Prague, Czech Republic, [4]National Renewable Energy Laboratory, Golden, CO, USA, [5]California Institute of Technology, Pasadena, CA, USA, [6]Paul-Drude Institute, Berlin, Germany

4:45 **(780) Rapid Characterization of Extended Defects in III-V/Si by Electron Channeling Contrast Imaging**
Santino D. Carnevale[1], Julia I. Deitz[2], Tyler J. Grassman[1,2], John A. Carlin[3], Yoosuf N. Picard[4], Marc De Graef[4], Steven A. Ringel[1,3]
[1]Department of Electrical and Computer Engineering, The Ohio State University, Columbus, OH, USA, [2]Department of Materials Science and Engineering, The Ohio State University, Columbus, OH, USA, [3]Institute for Materials Research, The Ohio State University, Columbus, OH, USA, [4]Department of Materials Science and Engineering, Carnegie Mellon University, Pittsburgh, PA, USA

Area 1 - Orals

3:30 - 5:00 PM **Ballroom 1AB**

Light Management 2: Light Trapping and Advanced ARCs

Chair(s): Jonathan Grandidier, Pei-chen Yu

3:30 **(781) High-Efficiency Solar Cells by Nanophotonic Design**
Albert Polman
FOM Institute AMOLF, Amsterdam, Netherlands

4:00 **Best Student Presentation Award Finalist**
(782) Plasmonic Nanocavity Organic Solar Cells with Highly Enhanced Power Conversion Efficiency, Broad-Band, and Omni-Acceptance
Wei Ding, Stephen Y. Chou
Princeton University, Princeton, NJ, USA

4:30 **(783) Advanced Broadband Antireflection Coatings Based on Cellulose Micro-fiber Paper**
Dongheon Ha[1,2], Zhiqiang Fang[3], Liangbing Hu[3], Jeremy N. Munday[1,2]
[1]Department of Electrical and Computer Engineering, University of Maryland, College Park, MD, USA, [2]Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD, USA, [3]Department of Materials Science and Engineering, University of Maryland, College Park, MD, USA

4:45 **(784) Metal nanogrids for efficient light harvesting in ultrathin GaAs solar cells**
Nicolas VANDAMME[1], Ines MASSIOT[1], Clement COLIN[1,2], Aristide LEMAITRE[1], Andrea CATTONI[1], Jean-Francois GUILLEMOLES[2], Stephane COLLIN[1]
[1]LPN-CNRS, MARCOUSSIS, France, [2]IRDEP-EDF/CNRS/Chimie ParisTech, CHATOU, France

Area 4 - Orals

3:30 - 5:00 PM **Ballroom 1EF**

Contacts

Chair(s): Giso Hahn, David Smith

3:30 **Best Student Presentation Award Finalist**
(785) Transparent electrodes for silicon heterojunction solar cells fabricated by atomic layer deposition
Benedicte Demaurex[1], Johannes Peter Seif[1], Sjoerd Smit[2], Bart Macco[2], W.M.M. Kessels[2], Stefaan De Wolf[1], Christophe Ballif[1]
[1]Ecole Polytechnique Fédérale de Lausanne (EPFL) Institute of Microengineering (IMT) / Photovoltaics and thin-film electronics laboratory, Neuchatel, Switzerland, [2]Eindhoven University of Technology, Department of Applied Physics, Eindhoven, Netherlands

3:45 **(786) Emitter Recombination Current Densities of Boron Emitters with Silver/Aluminum Pastes**
Fabian Kiefer[1], Robby Peibst[1], Tobias Ohrdes[1], Jan Krügener[2], H. Jörg Osten[2], Rolf Brendel[1,3]
[1]Institute for Solar Energy Research Hamelin, Emmerthal, Germany, [2]Institute of Electronic Materials and Devices, Leibniz Universität Hannover, Hanover, Germany, [3]Institute of Solid State Physics, Leibniz Universität Hannover, Hanover, Germany

4:00 **(787) Point-contacting by Localised Dielectric Breakdown: a robust approach to contacting silicon for solar applications**
Ned J Western, Stephen P Bremner
School of Photovoltaic and Renewable Energy Engineering, Sydney, Australia

4:15 **(788) Selective Anodisation**
Pei Hsuan Doris Lu, Stuart Wenham, Alison Lennon
UNSW, Sydney, Australia

4:30 **(789) Copper Metallization of Silicon PERL Solar Cells: 21% Cell Efficiency and Module Assembly Using Conductive Film**
Kyumin LEE, Dohyeon KYEONG, Moonseok KIM, Won-jae LEE, Eun-Chel CHO
Hyundai Heavy Industries, Co., Ltd., Yongin, South Korea

4:45 **(790) Understanding Peel Force Variation during Ag Grid Line Adhesion Measurements**
Liang Liang, Zhigang Li, Nick Glassmaker, Lapkin Cheng
DuPont CR&D, Wilmington,, DE, USA

Area 5 - Orals

3:30 - 5:00 PM **Ballroom 1CD**

Amorphous, Nano- and Micro-Crystalline Silicon

Chair(s): Hitoshi Sai, Franz-Josef Haug

3:30 **(791) Development and Progress in Thin Film Si Photovoltaic Technologies by Photovoltaic Power Generation Technology Research Association**
Isao Yoshida[1], Takuya Matsui[2], Hitoshi Sai[2], Takashi Suezaki[3], Hirotaka Katayama[4], Mitsuhiro Matsumoto[4], Shuichiro Sugiyama[5], Takuro Masuda[6], Mitsuru Ushijima[7], Shuichi Nonomura[9], Masaharu Shiratani[10], Makoto Konagai[11], Kimihiko Saito[1,8], Michio Kondo[2], Makoto Tanaka[4], Shigeru Niki[2]
[1]PVTEC, Tsukuba, Japan, [2]AIST, Tsukuba, Japan, [3]Kaneka Corp., Settsu, Japan, [4]Panasonic Corp., Moriguchi, Japan, [5]Sharp Corp., Katsuragi, Japan, [6]Mtsubishi Heavy Industries Ltd., Isahaya, Japan, [7]Tokyo Electron Ltd., Tsukuba, Japan, [8]Fukushima University, Tsukuba, Japan, [9]Gifu University, Gifu, Japan, [10]Kyushu University, Fukuoka, Japan, [11]Tokyo Institute of Technology, Meguro-ku, Japan

4:00 **(792) Nano-imprint lithography for advanced light management concepts in multi-junction solar cells**
Matthias Meier[1], Ulrich Wilhelm Paetzold[1], Michael Ghosh[1], Rob van Erven[2]
[1]Forschungszentrum Juelich GmbH, Juelich, Germany, [2]OM&T B.V. - Moser Baer Technologies, Eindhoven, Netherlands

4:15 **(793) High efficiency thin film solar cells deposited at the amorphous-to-microcrystalline transition using $SiF_4/H_2/Ar$ gas mixtures**
Jean-Christophe Dornstetter[1,2], Bastien Bruneau[2], Pavel Bulkin[2], Erik V. Johnson[2], Pere Roca i Cabarrocas[2]
[1]TOTAL New Energies, Paris La Defense, France, [2]LPICM CNRS - Ecole Polytechnique, Palaiseau, France

4:30 **Best Student Presentation Award Finalist**
(794) Effect of ion energy on microcrystalline silicon material and devices: a study using Tailored Voltage Waveforms
Bastien Bruneau[1], Junkang Wang[1], Jean-Christophe Dornstetter[1,2], Erik Johnson[1]
[1]LPICM, Ecole Polytechnique, Palaiseau, France, [2]Total, Paris La Defense, France

4:45 **Best Student Presentation Award Finalist**
(795) The nature and the kinetics of light-induced defect creation in hydrogenated amorphous silicon films and solar cells.
Jimmy Melskens[1], Marc Schouten[1], Awital Mannheim[2], Albert S. Vullers[1], Yalda Mohammadian[1], Stephan W.H. Eijt2, Henk Schut[3], Takuya Matsui[4,5], Miro Zeman[1], Arno H.M. Smets[1]. [1]Photovoltaic Materials and Devices, Faculty of Electrical Engineering, Mathematics and Computer Science, Delft University of Technology, Delft, Netherlands. [2]Fundamental Aspects of Materials and Energy, Faculty of Applied Sciences, Delft University of Technology, Delft, Netherlands. [3]Neutron and Positron Methods in Materials, Faculty of Applied Sciences, Delft University of Technology, Delft, Netherlands. [4]Research Center for Photovoltaic Technologies, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan. [5]Thin Film Silicon Lab, Photovoltaic Power Generation Technology Research Association (PVTEC), Tsukuba, Japan

Area 6 - Orals

3:30 - 5:00 PM **Ballroom 2A**

OPV Fabrication and Reliability

Chair(s): Wolfgang Tress, Yang Yang, Gang Li

3:30 **(796) High Specific Power Plastic Solar Cells**
Yue Wu
Solarmer, El Monte, CA, USA

4:00 **(797) Ultrasonic Spray Coating of 6.4% Efficient Diketopyrrolopyrrole Based Organic Photovoltaics**
Jeffrey G. Tait[1,2], Cindy Wong[2,3], David Cheyns[2], Mathieu Turbiez[4], Barry P. Rand[5], Paul Heremans[1,2]
[1]KU Leuven, Leuven, Belgium, [2]IMEC, Leuven, Belgium, [3]The Cooper Union, New York, NY, USA, [4]BASF, Basel, Switzerland, [5]Princeton University, Princeton, NJ, USA

4:30 **(798) Organic Photovoltaic Cells with All Inkjet Printed Layers and Freedom of Form**
Tamara Eggenhuisen[1], Yulia Galagan[1], Anne Biezemans[2], Michiel Coenen[1], Jan Gilot[1], Pim Groen[1,3], Ronn Andriessen[1]
[1]Holst Centre, Eindhoven, Netherlands, [2]ECN Solar Energy, Eindhoven, Netherlands, [3]Delft University, Delft, Netherlands

4:45 **(799) Controlling the Reliability of Polymer Solar Cells**
Stephanie R Dupont, Chris Bruner, Reinhold H Dauskardt
Stanford University, Stanford, CA, USA

Area 9 - Orals

3:30 - 5:00 PM **Ballroom 2B**

Predicting Module Performance

Chair(s): Clifford Hansen, Joshua Stein

3:30 **(800) Modeling the Irradiance and Temperature Dependence of Photovoltaic Modules in PVsyst**
Kenneth J. Sauer[1], Thomas Roessler[2], Clifford W. Hansen[3]
[1]Yingli Green Energy Americas, Inc., San Francisco, CA, USA, [2]Yingli Green Energy Europe GmbH, Munich, Germany, [3]Sandia National Laboratories, Albuquerque, NM, USA

3:45 **(801) Procedure for Applying IEC-61853 Test Data to a Single Diode Model**
Aron P. Dobos, Sara M. MacAlpine
National Renewable Energy Laboratory, Golden, CO, USA

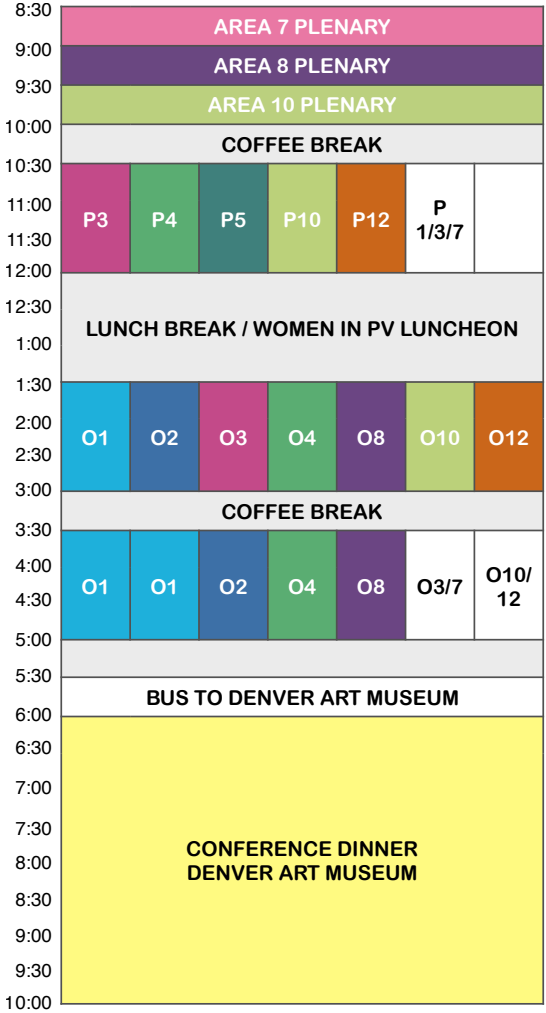
4:00 **Best Student Presentation Award Finalist**
(802) Likelihood Methods for Single Diode Model Parameter Estimation from I-V Curve Data with Noise
Brian Zaharatos[1], Mark Campanelli[2], Clifford Hansen[3], Keith Emery[2], Luis Tenorio[1]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]Sandia National Laboratories, Albuquerque, NM, USA

4:15 **(803) A Time Dependent Model for Utility Scale PV Module Temperature**
William J Hayes, Lauren M Ngan
First Solar, Inc., San Francisco, CA, USA

4:30 **(804) Angle of incidence effects on external quantum efficiency in polycrystalline silicon photovoltaics**
R. Beal[1], B.G. Potter[1], J.H. Simmons[1,2]
[1]University of Arizona, Tucson, AZ, USA, [2]Florida Gulf Coast University, Ft. Myers, FL, USA

4:45 **(805) Direct Analysis of the Current-Voltage Curves Applied to an Outdoor-Degrading CdTe Module**
Carolin Ulbrich[1], Sarah Kurtz[2], Dirk Jordan[2], Marzella Görig[1], Andreas Gerber[1], Uwe Rau[1]
[1]IEK5-Photovoltaik, Forschungszentrum Jülich, Jülich, Germany, [2]National Renewable Energy Laboratory, Golden, CO, USA

THURSDAY PROGRAM SUMMARY



	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 7 - Plenary

8:30 - 9:00 AM **Ballroom 3-4**

Space PV Devices and Systems

Chair(s): Mitsuru Imaizumi, Phillip Jenkins

8:30 **(806) Development and High-Irradiance High-Temperature Testing of the Solar Probe Plus Array**
Andreea Boca, Rick Stall, Philip Blumenfeld, Karen De Zetter, Benjamin Richards, Chaz Sarver, Mark Stan, Kevin Crist, Paul Sharps
Emcore Photovoltaics, Albuquerque, NM, USA

Area 8 - Plenary

9:00 - 9:30 AM **Ballroom 3-4**

Characterization Methods

Chair(s): Keith Emery

9:00 **(807) Luminescence Imaging for Quantitative Solar Cell Analysis**
Bernhard Michl, Florian Schindler, Milan Padilla, Wilhelm Warta, Martin C. Schubert
Fraunhofer ISE, Freiburg, Germany

Area 10 - Plenary

9:30 - 10:00 AM **Ballroom 3-4**

PV Systems and Applications

Chair(s): Greg Ball

9:30 **(808) All about PV Power Plants: Technical challenges for technical bankability**
Boris Farnung
Fraunhofer ISE, Freiburg, Germany

10:00 - 10:30 AM **Ballroom Pre-function**

Coffee Break

Joint Session: Areas 1,3,7 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Quantum Confinement for Space and Multijunction Solar Cell Applications

Chair(s): Sheila Bailey, Shin-Ichiro Sato, Maria Gonzalez

(809-P41) **Growth and Characterization of GaAs/GaPAs Metamorphic, Epitaxial Nanostructures.** Phil Ahrenkiel, Nan Zheng, Joseph A. Street. *South Dakota School of Mines & Technology, Rapid City, SD, USA.*

(810-P43) **Multi-quantum well solar cell modeling and optimization.** Diego Alonso-Álvarez, Markus Führer, Tomos Thomas, Ned Ekins-Daukes. *Imperial College London, London, UK.*

(811-P45) **Radiation Effects on InAlGaAs / InGaAs Quantum Well Solar Cells.** Christopher G Bailey[1], Raymond Hoheisel[1,2], Maria Gonzalez[1,3], David V Forbes[4], Matthew P Lumb[1,2], Seth M Hubbard[4], David A Scheiman[1], Louise C Hirst[1], Kenneth J Schmieder[1], Scott R Messenger[5], Brad D Weaver[1], Cory D Cress[1], Jeffrey Warner[1], Michael K Yakes[1], Phillip P Jenkins[1], Robert J Walters[1]. *[1]U.S. Naval Research Laboratory, Washington, DC, USA, [2]George Washington University, Washington, DC, USA, [3]Sotera Defense Solutions, Annapolis Junction, MD, USA, [4]Nanopower Research Labs, Rochester Institute of Technology, Rochester, NY, USA, [5]University of Maryland Baltimore County, Baltimore, MD, USA.*

(812-P47) **Enhanced Light Trapping in Multiple Quantum Wells by Thin Film Structure and Backside Grooves with Dielectric Interface.** Tomoyuki Inoue[1], Kentaroh Watanabe[2], Masakazu Sugiyama[1], Yoshiaki Nakano[1]. *[1]School of Engineering, the University of Tokyo, Tokyo, Japan, [2]Research Center for Advanced Science and Technology, Tokyo, Japan.*

(813-Q1) **Transport modeling of InGaN/GaN multiple quantum well solar cells.** Nicolas Cavassilas, Fabienne Michelini, Marc Bescond. *IM2NP - Aix-Marseille Université - CNRS, Marseille, France.*

(814-Q3) **Thermal Survivability Characterization of Quantum Dot Multi-Junction Photovoltaic Cells.** Peter S Ericksen[1], Alex Howard[2], David M Wilt[2]. *[1]Cornell University, Ithaca, NY, USA, [2]Air Force Research Laboratory, Albuquerque, NM, USA.*

(815-Q5) **Direct Measurement of Conduction Miniband Structure in Superlattice by Visible-Light Photoemission Spectroscopy.** Fumiaki Ichihashi, Daiki Shimura, Kenji Nishitani, Makoto Kuwahara, Takahiro Ito, Shunta Harada, Hiroyasu Katsuno, Miho Tagawa, Toru Ujihara. *Nagoya University, Nagoya, Japan.*

(816-Q7) **Radiation Response of the Fill-Factor for GaAs Solar Cells with InGaAs Quantum Dot Layers.** Tetsuya Nakamura[1], Taishi Sumita[1], Mitsuru Imaizumi[1], Takeyoshi Sugaya[2], Koji Matsubara[2], Shigeru Niki[2], Toru Mochizuki[3], Akihiro Takeda[3], Yoshinobu Okano[3], Shin-ichiro Sato[4], Takeshi Ohshima[4]. *[1]Japan Aerospace Exploration Agency (JAXA), Tsukuba, Japan, [2]National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, [3]Tokyo City University, Setagaya-ku, Japan, [4]Japan Atomic Energy Agency (JAEA), Takasaki, Japan.*

(817-Q9) **Analysis of GaAs/AlGaAs quantum nanodisk solar cell with intermediate band carrier transportation.** Akio Ogura, Tomah Sogabe, Daniel J Farrell, Yoshitaka Okada. *Research Center for Advanced Science and Technology(RCAST), The University of Tokyo, Tokyo, Japan.*

(818-Q11) **Simulation Study of Schottky Contact Based Single Si Wire Solar Cell.** M. Golam Rabbani[1], Amit Verma[2], Reza Nikovei[2], Mahmoud M. Khader[3], M. P. Anantram[1]. *[1]Dept. of Electrical Engineering, University of Washington, Seattle, WA, USA, [2]Dept. of Electrical Engineering and Computer Science, Texas A & M University – Kingsville, Kingsville, TX, USA, [3]Gas Processing Center, College of Engineering, Qatar University, Doha, Qatar.*

(819-Q13) **High Quality MBE grown dilute nitride quantum wells with novel Nitrogen-Plasma Source design.** Gopi Vijaya[1], Alex Freundlich[1], Dinghao Tang[2], David Smith[2]. *[1]University of Houston, Houston, TX, USA, [2]Arizona State University, Tempe, AZ, USA.*

(820-Q15) **Charged Quantum Dot Towards the Concept of Intermediate Band Solar Cells.** Jiang Wu[1], Phu Lam[1], Sabina Hatch[1], Mingchu Tang[1], Vitaliy G Dorogan[2], Yuriy I Mazur[2], Gregory J Salamo[2], Huiyun Liu[1]. *[1]Department of Electronic and Electrical Engineering, University College London, London, UK, [2]Institute for Nanoscience and Engineering, University of Arkansas, Fayetteville, AR, USA.*

(821-Q17) **Silicon Nanowire Arrays Passivated by Al2O3/ TiO2 Stack Layers.** Yasuharu Yamada[1], Yasuyoshi Kurokawa[1,2], Shinya Kato[4], Akira Yamada[1,3]. *[1]Department of Physical Electronics, Tokyo, Japan, [2]PRESTO, Saitama, Japan, [3]Photovoltaics Research Center (PVREC), Tokyo, Japan, [4]FUTURE-PV Innovation, Tokyo, Japan.*

(822-Q19) **Effect of Barrier Thickness on Carrier Transport inside Multiple Quantum Well Solar Cells under High-concentration Light Illumination.** Warakorn Yanwachirakul[1], Hiromasa Fujii[1], Kentaroh Watanabe[2], Masakazu Sugiyama[1], Yoshiaki Nakano[1]. *[1]Graduate School of Engineering, The University of Tokyo, Tokyo, Japan, [2]Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan.*

(823-Q21) **Simulation of Electron Escape from GaNAs/ GaAs Quantum Well Solar Cells.** Yongjie Zou[1], Christiana B. Honsberg[1], Alexandre Freundlich[2], Stephen M. Goodnick[1]. *[1]School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ, USA, [2]Photovoltaic and Nanostructures Laboratories, Center for Advanced Materials, University of Houston, Houston, TX, USA.*

Area 3 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Low and High Concentration CPV

Chair(s): Geoffrey Kinsey, Pilar Espinet-González

(824-E21) **Performance Characterization of a Small Form-Factor 100X Micro-Optic Concentrator.** Gautam Agrawal, Tian Gu, Michael W. Haney. *University of Delaware, Newark, DE, USA.*

(825-E24) **Sensitivity Analysis Applied to a Concentrator Photovoltaic System.** Kristine Drew, Michael Sinclair, Stefan Myrskog, John Paul Morgan. *Morgan Solar Inc., Toronto, ON, Canada.*

(826-E27) **Comparison of Predicted, Expected, and Measured Current from CPV and Silicon PV Modules.** Geoffrey S Kinsey[1], Cameron Stark[1], Aditya Dhathathreyan[1], Tobias Gerstmaier[2], Renato Moretta[2]. *[1]Fraunhofer CSE, Boston, MA, USA, [2]Soitec Solar, Freiburg, Germany.*

(827-E30) **Technical Issues and Challenges in the Fabrication of a Large High-Concentrating Photovoltaic Receiver.** Leonardo Micheli[1], Nabin Sarmah[1], Eduardo F. Fernández[1], K.S. Reddy[2], Tapas K. Mallick[1]. *[1]Environment and Sustainability Institute, University of Exeter, Penryn Campus, Penryn, UK, [2]Heat Transfer and Thermal Power Laboratory, Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai, India.*

(828-F1) **Cost Analysis of Flat-Plate Concentrators Employing Microscale Photovoltaic Cells for High Energy Per Unit Area Applications.** Scott M. Paap[1], Vipin P. Gupta[2], Anna Tauke-Pedretti[2], Paul J. Resnick[2], Carlos A. Sanchez[2], Gregory N. Nielson[2], Jose Luis Cruz-Campa[2], Bradley H. Jared[2], Benjamin J. Anderson[2], Jeffrey S. Nelson[2], Murat Okandan[2], William C. Sweatt[2]. *[1]Sandia National Laboratories, Livermore, CA, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA.*

(829-F4) **An innovative concentrator system based on Cu(In,Ga)Se2 microcells.** Myriam Paire[1,2,3], Laurent Lombez[1,2,3], Stéphane Collin[4], Jean-Luc Pelouard[4], Daniel Lincot[1,2,3], Jean-François Guillemoles[1,2,3]. *[1]1) Institute for Research and Development on Photovoltaic Energy (IRDEP), EDF R&D, Chatou, France, [2]IRDEP, CNRS, Chatou, France, [3]IRDEP-Chimie Paristech, Paris, France, [4]Laboratoire de photonique et nanostrcutures, LPN-CNRS, Marcoussis, France.*

(830-F7) **Cu(In,Ga)Se2 Solar Cells Measured under Low Flux Optical Concentration.** James S. Ward, Brian Egaas, Rommel Noufi, Miguel A. Contreras, Kannan Ramanathan, Carl Osterwald. *NREL, Golden, CO, USA.*

Area 4 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Materials and Junction Formation

Chair(s): Gianluca Coletti, Thibaut Desrues, Robby Peibst

(831-G2) **The Distribution of Chromium in Multicrystalline Silicon.** Mallory Ann Jensen[1], Jasmin Hofstetter[1], David P. Fenning[1], Ashley E. Morishige[1], Gianluca Coletti[2], Barry Lai[3], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]ECN Solar Energy, Petten, Netherlands, [3]Advanced Photon Source at Argonne National Laboratory, Argonne, IL, USA.*

(832-G6) **A simple approach for the simulations in the mechanical studies of drilled wafers.** Josu Barredo[1], Alberto Fraile[2], Covadonga Alarcón[3], Lutz Hermanns[2]. *[1]Center for Modeling in Mechanical Engineering, Madrid, Spain, [2]Department of Structural Mechanics and Industrial Constructions, UPM, Madrid, Spain, [3]Department of Materials Engineering, UPM, Madrid, Spain.*

(833-G10) **Scanning Electron Microscopy Analysis of Defect Clusters in Multicrystalline Solar Grade Silicon Solar Cells.** charly berthod[1], tor oskar sætre[1], jan ove odden[2]. *[1]UiA, Grimstad, Norway, [2]Elkem Solar Silicon, Kristiansand, Norway.*

(834-G14) **Indium-Doped Mono-Crystalline Silicon Substrates Exhibiting Negligible Lifetime Degradation Following Light Soaking.** Martin J. Binns, Jesse Appel, Jason Guo, Jihong Chen, T.N. Swaminathan, Ethan A. Good. *SunEdison, Inc, St. Peters, MO, USA.*

(835-G18) **Analysis of the topography and the sub-surface damage of Cz- and mc-silicon wafers sawn with diamond wire.** Rajko Buchwald, Sindy Würzner, Marcel Fuchs, Stefan Retsch, Kilian Fröhlich, Toni Lehmann, Hans Joachim Möller. *Fraunhofer Technologiezentrum Halbleitermaterialien THM, Freiberg, Germany.*

(836-G22) **Predicting Dislocation Recombination Strength in Multicrystalline Silicon using Etch-Pit Geometry Variation.** Sergio Castellanos[1], Jasmin Hofstetter[1], Maulid Kivambe[1], Markus Rinio[2], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Karlstad University, Karlstad, Sweden.*

(837-G26) **Investigation of Electrical Properties on Industrial PERC Mono-like Si Solar cell.** Yu-Hsuan Chang, Shang-Jue Su, Po-Sheng Huang, Li-Wei Cheng. *No. 1560, Sec. 1, Zhongshan Rd., Guanyin Township, Taoyuan County, Taiwan.*

(838-G30) **Investigation of Cooling Effect on the formation of Al-p+ emitter For N-type Silicon Solar Cell.** Tseng-Jung Chang, Sean H.T. Chen, Chia-Yu Shen, Shao-Peng Su, Li-Wei Cheng. *Topcell solar international CO., LTD, Taoyuan County, Taiwan.*

(839-G34) **Comparison of POCl3 Diffusion with Phosphorus Ion Implantation for Czochralski and Quasi-mono Silicon Solar Cells.** Eunhwan Cho, Youngwoo Ok, Kyungsun Ryu, Brian Rounsaville, Ajay D. Upadhyaya, Vijaykumar Upadhyaya, Ajeet Rohatgi. *University Center of Excellence for Photovoltaic Research and Education, Georgia Institute of Technology, Atlanta, GA, USA.*

(840-G38) **Cold-Container Crystal Growth of "Last-to-Freeze" Silicon Samples, for Enhanced Detection of Metallic Impurities by ICP-MS.** T. F. Ciszek[1], H. E. Gotts[2]. *[1]Siliconsultant Division of Geolite, Evergreen, CO, USA, [2]Air Liquide Electronics U. S. LP – Balazs NanoAnalysis, Fremont, CA, USA.*

(841-H2) **Residual Dopant Levels in Silicon Feedstock Grown by Pilot-Scale Atmospheric Pressure Iodine Vapor Transport.** T.F. Ciszek. *Siliconsultant Division of Geolite, Evergreen, CO, USA.*

(842-H6) **High Efficiency Solar Cells on Direct Kerfless 156 mm Mono Crystalline Si Wafers by High Throughput Epitaxial Growth.** Ruiying Hao[1], T.S. Ravi[1], V. Siva[1], Jean Vatus[1], Dan Miller[1], Joel Custodio[1], Ken Moyers[1], Chia-Wei Chen[2], Ajay Upadhyaya[2], Ajeet Rohatgi[2,3]. *[1]Crystal Solar Inc., Santa Clara, CA, USA, [2]Georgia Institute of Technology, Atlanta, GA, USA, [3]Suniva Inc., Norcross, GA, USA.*

(843-H10) **High-Throughput Si Foil Technologies at Fraunhofer ISE.** Stefan Janz, Marion Drießen, Nena Milenkovic, Martin Keller, Elke Gust, Stefan Reber. *Fraunhofer ISE, Freiburg, Germany.*

(844-H14) **High quality multicrystalline silicon wafer by grain size control on directional growth method.** Ho Kai-An, Chou Jian-Kang, Tzeng Shi-Kai, Liao Lung-Sheng, Yang Chen-Hao, Wu Jui-Pin, Wu Yu-Hao, Chen Yu-Chung. *Motech Industries Inc., Tainan, Taiwan.*

(845-H18) **>1.8 Millisecond Effective Lifetime in n-type Silicon Grown by the Noncontact Crucible Method.** Maulid Kivambe[1], Douglas M. Powell[1], Mallory Ann Jensen[1], Ashley E Morishige[1], Kazuo Nakajima[2], Ryota Murai[2], Kohei Morishita[2], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Graduate School of Energy Science, Kyoto University, Kyoto, Japan*

(846-H22) **Ingots Pulled with Electron Beam Heating from Skull - a New Feedstock for FZ Crystals Applicable for Solar Cells.** Anatoly Kravtsov. *SIA "KEPP EU", Riga, Latvia.*

(847-H26) **Analysis of Emitter Performance contacted with Silicide induced Dopant Segregation.** Markus Lenz, Joachim Knoch. *RWTH Aachen University, Institute of Semiconductor Electronics, Aachen, Germany.*

(848-H30) **Double Shottcky of NiOx/Graphene/Si for Enhance Efficiency Solar Cells.** M. Mohammed[1,3], T. Chen[2]. *[1]Department of Applied Science, Unversity of Arkansas at Little Rock and Green Solar Cell Research, Little Rock, AR, USA, [2]Department of Physics and Astronomy, Unversity of Arkansas at Little Rock and Green Solar Cell Research, Little Rock, AR, USA, [3]College of Science, University of Al-Qadisiyah, Al-Qadisiyah, Iraq.*

(849-H34) **Elucidating and Engineering Recombination-Active Metal-Rich Precipitates in n-type Multicrystalline Silicon.** Ashley E. Morishige[1], David P. Fenning[1], Jasmin Hofstetter[1], Mallory Ann Jensen[1], Saptharishi Ramanathan[2], Chenlei Wang[2], Barry Lai[3], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Sunpreme, Sunnyvale, CA, USA, [3]Advanced Photon Source, Argonne National Laboratory, Argonne, IL, USA.*

(850-H38) **Analysis of Different Models of Iron Precipitation in Multicrystalline Silicon.** Ashley E. Morishige[1], Hannu S. Laine[2], Jonas Schön[3], Jasmin Hofstetter[1], Antti Haarahiltunen[2], Martin Schubert[3], Hele Savin[2], Tonio Buonassisi[1]. *[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Aalto University, Department of Micro and Nanosciences, Espoo, Finland, [3]Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany.*

(851-I2) **POCl3 diffusion process optimization for the formation of emitters in the crystalline silicon solar cells.** Karthick Murukesan[1,2], Sandeep kumbhar[2], Ashok Kapoor[3], Anuradha Dhaul[3], Saravanan S[2], Richard Pinto[1,2], Arora Brij Mohan [1,2]. *[1]Indian Institute of Technology, Powai, Mumbai 400076, India, [2]National Center for Photovoltaic Research and Education,Powai, Mumbai 400076, India, [3]Solid State Physics Laboratory, Lucknow Road, Delhi 110054, India.*

(852-I6) **Sacrificial High-Temperature Phosphorus Diffusion Gettering Process for Lifetime Improvement of Multi-Crystalline Silicon Wafers.** Stephanie M. Scott, Jasmin Hofstetter, Ashley E. Morishige, Tonio Buonassisi. *Massachusetts Institute of Technology, Cambridge, MA, USA.*

(853-I10) **Improvement of Annealing Procedure to Suppress Defect Generation during Impurity Gettering in Multicrystalline Silicon for Solar Cells.** Isao Takahashi[1], Supawan Joonwichien[1], Kentaro Kutsukake[2], Satoru Matsushima[1], Ichiro Yonenaga[2], Noritaka Usami[1]. *[1]Graduate School of Engineering Nagoya University, Nagoya, Japan, [2]Institute for Materials Research Tohoku University, Sendai, Japan.*

(854-I14) **Silicon Solar Cell Voltage Increase Based on Limited Area Junction.** Peinan Teng[1], Xinrui An[1], Alexander To[1], Hamid Mehrvarz[1], Thorsten Trupke[1,2], Allen Barnett[1]. *[1]University of New South Wales, Sydney, Australia, [2]BT Imaging, Sydney, Australia.*

(855-I18) **The influence of phosphorus diffusion gettering in interdigitated back contact solar cells.** Yun-Kuo Tsao[1], Richard Pai[2]. *[1]Motech Industries, Inc. Sicence Park Branch, Tainan, Taiwan, [2]Motech Industries, Inc. Sicence Park Branch, Tainan, Taiwan.*

(856-I20) **Controlling the defects of mc-Si ingot in industrial scale during crystallization.** Shi-Kai Tzeng, Jui-Pin Wu, Chen-Hao Yang, Lung-Sheng Liao, Kai-An Hao, Jiang-Kang Chou, Yu-Hao Wu, Yu-Chung Chen. *1, Tainan, Taiwan.*

(857-I22) **The Enhancement of Thin Silicon Solar Cell by Selective Emitter Structure.** Teng-Yu Wang[1], Yu-Ruei Chen[1,2], Chen-Hsun Du[1,3], Chung-Yuan Kung[2]. *[1]Industrial Technology Research Institute, Hsinchu, Taiwan, [2]National Chung Hsing University, Taichung, Taiwan, [3]National Tsing Hua University, Hsinchu, Taiwan.*

(858-I24) **Study of P-type silicon laser doping with ALD AlOx as dopant source.** Bo Xiao, Ly Mai, Dong Lin, Brett Hallam, Chee Mun Chong, Alison Lennon, Stuart Wenham. *University of New South Wales, Sydney, Australia.*

(859-I26) **Crystal growth, microstructure characterization and cell performance analysis of casting-monocrystalline ingots with orientation.** Zhen Xiong[1], Yingbin Zhang[1,2], Shaoyong Fu[1], Zhiqiang Zhang[1], Guanchao Xu[1], Zhiqiang Feng[1], Junhao Chu[2], Pierre J. Verlinden[1]. *[1]State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China, [2]Key Laboratory of Polar Materials and Devices, Ministry of Education, Department of Electronics, East China Normal University, 500 Dongchuan Road, Shanghai, China.*

(860-I27) **nm-scaled workfunction mapping of the interfaces of silicon heterojunction (SHJ) solar cell using Kelvin probe force microscopy.** Fumihiko Yamada, Takefumi Kamioka, Tomihisa Tachibana, Kyotaro Nakamura, Yoshio Ohshita, Itaru Kamiya. *Toyota Technological Institute, Nagoya, Japan.*

(861-I28) **Modeling of Hydrogenated Heavy B Diffusion for n-type Silicon Solar Cells.** Matthew G Young[1,2,3], Seth Shumate[1,2,4], Hafeezuddin Mohammed[1], Scott Little[1], Douglas Hutchings[1,2], Hameed Naseem[3]. *[1]Silicon Solar Solutions, LLC, Fayetteville, AR, USA, [2]Picasolar, Inc., Fayetteville, AR, USA, [3]University of Arkansas Electrical Engineering, Fayetteville, AR, USA, [4]University of Arkansas Microelectronics-Photonics, Fayetteville, AR, USA.*

(862-I29) **Growth of low defect density mc-Si ingots and wafers for PV application.** Zhiqiang Zhang[1], Yingbin Zhang[1,2], Zhen Xiong[1], Hongliang Ye[1], Feilin Ping[1], Shaoyong Fu[1], Zhiqiang Feng[1], Pierre J. Verlinden[1]. *[1]State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China, [2]Key Laboratory of Polar Materials and Devices, Ministry of Education, Department of Electronics, East China Normal University, Shanghai, China.*

(863-I30) **Etch-Back Simplifies Interdigitated Back Contact Solar Cells.** Ngwe Zin, Kean Fong, Evan Franklin, Teng Kho, Nick Grant, Da Wang, Eric Wang. *Australian National University, Canberra, Australia.*

Area 5 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Thin Film Si: Processing and Light Management

Chair(s): Nikolas Podraza, Matthias Meier

(864-I32) **Thin-Film Silicon Solar Cells Fabricated at Low Temperature: A Versatile Technology for Application on Transparent Flexible Plastic Substrates and in Integrated Photoelectrochemical Water Splitting Modules.** Karen Wilken, Vladimir Smirnov, Oleksandr Astakhov, Friedhelm Finger. *Forschungszentrum Jülich GmbH, Jülich, Germany.*

(865-I34) **P+ layer effects on a-Si:H solar cell performance.** Kibum Kim, Yue Kuo. *Texas A&M University, College Station, TX, USA.*

(866-I36) **Open circuit voltage ~ 0.95 V for microcrystalline silicon mixed phase solar cell.** Jatindra Kumar Rath. *Utrecht University, Faculty of Science,, Eindhoven,, Netherlands.*

(867-I38) **Low Temperature Deposition of Device-Quality Silicon Thin Films for Flexible PV Application.** Nilesh A Wadibhasme, Rajiv O Dusane. *Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Mumbai, India.*

(868-I40) **Study of Intrinsic Stress in Hydrogenated Amorphous Silicon PECVD Films with Cyclohexasilane (CHS) as a Precursor.** Konstantin Pokhodnya, Kenneth J. Anderson, Philip R Boudjouk. *Center for Nanoscale Science and Engineering, North Dakota State University, Fargo, ND, USA.*

(869-J2) **Atmospheric Pressure Chemical Vapor Deposition of Silicon Thin Films using Cyclohexasilane.** Guruvenket Srinivasan, Justin M Hoey, Kenneth J Anderson, Matthew Frohlich, Gregory Strommen, Robert A Sailer, Philip Boudjouk. *Center for Nanoscale Science and Engineering, North Dakota State University, Fargo, ND, USA.*

(870-J4) **~10% Increase in Short-Circuit Current Density using 100 nm Plasmonic Au Nanoparticles on Thin Film n-i-p a-Si:H Solar Cells.** Kazi Islam, Farsad Chowdhury, Aaesha Alnuaimi, Ammar Nayfeh. *Institute Center for Future Energy Systems (iFES), Department of Electrical Engineering and Computer Science (EECS), Masdar Institute of Science and Technology, Abu Dhabi, United Arab Emirates.*

(871-J6) **Nanoplasmonic Architecture for Semi-Transparent Nanocrystalline Silicon Thin Film.** Mohsen Mahmoudysepehr, Jahed Navid, Siva Sivoththaman. *The Centre for Advanced Photovoltaic Devices and Systems, University of Waterloo, Waterloo, ON, Canada.*

(872-J8) **Optical transmission and reflection analysis for semi-transparent amorphous silicon solar cells using scattering matrix method.** Da Jung Lee[1,2], Seong Hyun Lee[1,2], Sun Jin Yun[1,2], Jung Wook Lim[1,2], Myunghun Shin[3]. *[1]University of Science and Technology, Daejeon, Korea, [2]Electronics and Telecommunications Research Institute, Daejeon, Korea, [3]Korea Aerospace University, Goyang-city, Korea.*

(873-J10) **Periodic Surface texturing effect on ultra thin a-Si/DMD solar cell studied by optical modeling.** Masanori Fukuda, Kyu-Tae Lee, Jae-Yong Lee, L. Jay Guo. *University of Michigan, EECS, Ann Arbor, MI, USA.*

(874-J12) **Parasitic absorption effects in metallic back reflectors with texture.** Franz-Josef Haug[1], Jia Li[2], Christophe Ballif[1]. *[1]Ecole Polytechnique Fédérale de Lausanne, PV-Lab, Neuchatel, Switzerland, [2]Ningbo Institute of Material Technology and Engineering, Ningbo, China.*

(875-J14) **Efficiency Enhancement of Thin-Film a-Si:H Solar Cell with Periodic Anti-ring Back Reflector.** Hui-Hsin Hsiao, Po-Yuan Chen, I-Chun Cheng, Hung-Chun Chang, Yuh-Renn Wu. *National Taiwan University, Taipei, Taiwan.*

(876-J16) **30% Increase in Available Photons/Cell Area Using Nanoelement Array Light Trapping in 700nm Thick nc-Si Solar Cells.** Wook Jun Nam[1,2], Diego Fischer[3], Zachary Gray[1], Liming Ji[1], Douglas Neidich[4], Stephen Fonash[1,2,4]. *[1]Center for Nanotechnology Education and Utilization, The Pennsylvania State University, University Park, PA, USA, [2]Department of Engineering Science and Mechanics, The Pennsylvania State University, University Park, PA, USA, [3]PV and Renewable Energy Technology and Engineering, Neuchâtel, Switzerland, [4]Solarity LLC, State College, PA, USA.*

(877-J18) **Influence of Interface Textures in Thin-Film Si Solar Cells with Intermediate Reflector on Light Management.** Chao Zhang, Matthias Meier, André Hoffmann, Wendi Zhang, Markus Ermes, Karsten Bittkau, Gabrielle Jost, Ulrich Paetzold, Tsvetelina Merdzhanova. *IEK5 Photovoltaik, Forschungszentrum Jülich, Jülich, Germany.*

(878-J20) **Influence of the ZnO layer on performance of a- Si/ a-SiGe tandem solar cells with Aluminum/ZnO back reflector.** changyong chen. *The University of Toledo, Toledo, OH, USA.*

(879-J22) **Optimization of the Backside Metallization for a-Si:H/uc-Si:H Thin Film Tandem Solar Cells.** Xinwei Niu, Shiyong Liu, Wang Li, Jiayi Zheng, Chuan Lu. *Chint Solar (Zhejiang) Co., Ltd., 1335 Binan Lu, Hangzhou, China.*

(880-J24) **Low-refractive-index silicon-oxide interlayers for high-stable-efficiency multi-junction thin-film silicon solar cells.** Mathieu Boccard, Matthieu Despeisse, Jordi Escarre, Xavier Niquille, Grégory Bugnon, Simon Hänni, Maximilien Bonnet-Eymard, Fanny Meillaud, Christophe Ballif. *PV-lab, Ecole Polytechnique Fédérale de Lausanne (EPFL), Neuchâtel, Switzerland.*

(881-J25) **Optical Modeling of an Efficient Water Splitting Device Based on Bismuth Vanadate Photoanode and Micromorph Silicon Solar Cells.** Lihao Han[1], Fatwa Abdi[2,3], Roel van de Krol[3], Bernard Dam[2], Miro Zeman[1], Arno Smets[1]. *[1]Photovoltaic Materials and Devices (PVMD) Laboratory, Delft University of Technology, Delft, Netherlands, [2]Materials for Energy Conversion and Storage (MECS) Laboratory, Delft, Netherlands, [3]Helmholtz-Zentrum Berlin für Materialien und Energie Gmbh, Institute for Solar Fuels, Berlin, Germany.*

(882-J26) **Thin Heterojunction a-Si:H Photovoltaic Cell Design With No Doped a-Si:H Layers.** Erenn Ore, Gehan Amaratunga. *University of Cambridge, Cambridge, UK.*

Area 10 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Power Conversion

Chair(s): Ward Bower, Pierre Verlinden

(883-N18) **Un-interrupted DC Power from Grid: Will this accelerate decentralized solar deployments at Indian homes?.** Ashok Jhunjunwala, Bhaskar Ramamurthi, Krishna Vasudevan, Lakshmi Narasamma. *Indian Institute of technology, Madras, Chennai, India.*

(884-N22) **Novel 1-Ø Multilevel Current Source Inverter for Balanced/Unbalanced PV sources.** Phanikumar Chamarthi, Nataraj Pragallapati, Agarwal Vivek. *IIT BOMBAY, MUMBAI, India.*

(885-N26) **A New Coupled Inductor Based 9-level Inverter with Reduced Number of Switches for Standalone/Grid Connected Solar PV Applications.** Phanikumar Chamarthi, Agarwal Vivek. *IIT Bombay, Mumbai, India.*

(886-N30) **Development of a String Level Fault Detection System for Solar Tracking Applications.** Yunus Erkaya, Hareen Sekhr Illa, Caitlin Conway, Shirshak Dhali, Sylvain X. Marsillac. *Virginia Institute of Photovoltaics, Norfolk, VA, USA.*

(887-N34) **Development of a String Level I-V Curve Tracer.** Yunus Erkaya, Isaac Flory, Sylvain X. Marsillac. *Virginia Institute of Photovoltaics, Norfolk, VA, USA.*

(888-N38) **Multi-Objective Study for Down Selection of A Micro-Invreter Topology for Residential PV Applications.** Maja Harfman-Todorovic[1], Fenfeng Tao[1], Rui Zhou[1], Robert Steigerwald[1], Mohammed Agamy[1], Yan Jiang[1], Luis Garces[1], Michael Schutten[1], Donald Marabell[2]. *[1]GE Global Research Center, Niskayuna, NY, USA, [2]GE Critical Power, Plano, TX, USA.*

(889-N42) **Smart Combiner for Fixed Commercial Photovoltaic Systems Using Power Line Communication.** Chad Herndon, Yunus Erkaya, Chunsheng Xin, Shirshak Dhali, Sylvain X. Marsillac. *Virginia Institute of Photovoltaics, Norfolk, VA, USA.*

(890-N46) **Development of monolithically integrated high performance hybrid PV/a-SiC devices for photoelectrochemical water splitting.** Jian Hu[1], Feng Zhu[1], Augusto Kunrath[1], Dixit Prasher[2], Nicolas Gaillard[2]. *[1]MVSystems, Inc, Golden, CO, USA, [2]Hawaii Natural Energy Institute, Honolulu, HI, USA.*

(891-O2) **Integration of PV into the Energy System : Challenges and Measures for Generation and Load management.** Stefan Krauter. *University of Paderborn, Paderborn, Germany.*

(892-O6) **Comparative Evaluation of Current Source Inverters Interfacing Photo-Voltaic System to Grid for Modified Space Vector PWM Techniques.** Saravanan Sivanesan, Krishna Vasudevan. *Indian Institute of Technology, Chennai, India.*

(893-O10) **The Goal Oriented PV Inverter.** Sorin Spanoche[1], Behnam Behziz[2]. *[1]Optimhedron.com, Santa Clara, CA, USA, [2]Lam Research Corporation, Fremont, CA, USA.*

(894-O14) **A Novel Low Cost Portable Integrated Solar PV, Fuel Cell and Battery Emulator with Fast Tracking Algorithm.** Sushil Thale, Rupesh Wandhare, Vivek Agarwal. *Indian Institute of Technology-Bombay, Mumbai, India.*

(895-O17) **Design of a Photovoltaic Power Conditioning System for Hierarchical Control of a Microgrid.** Rupesh Wandhare, Sushil Thale, Vivek Agarwal. *Indian Institute of Technology- Bombay, Mumbai, India.*

(896-O20) **Precise Active and Reactive Power Control of the PV-DGS Integrated with Weak Grid to Increase PV Penetration.** Rupesh Wandhare, Vivek Agarwal. *Indian Institute of Technology- Bombay, Mumbai, India.*

Area 12 - Posters

10:30 - 12:00 PM **Exhibit Hall D**

Reliability 2

Chair(s): Ben Bourne, Sean Fowler, Eric Gerritsen

(897-O48) **The Reliability Assessment of Central Photovoltaic Inverter in Electric Power System.** Ahmad Alferidi, Yasser A.-R. I. Mohamed. *1, Edmonton, AB, Canada.*

(898-P2) **Degradation Rate Evaluation of 26-Year-Old 200 kW Power Plant in a Hot-Dry Desert Climate.** Jonathan Belmont, Kolapo Olakonu, Jaya Mallineni, Joseph Kuitche, Govindasamy TamizhMani. *Arizona State University ASU-PRL, Mesa, AZ, USA.*

(899-P4) **EL Inspection Of Thin-Film PV Modules In Between Field Operation.** Matevû Bokalič, Marko Topič. *University of Ljubljana, Faculty of Elec Eng, Ljubljana, Slovenia.*

(900-P6) **Ambient Airborne Particle Concentration and Soiling of PV Cover Plates.** Liza N Boyle, Holly N Flinchpaugh, Michael P Hannigan. *University of Colorado Boulder, Boulder, CO, USA.*

(901-P8) **Effect of Tilt Angle on Soiling of Photovoltaic Modules.** Jose Cano[1], Jim Joseph John[1,2], Sai Tatapudi[1], Govindasamy Tamizhmani[1]. *[1]Arizona State University Photovoltaic Reliability Lab, Mesa, AZ, USA, [2]Indian Institute of Technology Bombay, Mumbai, India.*

(902-P10) **Behavior of Light-Induced Degradation for Temperature Cycling Test.** Chien Yu Chen, Haomin Chen, C. H. Hsueh, MaoYi Chang. *AU Optronics Corporation(Benq Solar), Taichung, Taiwan.*

(903-P12) **Reliability & Risk Analysis for PV Systems: The Road to Probabilistic Risk Assessment.** Alessandra Colli. *Brookhaven National Laboratory, Upton, NY, USA.*

(904-P14) **Performance Degradation in Field-aged Crystalline Silicon PV Modules in Different Indian Climatic Conditions.** Rajiv Dubey[1], Shashwata Chattopadhyay[1], Vivek Kuthanazhi[1], Jim J. John[1], Chetan S. Solanki[1], Anil Kottantharayil[1], Brij M. Arora[1], K.L. Narasimhan[1], Juzer M. Vasi[1], Arun Kumar[2], O.S. Sastry[2]. *[1]National Centre for Photovoltaic Research and education, Indian Institute of Technology Bombay, Powai, Mumbai, 400076, India, [2]Solar Energy Center, Ministry of New and Renewable Energy, New Delhi, 110003, India.*

(905-P16) **An Innovative Photovoltaic DC Arc Fault Detection Method through Multiple Criteria Algorithm Based on a New Arc Initiation Method.** Yuan Gao, Yandan Lin, Yaojie Sun. *Department of Light Sources and Illuminating Engineering, School of Information Science and Technology, Fudan University, Shanghai, China.*

(906-P18) **Outdoor exposure tests of silicon crystalline photovoltaic for reliability.** Hyun-A Kim, Jung-Jin Choi, Sang-Cheol Kim. *Korea Conformity Laboratories, Seoul, Korea.*

(907-P20) **Soiling Losses of Utility-Scale PV Systems in Hot-Dry Desert Climates: Results from Four 4-16 Years Old Power Plants.** Jaya Krishna Mallineni, Karan Rao Yedidi, Sanjay Mohan Shrestha, Brett Knisely, sai tatapudi, Joseph Kuitche, Govindasamy Tamizhmani. *Arizona State University, Mesa, AZ, USA.*

(908-P22) **Evaluation Method for Arc Fault Detection Algorithms.** Stephen McConnell[1], Zhan Wang[1], Robert S. Balog[1], Jay Johnson[2]. *[1]Texas A&M University, College Station, TX, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA.*

(909-P24) **On-field Performance Assessment of Solar PV System under Different Operating Conditions.** Parimita Mohanty, K Rahul Sharma, Mukesh Gujar, Alekhya Datta. *TERI, India Habitat Centre, Lodhi Road, New Delhi, India.*

(910-P26) **Degradation and Failure Modes of 26-Year-Old 200 kW Power Plant in a Hot-Dry Desert Climate.** Kolapo Olakonu, Jonathan Belmont, Sai Tatapudi, Joseph Kuitche, Govindasamy TamizhMani. *Arizona State University ASU-PRL, Mesa, AZ, USA.*

(911-P28) **Comparison of trend extraction methods for calculating performance loss rates of different photovoltaic technologies.** Alexander Phinikarides, George Makrides, Nitsa Kindyni, George E. Georghiou. *FOSS Research Centre for Sustainable Energy, Photovoltaic Technology, Department of Electrical and Computer Engineering, University of Cyprus, Nicosia, Cyprus.*

(912-P30) **Performance Variation of Commercially Available Modules after Six Months of Outdoor System Voltage Stress Testing.** Eric Schneller, Narendra S. Shiradkar, Neelkanth G. Dhere. *Florida Solar Energy Center, Cocoa, FL, USA.*

(913-P32) **Identification of changes in power through DC string monitoring.** Rajalakshmi Sundaramoorthy, Nicholas J Alexander, David Metacarpa, Jim R Lloyd, Pradeep Haldar. *US Photovoltaic Manufacturing Consortium (PVMC), SUNY College of Nanoscale Science and Engineering, Albany, NY, USA.*

(914-P34) **Tightening nameplate rating tolerance below 5%: Can it be rationally and objectively required in test standards?.** GovindaSamy TamizhMani[1], Sailaja Radhakrishnan[2], William Shisler[1]. *[1]TUV Rheinland PTL, Tempe, AZ, USA, [2]Arizona State University, Mesa, AZ, USA.*

(915-P36) **Two Years Performance Comparison of Elkem Solar Multicrystalline Silicon with Polysilicon in a PV Grid-Connected System.** Muhammad Tayyib[1], Jan Ove Odden[2], N Ramchander[3], M B Prakash[3], R Muneeshwar[3], A V Sarma[4], M Ramanjaneyulu[4], tor Oskar Saetre[5]. *[1]Teknova AS Gimlemoen 19, 4630, Kritiansand S, Norway, [2]Elkem Solar AS. P.O. Box 8040 Vaagsbygd. NO-4675, Kritiansand S, Norway, [3]Padmasri Dr. B.V. Raju Inst. Of Techn., Vishnupur,, Narsapur, India, [4]Titan Energy Systems Ltd., 16 Aruna Enclave, Trimulgherry,, Secunderabad, India, [5]University of Agder, Postboks 509, NO-4898, Grimstad, Norway.*

(916-P37) **A Statistical Analysis on the Cell Parameters Responsible for Power Degradation of Fielded PV Modules in a Hot-Dry Climate.** Suryanarayana Vasantha Janakeerama, Jaspreet Singh, Joseph Kuitche, Jaya Krishna Mallineni, GovindaSamy TamizhMani. *Arizona State University- Photovoltaic Reliability Laboratory, Mesa, AZ, USA.*

(917-P38) **Arc Fault Signal Detection - Fourier Transformation vs. Wavelet Decomposition Techniques using Synthesized Data.** Zhan Wang[1], Stephen McConnell[1], Robert S. Balog[1], Jay Johnson[2]. *[1]Texas A&M University, College Station, TX, USA, [2]Sandia National Laboratory, Albuquerque, NM, USA.*

(918-P39) **Failure and Degradation Modes and Rates of PV Modules in a Hot-Dry Climate: Results after 16 years of field exposure.** Karan Rao Yedidi, Sai Tatapudi, Jaya Krishna Mallineni, Brett Knisely, Joseph Kuitche, Govindasamy Tamizhmani. *ASU, Mesa, AZ, USA.*

Special Event

12:00 - 1:30 PM **MR 501**

Women in PV Luncheon

Area 1 - Orals

1:30 - 3:00 PM **Ballroom 1AB**

Two-step Photon Absorption Concepts and Implementation

Chair(s): Gergely Zimanyi, Alexandre Freundlich

1:30 **(919) Spectrally resolved interband and intraband transitions by two-step photon absorption in InGaAs/GaAs quantum dot solar cells**
Ryo Tamaki, Yasushi Shoji, Yoshitaka Okada, Kenjiro Miyano
Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Tokyo, Japan

2:00 **(920) New Nanostructured Materials for Efficient Photon Upconversion**
Diane G. Sellers[1], Steve Polly[2], Yujun Zhong[1], Eric Chen[1], Seth Hubbard[2], Joshua M.O. Zide[1], Matthew F. Doty[1]
[1]Department of Materials Science and Engineering, University of Delaware, Newark, DE, USA, [2]NanoPower Research Labs, Rochester Institute of Technology, Rochester, NY, USA

2:15 **(921) Analysis and Design of Core-Shell Upconverting Nanostructures (CSUNs)**
Mark A. Wistey, Victor Patel, Meng Qi, William A. O'Brien, Joseph L. Loof, Anthony J. Erdman, Chad Stephenson
University of Notre Dame, Notre Dame, IN, USA

2:30 **(922) Two-photon photocurrent and voltage up-conversion in a quantum dot intermediate band solar cell**
Iñigo Ramiro[1], Elisa Antolin[1,2], Pablo G. Linares[1], Esther López[1], Irene Artacho[1], Alejandro Datas[1], Antonio Martí[1], Antonio Luque[1], Mathew J. Steer[3], Colin R. Stanley[3]
[1]Instituto de Energia Solar, Universidad Politecnica de Madrid, Madrid, Spain, [2]School of Physics and Astronomy, University of Nottingham, Nottingham, UK, [3]School of Engineering, Glasgow, UK

2:45 **(923) Dynamics and Two Photon Intersubband Absorption of Photovoltaic Quantum Structures**
Philipp Sippel[1], Klaus Schwarzburg[1], Mario Borgwardt[1], Mikaela Elagin[2], Simon Heitz[2], Mykhaylo Semtsiv[2], Ted Masselink[2], Thomas Hannappel[3], Rainer Eichberger[1]
[1]Helmholtz Zentrum Berlin, Berlin, Germany, [2]Humboldt University Berlin, Berlin, Germany, [3]Ilmenau University of Technology, Ilmenau, Germany

Area 2 - Orals

1:30 - 3:00 PM **MR 502-504**

CdTe 1

Chair(s): Matt Reese, Mike Walls

1:30 **(924) Advances in control of doping and lifetime in single-crystal and polycrystalline CdTe**
James M Burst, David S Albin, Joel N Duenow, Matthew O Reese, Stuart B Farrell, Darius Kuciauskas, Wyatt K Metzger
National Renewable Energy Laboratory, Golden, CO, USA

2:00 **Best Student Presentation Award Finalist**
(925) Arsenic Doped Heteroepitaxial CdTe by MBE for Applications in Thin-Film Photovoltaics
Eric Colegrove[1], Brian Stafford[1], Timothy Gessert[2], Sivalingam Sivananthan[1]
[1]University of Illinois at Chicago, Chicago, IL, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

2:15 **Best Student Presentation Award Finalist**
(926) Photoluminescence Spectroscopy of Cadmium Telluride Deep Defects
Paul J. Roland, Naba R. Paudel, Chuanxiao Xiao, Yanfa Yan, Randy J. Ellingson
Wright Center for Photovoltaics Innovation and Commercialization, Department of Physics and Astronomy, The University of Toledo, Toledo, OH, USA

2:30 **Best Student Presentation Award Finalist**
(927) Optical properties of monocrystalline CdTe/MgCdTe double heterostructures grown by molecular beam epitaxy
Xin-Hao Zhao[1], Michael J. DiNezza[1], Shi Liu[1], Pathiraja A. Jayathilaka[2], Odille C. Noriega[2], Thomas H. Myers[2], Yong-Hang Zhang[1]
[1]Arizona State University, Tempe, AZ, USA, [2]Texas State University, San Marcos, TX, USA

2:45 **(928) Extracting Cu Diffusion Parameters in Polycrystalline CdTe**
Richard Akis[1], Daniel Brinkman[2], Igor Sankin[3], Tian Fan[3], Da Gou[1], Christian Ringhofer[1]
[1]School of ECEE, Arizona State University, Tempe, AZ, USA, [2]School of Mathematical & Statistical Sciences, Arizona State University, Tempe, AZ, USA, [3]First Solar, Perrysburg, OH, USA

Area 3 - Orals

1:30 - 3:00 PM **Ballroom 2B**

CPV Modules and Systems

Chair(s): Kensuke Nishioka, Geoffrey Kinsey

1:30 **(929) Suncore's CPV Power Plant Deployment in Western China**
James Foresi[1], Rick Han[2], Alaric Babej[1], Charlie Wang[1], David King[3]
[1]Suncore Photovoltaics, Inc., Albuquerque, NM, USA, [2]Suncore Photovoltaic Technology, Huainan, China, [3]DK Solar Works, Albuquerque, NM, USA

2:00 **(930) Semprius Module and System Results**
Kanchan Ghosal, Doug Lilly, John Gabriel, Steve Seel, Brent Fisher, Scott Burroughs
Semprius Inc., Durham, NC, USA

2:15 **(931) Keys for the joint design of the optics and the solar cell in a CPV system**
Pilar Espinet-González, Marta Victoria, Ignacio Rey-Stolle, Stephen Askins, Carlos Algora, Ignacio Antón, Gabriel Sala
Solar Energy Institute (IES), Technical University of Madrid (UPM), Madrid, Spain

2:30 **(932) Modeling nonuniform irradiance and chromatic aberration effects in a four junction solar cell using SPICE**
Pratibha Sharma, Matthew Wilkins, Henry Schriemer, Karin Hinzer
University of Ottawa, Ottawa, ON, Canada

2:45 **(933) Effect of the Encapsulant Temperature on the Angular and Spectral Response of Multi-Junction Solar Cells**
Pablo Garcia-Linares, César Dominguez, Pierre Besson, Mathieu Baudrit
CEA-LITEN, LMPV, Le Bourget du Lac, France

Area 4 - Orals

1:30 - 3:00 PM **Ballroom 1EF**

Surface Passivation

Chair(s): Ajeet Rohatgi, Klaus Weber

1:30 **(934) Requirements for Achieving Extremely Low Surface Recombination Velocity and Negligible Optical Loss in Cat-CVD SiNx/a-Si Stacked Passivation**
Koichi Koyama, Trinh Cham Thi, Koichi Higashimine, Keisuke Ohdaira, Hideki Matsumura
Japan Advanced Institute of Science and Technology, Nomi, Japan

1:45 **Best Student Presentation Award Finalist**
(935) Dielectric Charge Tailoring in PECVD SiO*x*/SiN*x* Stacks and its Impact on Industrial *p*-Type Si Wafer Solar Cell Efficiency
Shubham Duttagupta[1,2], Ziv Hameiri[1], Bram Hoex[1], Armin G. Aberle[1,2]
[1]Solar Energy Research Institute of Singapore, Singapore, Singapore, [2]National University of Singapore, Singapore, Singapore

2:00 **(936) Back-Side AlOx Passivation Material and Technology for the Application of High Efficiency (20%) and Low Cost PERC Solar Cells**
Jui-Yi Hung[1], Jung-Ching Wang[2], Shian-Wen Chen[2], Tsung-Cheng Chen[3], Yung-Sheng Lin[3], Chen-Hao Ku[3]
[1]2F, No. 3, Luke 1st Rd., Kaohsiung Science Park, Luzhu Dist., Kaohsiung, Taiwan, [2]No. 22, Changhsing Road, Luchu District, Kaohsiung, Taiwan, [3] No. 498, Sec.2, Bentian St., An-Nan Dist., Tainan, Taiwan

2:15 **(937) Numerical Analysis of Injection Level Dependent Effective Lifetime on 125-mm Undiffused Carrier Lifetime *c*-Si Samples**
Fa-Jun Ma[1,2], Ziv Hameiri[1], Ganesh S. Samudra[1,2], Marius Peters[1], Bram Hoex[1]
[1]Solar Energy Research Institute of Singapore, National University of Singapore, Singapore, Singapore, [2]Department of Electrical and Computer Engineering, National University of Singapore, Singapore, Singapore

2:30 **(938) Influence of the NH_3:SiH_4 Ratio and Surface Morphology on the Surface Passivation of Phosphorus-Diffused C-Si by PECVD SiN_x**
Yimao Wan[1], Di Yan[1], Andres Cuevas[1], Keith R McIntosh[2]
[1]1Research School of Engineering, The Australian National University, Canberra, Australia, [2]PV Lighthouse, Coledale, Australia

2:45 **(939) Realization of Al-alloyed local contacts for industrial PERC cells by a two-step metallization method**
Yifeng Chen[1,2], Pietro P. Altermatt[3], Jianwen Dong[2], Jiajing Liu[1], Dianlei Wang[1], Yuling Jiang[2], Binhui Liu[1,2], Daming Chen[2], Weiwei Deng[2], Jian Sheng[2], Hui Shen[1], Zhiqiang Feng[2], Pierre J. Verlinden[2]
[1]Institute for Solar Energy Systems, Sun Yat-Sen University, Guangzhou, China, [2]State Key Laboratory of PV Science and Technology, Trina Solar, Changzhou, China, [3]Department of Solar Energy, Leibniz University of Hannover, Hannover, Germany

Area 8 - Orals

1:30 - 3:00 PM **Ballroom 2A**

Thin Film Characterization

Chair(s): Dean Levi, Robert Collins

1:30 **(940) An Arbitrarily Programmable Solar Simulator Based on a Liquid Crystal Spatial Light Modulator**
Tasshi Dennis
National Institute of Standards and Technology, Boulder, CO, USA

1:45 **(941) Loss analysis on CIGS-modules by using contactless, imaging illuminated lock-in thermography and 2D electrical simulations**
Frank W. Fecher[1,2], Jens Adams[1], Andreas Vetter[2], Claudia Buerhop-Lutz[1], Christoph J. Brabec[1,2]
[1]ZAE Bayern, Erlangen, Germany, [2]i-MEET, Univerisität Erlangen-Nürnberg, Erlangen, Germany

2:00 **Best Student Presentation Award Finalist**
(942) Direct Evidence of a $Cu(In,Ga)_3Se_5$ Phase in a Bulk, High Efficiency $Cu(In,Ga)Se_2$ Device Using Atom Probe Tomography
Adam W Stokes[1,2], Brian P Gorman[1], Dave R Diercks[1], Mowafak M Al-Jassim[2]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

2:15 **(943) Correlating Multiple Spatially-Resolved Techniques (LBIC/Raman/PL/Reflectance/SEM/AFM) in the Study of Microscopic Inhomogeneity of Thin-Film Solar Cells: $Cu_2ZnSnSe_4$ as An Example**
Qiong Chen, Yong Zhang
Department of Electrical and Computer Engineering, and Energy Production and Infrastructure Center (EPIC), The University of North Carolina at Charlotte, CHARLOTTE, NC, USA

2:30 **(944) Nanoscale electrical properties of wide bandgap $Cu(In,Ga)Se_2$ and $Cu_2ZnSn(SSe)_4$ thin films**
C.-S. Jiang, M.A. Contreras, I.L. Repins, L.M. Mansfield, C. Beall, K. Ramanathan, M.M. Al-Jassim
National Renewable Energy Laboratory, Golden, CO, USA

2:45 **(945) Analysis of Light Propagation in Thin-Film Solar Cells by Dual-Probe Scanning Near-Field Optical Microscopy**
Stephan Lehnen, Ulrich Wilhelm Paetzold, Markus Ermes, Karsten Bittkau, Reinhard Carius
Forschungszentrum Jülich GmbH, Jülich, Germany

Area 10 - Orals

1:30 - 3:00 PM **Ballroom 1CD**

System Design

Chair(s): Mark Albers, Nicolas Bogdanski

1:30 **(946) Integrative Approach to PV Plant and Power Conversion Design**
Michael Schenck
Ipsum Power, San Rafael, CA

2:00 **(947)** *National Electrical Code* **Changes 2014 for Photovoltaics: Processes, Critical Industry Consensus Topics and Impacts**
Ward I Bower
Ward Bower Innovations LLC, Albuquerque, NM, USA

2:15 **(948) Reducing Solar PV Soft Costs: A Focus on Installation Labor**
Koben Calhoun[1], Joseph Goodman[2], Jesse Morris[1], Daniel Seif[1]
[1]Rocky Mountain Institute, Snowmass, CO, USA, [2]Georgia Tech Research Institute, Atlanta, GA, USA

2:30 **(949) Mechanical Design Methodology for Lightweight Deployable Solar Electric System for Commercial Rooftops**
Kevin S Myers, Yi Han, Charles S Korman
GE Global Research, Niskayuna, NY, USA

2:45 **(950) Hard Balance of System Cost Reduction from Module Level Power Optimizers**
Jonathan Topham[1], Dr. John Schmalzel[2]
[1]Graduate of Rowan University, Glassboro, NJ, USA, [2]Professor at Rowan University, Founding Chair, Glassboro, NJ, USA

Area 12 - Orals

1:30 - 3:00 PM **Ballroom 2C**

Field Reliability Experience

Chair(s): Charlie Hasselbrink, Ralph Gottschalg

1:30 **(951) Field Performance of 1.7 Gigawatts of Photovoltaic Systems**
Dirk C Jordan, Sarah R Kurtz
NREL, Golden, CO, USA

2:00 **(952) Visual Degradation in Field-aged Crystalline Silicon PV Modules in India and Correlation with Electrical Degradation**
Shashwata Chattopadhyay[1], Rajiv Dubey[1], Vivek Kuthanazhi[1], Jim J. John[1], Chetan S. Solanki[1], Anil Kottantharayil[1], Brij M. Arora[1], K.L. Narasimhan[1], Juzer M. Vasi[1], Arun Kumar[2], O.S. Sastry[2]
[1]National Centre for Photovoltaic Research and education, Indian Institute of Technology Bombay, Powai, Mumbai, 400076, India, [2]Solar Energy Center, Ministry of New and Renewable Energy, New Delhi, 110003, India

2:15 **(953) Evaluation of 12-Year-Old PV Power Plant in Hot-Dry Desert Climate: Potential Use of Field Failure Metrics for Financial Risk Calculation**
Jaya Krishna Mallineni, Brett J Knisley, Karan R Yedidi, Sai Tatapudi, Joseph Kuitche, Govindasamy Tamizhmani
Arizona State University Photovoltaic Reliability Laboratory(ASU-PRL), Mesa, AZ, USA

2:30 **Best Student Presentation Award Finalist**
(954) FMECA on Field Deployed c-Si Modules under Hot-Dry Desert Climate for Determining Dominant Failure Modes
Sanjay M Shrestha, Jaya K Mallineni, Sai Tatapudi, Brett Knisely, Karan Yedidi, Joseph Kuitche, Govindsamy TamizhMani
Arizona State University, Mesa, AZ, USA

2:45 **(955) Fifteen Years and Counting: The Reliable Long Term Performance of the First Grid-Connected, Building-Integrated, Thin-Film Photovoltaic Installation in Brazil**
Lucas Nascimento, Ricardo Ruther
Universidade Federal de Santa Catarina / UFSC, Florianopolis, Brazil

3:00 - 3:30 PM **Ballroom Pre-function**

Coffee Break

Joint Session: Areas 10,12 - Orals

3:30 - 5:00 PM **MR 505-507**

PV System Safety

Chair(s): Nicolas Bogdanski, Kent Whitfield

3:30 **(956) Comparative Evaluation of DC Fault Mitigation Techniques in Large PV Systems**
Mark J. Albers[1], Greg Ball[2]
[1]SunPower Corporation, Richmond, CA, USA, [2]DNV GL, Oakland, CA, USA

4:00 **(957) Characterizing Fire Danger from Low Power Photovoltaic Arc-Faults**
Kenneth M. Armijo, Michael Hibbs, Jay Johnson, Armando J. Fresquez
[1]Sandia National Laboratories, Albuquerque, NM, USA

4:15 **(958) Recommendations for RCD and Riso Ground Fault Detector Trip Thresholds**
Jack D. Flicker[1], Jay Johnson[1], Mark Albers[2], Greg Ball[3]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Sunpower Corporation, Richmond, CA, USA, [3]DNV GL-Energy, San Francisco, CA, USA

4:30 **(959) PV Module System Fire Classification**
Christopher Flueckiger
Underwriters Laboratories, Northbrook, IL, USA

4:45 **Best Student Presentation Award Finalist**
(960) Fault Experiments in a Commercial-Scale PV Laboratory and Fault Detection Using Local Outlier Factor
Ye Zhao[1], Florent Balboni[2], Thierry Arnaud[2], Jerry Mosesian[3], Roy Ball[3], Brad Lehman[1]
[1]Northeastern University, Boston, MA, USA, [2]Mersen France SB SAS, Annecy Le Vieux Cedex, France, [3]Mersen USA Newburyport-MA, LLC, Newburyport, MA, USA

Joint Session: Areas 3,7 - Orals

3:30 - 5:00 PM **Ballroom 2B**

Material Aspects and Design of III-V Solar Cells

Chair(s): Robert Walters, Andreas W. Bett

3:30 **(961) Implications of redesigned, high-radiative-efficiency GaInP junctions on III-V multijunction concentrator solar cells**
John F. Geisz[1], Myles A. Steiner[1], Ivan Garcia[1,2], Daniel J. Friedman[1], Sarah R. Kurtz[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Instituto de Energia Solar, Universidad Politecnica de Madrid, Madrid, Spain

4:00 **Best Student Presentation Award Finalist**
(962) Investigations on $Al_xGa_{1-x}As$ Solar Cells Grown by MOVPE
Stefan Heckelmann, David Lackner, Frank Dimroth, Andreas W. Bett
Faunhofer Institute for Solar Energy Systems, Freiburg, Germany

4:15 **(963) Conversion Efficiency Limits and Optimized Designs for Tandem Solar Cells with Realistic Sub-cell Material Quality**
Lin Zhu[1], Toshimitsu Mochizuki[1], Masahiro Yoshita[1], Shaoqiang Chen[1], Shintaroh Sato[1], Changsu Kim[1], Hidefumi Akiyama[1], Yoshihiko Kanemitsu[2]
[1]Institute for Solid State Physics, University of Tokyo and JST-CREST, Kashiwa, Chiba, Japan, [2]Institute for Chemical Research, Kyoto University and JST-CREST, Uji, Kyoto, Japan

4:30 **(964) Practical Limits of Multijunction Solar Cell Performance Enhancement from Radiative Coupling Considering Realistic Spectral Conditions**
Ngai Lam A Chan, Tomos Thomas, Ned Ekins-Daukes
Imperial College London, London, UK

4:45 **(965) "Minority Carrier Lifetimes in 1.0eV p-$In_{0.27}Ga_{0.73}As$ Layers Grown on GaAs Substrates"**
Rao Tatavarti[1], Keun-Yong Ban[1], Andree Wibowo[1], Darius Kuciauskas [2], Steve Johnston[2], Kim Jones[2], Harvey Guthrey[2], Andrew Norman[2], Mowafak Al-Jassim[2], Dean Levi[2]
[1]MicroLink Devices, Inc, Niles, IL, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

Area 1 - Orals

3:30 - 5:00 PM **Ballroom 1AB**

Advances in Hot Carrier Solar Cells

Chair(s): Daniell Farrell, Gavin Conibeer

3:30 **(966) A Hot Carrier Photovoltaic Cell by Offset Resonant Tunneling**
James A.R Dimmock, Stephen Day, Katherine Smith, Jon Heffernan, Matthias Kauer
Sharp Laboratories of Europe Ltd, Oxford, UK

4:00 **(967) Hot-Carriers in InGaAs Quantum Wells: Generation and Extraction**
Louise C. Hirst[1], Michael K. Yakes[1], Christopher G. Bailey[1], Joseph G. Tischler[1], Matthew P. Lumb[2], Maria Gonzalez[3], Markus F. Fuhrer[4], Nicholas J. Ekins-Daukes[4], Robert J. Walters[1]
[1]U.S. Naval Research Laboratory, Washington, DC, USA, [2]The George Washington University, Washington, DC, USA, [3]Sotera Defense Solutions Inc., Annapolis Junction, MD, USA, [4]Imperial College London, London, UK

4:15 **(968) Hot Carrier Extraction Using Energy Selective Contacts and Its Impact on the Limiting Efficiency of a Hot Carrier Solar Cell**
Steven Limpert, Stephen Bremner
University of New South Wales School of Photovoltaic and Renewable Energy Engineering, Sydney, Australia

4:30 **(969) Accurate measurement of temperature and electrochemical potential of InGaAsP/InP heterostructures: a first indication of hot carriers solar cell operation**
Laurent Lombez[1], Jean Rodière[1], Hervé Folliot[2], Alain LeCorre[2], Olivier Durand[2], Jean-François Guillemoles[1]
[1]IRDEP, Institute of R&D on Photovoltaic Energy, UMR 7174, CNRS-EDF-Chimie ParisTech 6 Quai Watier-BP 49, 78401, Chatou, France, [2]Université Européenne de Bretagne, INSA, CNRS, FOTON, UMR 6082, F-35708, Rennes, France

4:45 **(970) Evaluation of Hafnium Nitride and Zirconium Nitride as Hot Carrier Absorber**
Santosh Shrestha, Simon Chung, Neeti Gupta, Yu Feng, Xiaoming Wen, Hongze Xia, Gavin Conibeer
School of Photovoltaic and Renewable Energy Engineering, UNSW Australia, Sydney, Australia

Area 1 - Orals

3:30 - 5:00 PM **Ballroom 1CD**

Novel Materials and Concepts

Chair(s): Mariana Bertoni, Adele Tamboli, Mike Scarpulla

3:30 **Best Student Presentation Award Finalist**
(971) Growth morphology of ZnSe/Zn_3P_2 heterojunction solar cells
Jeffrey P Bosco[1], Steve J Rozeveld[2], Harry A Atwater[1]
[1]California Institute of Technology, Pasadena, CA, USA, [2]The DOW Chemical Company, Midland, MI, USA

4:00 **(972) Intrinsic defect engineering of cuprous oxide to enhance electrical transport properties for photovoltaic applications**
Michael A. Lloyd[1], Sin Cheng Siah[1], Riley E. Brandt[1], James Serdy[1], Steve W. Johnston[2], Yun Seog Lee[1], Tonio Buonassisi[1]
[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

4:15 **(973) Development of $ZnSiP_2$ for Si-Based Tandem Solar Cells**
Aaron D Martinez[1], Brenden R Ortiz[1], Nicole E Johnson[1], Lakshmi Krishna[1], Sukgeun Choi[2], Bobby To[2], Andrew G Norman[2], Vladan Stevanovic[1,2], Eric S Toberer[1,2], Paul Stradins[1,2], Adele C Tamboli[1,2]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

4:30 **(974) Exotic phase Si nanoparticles and Si-ZnS nanocomposites: new paradigms to improve the efficiency of MEG solar cells**
Marton Voros[1], Stefan Wippermann[2], Adam Gali[3,4], Francois Gygi[5], Gergely Zimanyi[1], Giulia Galli[6]
[1]Department of Physics, University of California Davis, Davis, CA, USA, [2]Interface Chemistry and Surface Engineering Department, Max-Planck-Institute for Iron Research, Düsseldorf, Germany, [3]Department of Atomic Physics, Budapest University of Technology and Economics, Budapest, Hungary, [4]Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Budapest, Hungary, [5]Department of Computer Science, University of California, Davis, Davis, CA, USA, [6]Institute for Molecular Engineering, The University of Chicago, Chicago, IL, USA

4:45 **(975) Improving Electron Transport in Ga-doped $Zn_{0.7}Mg_{0.3}O$, a Wide-Gap Band-Edge-Energy-Tunable Transparent Conducting Oxide**
John D. Perkins[1], Yi Ke[1,2], Stephan Lany[1], Joseph J. Berry[1], Andriy Zakutayev[1], Brian Gorman[2], Tim Ohno[2], Philip A. Parilla[1], Ryan O'Hayre[2], David S. Ginley[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado School of Mines, Golden, CO, USA

Area 2 - Orals

3:30 - 4:30 PM **MR 502-504**

Novel Materials and Concepts

Chair(s): Rebekah Garris, Takahiro Wada

3:30 **(976) Hydrazine-free Molecular Inks for 10.5% Efficient Cu2ZnSn(S,Se)4 Solar Cells and their Use in Combinatorial Exploration of Material Properties**
Hugh W. Hillhouse, Andrew D. Collord, Hao Xin, John Katahara, Steven Gaik
University of Washington, Seattle, WA, USA

4:00 **(977) The Potential of Nanoparticle Ink-based Processing for Chalcogenide Photovoltaics**
Charles J. Hages[1], Caleb K. Miskin[1], Steven M. McLeod[1], Wei-Chang Yang[2], Nathaniel J. Carter[1], Eric A. Stach[3], Rakesh Agrawal[1]
[1]School of Chemical Engineering, Purdue University, West Lafayette, IN, USA, [2]School of Material Science Engineering, Purdue University, West Lafayette, IN, USA, [3]Center for Functional Nanomaterials, Brookhaven National Laboratory, Upton, NY, USA

4:15 **Best Student Presentation Award Finalist**
(978) Nanoscale Engineering of Solution-processed CdTe Solar Cells using Nanocrystalline Precursors
Ryan W. Crisp[1,2], Matthew G. Panthani[3], Joseph J. Berry[2], William L. Rance[2], Joel N. Duenow[2], Dmitri V. Talapin[3], Joseph M. Luther[2]
[1]Colorado School of Mines, Golden, CO, USA, [2]National Renewable Energy Lab, Golden, CO, USA, [3]University of Chicago, Chicago, IL, USA

Area 4 - Orals

3:30 - 5:00 PM **Ballroom 1EF**

Passivated Contacts

Chair(s): Stefaan de Wolf, Paul Stradins

3:30 **(979) Tunnel oxide passivated carrier selective contacts**
Frank Feldmann, Maik Simon, Martin Bivour, Christian Reichel, Martin Hermle, Stefan Glunz
Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany

4:00 **Best Student Presentation Award Finalist**
(980) Passivated Contacts to n^+ and p^+ Silicon Based on Amorphous Silicon / Dielectric Stacks
James Bullock[1], Di Yan[1], Andres Cuevas[1], Benedicte Demaurex[2], Aicha Hessler-Wyser[2], Stefaan De Wolf[2]
[1]The Australian National University, Canberra, Australia, [2]Ecole Polytechnique Fédérale de Lausanne, Neuchatel, Switzerland

4:15 **(981) Low Temperature, Si/SiO_2/pc-Si Passivated Contacts to n-type Si Solar Cells**
William Nemeth, David L. Young, Benjamin G. Lee, Paul Stradins. *National Renewable Energy Laboratory, Golden, CO, USA*

4:30 **(982) >22.4% High Efficiency Tunnel Oxide Junction Bifacial Solar Cell with Electroplated Cu Gridlines.**
Jiunn Benjamin Heng, Jianming Fu, Bob Kong, Yongkee Chae, Wei Wang, Zhigang Xie, Anand Reddy, Kevin Lam, Chris Beitel, Chris Liao, Christoph Erben, Zhiquan Huang, Zheng Xu. *Silevo, Inc, Fremont, CA, USA*

Area 8 - Orals

3:30 - 5:00 PM **Ballroom 2A**

Silicon Characterization

Chair(s): Mowafak Al-Jassim, Fabian Fertig

3:30 **(983) On the Use of I-V Curves as a Diagnosis Tool for Proper External Quantum Efficiency Measurements of Multijunction Solar Cells.** Enrique Barrigon, Pilar Espinet-González, Yedileth Contreras, Ignacio Rey-Stolle, Carlos Algora. *Solar Energy Institute - Technical University of Madrid, Madrid, Spain*

3:45 **(984) Degradation of Tandem Solar Cells: Separating Matching Effects from Staebler-Wronski-Effect using the Power-Matching-Method**
Beatrix Blank, Carolin Ulbrich, Tsvetelina Merdzhanova, Jakob Kuhs, Christoph Zahren, Andreas Gerber, Uwe Rau. *Forschungszentrum Jülich, Jülich, Germany*

4:00 **(985) In-situ Observations of Glass Frit Related Effects during the Front Side Paste Contact Formation.** Markus Eberstein, Ulrike Schmidt, Kathrin Reinhardt, Stefan Körner, Robert Jurk. *Fraunhofer IKTS, Dresden, Germany*

4:15 **(986) Correlating Defect Band Luminesce to Elemental Distribution by X-ray Fluorescence**
Mariana I Bertoni[1], Steve Johnston[2], Mowafak Al-Jassim[2], Barry Lai[3], *[1]Arizona State University, Tempe, AZ, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA, [3]Advanced Photon Source, Argonne, IL, USA*

4:30 **(987) Quantitative local current-voltage analysis with different spatially-resolved camera-based techniques of silicon solar cells with cracks**
Tobias M. Pletzer[1], Justus I. van Mölken[1], Sven Rißland[2], Emanuele Cornagliotti[3], Joachim John[3], Otwin Breitenstein[2], Joachim Knoch[1]
[1]RWTH Aachen University, Aachen, Germany, [2]Max Planck Institute of Microstructure Physics, Halle, Germany, [3]IMEC, Leuven, Belgium

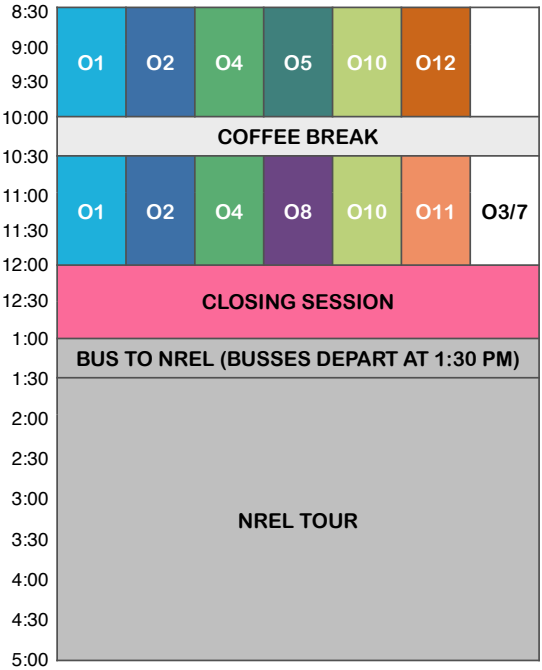
4:45 **(988) Iron contamination in silicon solar cell production environments**
Malcolm D. Abbott[1], Dmitry Poplavskyy[2], Giuseppe Scardera[2], Daniel Inns[2], Francesco Lemmi[2], Keith R. McIntosh[1], Simeon C. Baker-Finch[1]
[1]PV Lighthouse, Coledale, Australia, [2]DuPont, Sunnyvale, CA, USA

Special Event

6:00 - 10:00 PM **Denver Art Museum**

Conference Dinner

FRIDAY PROGRAM SUMMARY



	Area 1: Fundamentals and New Concepts for Future Technologies
	Area 2: Chalcogenide Thin Film Solar Cells
	Area 3: III-V and Concentrator Technologies
	Area 4: Crystalline Silicon Photovoltaics
	Area 5: Thin Film Silicon Based PV technologies
	Area 6: Organic Photovoltaics
	Area 7: Space Technologies
	Area 8: Characterization Methods
	Area 9: PV Modules and Manufacturing
	Area 10: PV Systems and Applications
	Area 11: PV Deployment
	Area 12: Reliability of PV

Area 1 - Orals

8:30 - 10:00 AM **Ballroom 1AB**

Quantum-Confined Structures

Chair(s): Seth Hubbard, Masakazu Sugiyama, Diego Alonso Alvarez

8:30 **(989) Enhancement of current collection in epitaxial lift-off InAs/GaAs quantum dot thin film solar cell and concentrated photovoltaic study**
Tomah Sogabe[1], Yasushi Shoji[1], Peter Mulder[2], John Schermer[2], Efrain Tamayo[1], Yoshitaka Okada[1]
[1]Research Center for Advanced Science and Technology (RCAST), The University of Tokyo, Tokyo, Japan, [2]Institute for Molecules and Materials, Radboud University Nijmegen, Nijmegen, Netherlands

8:45 **(990) The Effect of Barrier Composition on Quantum Dot Solar Cell Performance**
David V. Forbes[1], Yushuai Dai[1], Stephen J. Polly[1], Christopher G. Bailey[2], Staffan D. Hellstroem[1], Seth M, Hubbard[1]
[1]Rochester Institute of Technology, Rochester, NY, USA, [2]Naval Research Laboratory, Washington, DC, USA

9:00 **(991) Electric Field Effect on Carrier Escape from InAs/GaAs Quantum Dots Solar cells**
Yushuai Dai, Stephen Polly, Staffan Hellstroem, David Forbes, Seth Hubbard
NanoPower Research Laboratory, Rochester Institute of Technology, Rochester, NY, USA

9:15 **(992) Probing the operation mechanism within PbS quantum dot-based solar cells**
Rachelle Ihly[1,2], Sanjini U. nanayakkara[1], Jianbo Gao[1], Jianbing Zhang[1], William Nemeth[1], Matt Law[2], Joseph M. Luther[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]University of California, Irvine, Irvine, CA, USA

9:30 **(993) Dual reactor deposition of quantum confined nanocrystalline silicon**
Chito Kendrick[1,2], Grant Klafehn[1,2], Tianyuan Guan[1,2], San Theingi[1,2], Reuben Collins[1,2]
[1]Colorado School of Mines, Golden, CO, USA, [2]Renewable Energy Materials Research Science and Engineering Center, Golden, CO, USA

9:45 **(994) Achieving Near-Unity Broadband Absorption in Sparse Arrays of GaAs Nanowires via a Fundamental Understanding of Localized Radial Modes**
Katherine T. Fountaine[1,2], William S. Whitney[2,4], Harry A. Atwater[2,3]
[1]Division of Chemistry & Chemical Engineering, California Institute of Technology, Pasadena, CA, USA, [2]Joint Center for Artificial Photosynthesis, California Institute of Technology, Pasadena, CA, USA, [3]Division of Applied Physics & Materials Science, Pasadena, CA, USA, [4]Department of Physics, California Institute of Technology, Pasadena, CA, USA

Area 2 - Orals

8:30 - 10:00 AM **MR 502-504**

CdTe 2

Chair(s): Teresa Barnes, Gang Xiong

8:30 **(995) CdTe Thin Films doped by Cu and Ag – a Comparison in Substrate Configuration Solar Cells**
Christina Gretener, Michael Wyss, Lukas Kranz, Julian Perrenoud, Stephan Buecheler, Ayodhya N. Tiwari
Empa - Swiss Federal Laboratories for Materials Science and Technology, Dübendorf, Switzerland

8:45 **(996) Low Cost Non-Toxic Alternatives to the $CdCl_2$ Treatment Step in CdTe Thin Film Solar Cells**
Jonathan D Major, Robert E Treharne, Laurie J Phillips, Ken Durose
Stephenson Institute for Renewable Energy, University of Liverpool, Liverpool, UK

9:00 **(997) Measurement of Chlorine Concentrations at CdTe Grain Boundaries**
Dan Mao, Charles E Wickersham, Jr., Markus Gloeckler
First Solar, Perrysburg, OH, USA

9:15 **(998) Qualitative and Quantitative Analysis of Grain Boundaries and Grain Interiors in CdTe Thin-Films by Low-Temperature Cathodoluminescence Spectrum Imaging**
John M Moseley[1,2], Mowafak M Al-Jassim[1], Helio R Moutinho[1], Harvey L Guthrey[1], Naba Paudel[3], Yanfa Yan[3], Wyatt K Metzger[1], Richard K Ahrenkiel[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado School of Mines, Golden, CO, USA, [3]University of Toledo, Toledo, OH, USA

9:30 **(999) Surface Passivation of CdTe Single Crystals and Polycrystalline Films**
Matthew O. Reese, Craig L. Perkins, James M. Burst, Joseph M. Luther, Steven W. Johnston, Darius Kuciauskas, Teresa M. Barnes, Tim A. Gessert, Wyatt K. Metzger
National Renewable Energy Lab, Golden, CO, USA

9:45 **(1000) Reduction of Carrier Recombination by the Addition of a $Cd_{1-x}Mg_xTe$ Electron Reflector Film**
DE Swanson[1], RM Geisthardt[2], PS Kobyakov[1], JM Raguse[2], J Drayton[2], KL Barth[1], JR Sites[2], WS Sampath[1]
[1]Mechanical Engineering Department Colorado State University, Fort Collins, CO, USA, [2]Physics Department Colorado State University, Fort Collins, CO, USA

Area 4 - Orals

8:30 - 10:00 AM **Ballroom 1EF**

Material Technology

Chair(s): Mariana Bertoni, Michio Tajima

8:30 **(1001) Epitaxial Si films carried by thick polycrystalline Si as a drop-in replacement for conventional Si wafers**
Rolf Brendel[1,2], Verena Steckenreiter[1], Jan Hensen[1], Sarah Kajari-Schröder[1]
[1]Institute for Solar Energy Research Hamelin, 31860, Germany, [2]Institute for Solid State Physics, Leibniz Universität Hannover, 30167, Germany

9:00 **(1002) Use of Indium Doping to Mitigate Light Induced Degradation in High Efficiency p-Type Silicon Solar Cells**
J.-H. Lai[1], A.D. Upadhyaya[1], E. Cho[1], A. Rohatgi[1], M.J. Binns[2], J. Appel[2], J. Guo[2], H. Fang[2], E.A. Good[2]
[1]Georgia Institute of Technology, Atlanta, GA, USA, [2]SunEdison, St. Peters, MO, USA

9:15 **(1003) Numerical Analysis of Oxygen Control During Growth of Czochralski Silicon Single Crystals**
Moez Jomâa[1], Mohammed M'Hamdi[1], Yu Hu[2], Øyvind Nielsen[2]
[1]SINTEF Materials and Chemistry, Oslo, Norway, [2]NorSun AS, Oslo, Norway

9:30 **(1004) High-Lifetime Kerfless Wafers though Epitaxy on Porous Silicon**
Douglas M. Powell[1], Jasmin Hofstetter[1], David P. Fenning[1], Ruiying Hao[2], Mallory Ann Jensen[1], T.S. Ravi[2], Tonio Buonassisi[1]
[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Crystal Solar Inc., Santa Clara, CA, USA

9:45 **(1005) High Speed Growth of Square-like Si Single Bulk Crystals with a Size of 23 x 23 cm^2 for Solar Cells using the Noncontact Crucible Method**
Kazuo Nakajima[1], Ryota Murai[1], Kohei Morishita[1], Doug M. Powell[2], Maulid Kivambe[2], Tonio Buonassisi[2]
[1]Graduate School of Energy Science, Kyoto University, Kyoto, Japan, [2]Massachusetts Institute of Technology, Cambridge, MA, USA

Area 5 - Orals

8:30 - 10:00 AM **Ballroom 2A**

Manufacturing and Process Control

Chair(s): Matthias Meier, Nikolas Podraza

8:30 **(1006) Processing Glass-bonded epitaxial Silicon Foils with very high Lifetimes into highly efficient Solar Devices**
Ivan Gordon, Hariharsudan Sivaramakrishnan, Stefano N Granata, Twan Bearda, Valerie Depauw, Jonathan Govaerts, Marwa Karim, Riet Labie, Roberto Martini, Hosny Meddeb, Kris van Nieuwenhuysen, Jef Poortmans
imec, Leuven, Belgium

9:00 **(1007) Nanocrystalline Silicon Based Solar Cell Technology for Large Volume Manufacturing**
Anhong Hu, Minghao Qu, Jinyan Zhang, Xinghong Zhou, Shaofei Yang, Jack Xiao, Chuck Hu, Changtao Peng, Xixiang Xu
Hanergy Solar Group, Chengdu, China

9:15 **(1008) Flexible thin film silicon module for indoor energy harvesting**
Marina Foti[1], Anna Battaglia[2], Cristina Tringali[1], Noemi Sparta[1], Salvatore Lombardo[3], Cosimo Gerardi[1]
[1]STMicroelectronics, Catania, Italy, [2]3SUN, Catania, Italy, [3]CNR IMM, Catania, Italy

9:30 **(1009) Optimization of Thin Film Silicon Based Solar Cells**
Frank Liu[1,2], Wei Zi[2], Xiaojing Liu[2], Fengwei Xiao[2], Bo Yang[2]
[1]Dalian Institute of Chemical Physics, Dalian National Lab for Clean Energy, Chinese Academy of Sciences, Dalian, China, [2]Key Laboratory of Applied Surface and Colloid Chemistry, National Ministry of Education, School of Materials Science and Engineering, Shaanxi Normal University, Xi'an, China

9:45 **(1010) Spectroscopic Ellipsometry Applied in the Full p-i-n a-Si:H Solar Cell Device Configuration**
Maxwell M. Junda[1,2], Robert W. Collins[1,2], Nikolas J. Podraza[1,2]
[1]Wright Center for Photovoltaics Innovation and Commercialization, Toledo, OH, USA, [2]University of Toledo, Toledo, OH, USA

Area 10 - Orals

8:30 - 10:00 AM **Ballroom 1CD**

BOS and Off-Grid Advances

Chair(s): Dave Click, Alexander Scheis, John Berdner

8:30 **(1011) Evaluation of mounting mechanisms for the installation of lightweight PV systems on commercial rooftops**
Ankush Halbe, Jennifer Novak, Chris Hull, Kevin Sharpe, Pradeep Haldar
SUNY College of Nanoscale Science & Engineering, Albany, NY, USA

8:45 **(1012) Parametric Study of PV Arc-Fault Generation Methods and Analysis of Conducted DC Spectrum**
Jay Johnson[1], Kenneth M. Armijo[2]
[1]Sandia National Laboratories, Albuquerque, NM, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA

9:00 **(1013) Arc Fault Risk Assessment and Degradation Model Development for Photovoltaic Connectors**
Benjamin B. Yang, Jay Johnson, Kenneth M. Armijo, Jason M. Taylor, N. Robert Sorensen
Sandia National Laboratories, Albuquerque, NM, USA

9:15 **(1014) Remote Markets 2.0 the Next Wave of PV Expansion**
Bill Rever[1], Paula J Mints[2]
[1]WB Rever and Associates, Linthicum Heights, MD, USA, [2]SPV Market Research, San Jose, CA, USA

9:30 **(1015) Potential and Cost-Effectiveness of Off-Grid PV Systems in Indonesia Evaluated on a Provincial Level**
Anton J. Veldhuis, Angele H.M.E. Reinders
University of Twente, Enschede, Netherlands

9:45 **(1016) A High Performance Power Supply for an Electric Vehicle with Solar PV, Battery and Ultracapacitor Support for Extended Range and Enhanced Dynamic Response**
Manmesha Patankar, Rupesh Wandhare, Vivek Agarwal
Indian Institute of Technology- Bombay, Mumbai, India

Area 12 - Orals

8:30 - 10:00 AM **Ballroom 2B**

Design and Manufacturing for Reliability

Chair(s): Masaaki Yamamichi, Chris Flueckiger

8:30 **(1017) Requirements for Quality Management System for PV Module Manufacturing**
Yoshihito Eguchi[1], Govind Ramu[2], Sumanth V Lokanath[3], Masaaki Yamamichi[4], Sarah Kurtz[5], John Wohlgemuth[5], Eiji Yamada[1], Michio Kondo[4]
[1]Japan Electrical safety & Environment Technology Laboratories, Yokohama, Japan, [2]SunPower Corporation, San Jose, CA, USA, [3]First Solar Inc., Tempe, AZ, USA, [4]National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan, [5]National Renewable Energy Laboratory, Golden, CO, USA

9:00 **(1018) Regional Influence on Module Design Quality: Qualification Testing Failure Rate Results from Regional Labs of TUV Rheinland around the World**
GovindaSamy TamizhMani[1], Bo Li[1], William Shisler[1], Christos Monokroussos[2], Christian Dreier[2], SooBong Lim[3], CS Kamalaksha[4], Seiya Sugita[5], Eckart Janknecht[6]
[1]TUV Rheinland, Tempe, AZ, USA, [2]TUV Rheinland, Shanghai, China, [3]TUV Rheinland, Gyeongsan, Korea, [4]TUV Rheinland, Bangalore, India, [5]TUV Rheinland, Yokohama, Japan, [6]TUV Rheinland, Cologne, Germany

9:15 **Best Student Presentation Award Finalist**
(1019) Predicting Thermal Runaway in Bypass Diodes in Photovoltaic Modules
Narendra Shiradkar[1], Eric Schneller[1], Neelkanth G. Dhere[1], Vivek Gade[2]
[1]Florida Solar Energy Center, University of Central Florida, Cocoa, FL, USA, [2]Jabil Circuit Inc., St. Petersburg, FL, USA

9:30 **(1020) Reverse Bias Behavior of n-Type Cz-Si Solar Cells**
Elmar Lohmüller, Sabrina Werner, Fabian Fertig, Florian Clement, Daniel Biro
Fraunhofer ISE, Freiburg, Germany

9:45 **(1021) Photovoltaic Module Qualification Plus Testing**
John H Wohlgemuth
N, Golden, CO, USA

10:00 - 10:30 AM **Ballroom Pre-function**

Coffee Break

Joint Session: Areas 3,7 - Orals

10:30 - 12:00 PM **MR 505-507**

III-V Solar Cells for Space and CPV

Chair(s): Paul Sharps, Tatsuya Takamoto

10:30 **(1022) Development of Lightweight Space Solar Cells with 30% Efficiency at End-of-Life**
Gerhard F.X. Strobl
AZUR SPACE Solar Power GmbH, Heilbronn, Germany

11:00 **Best Student Presentation Award Finalist**
(1023) Effects of Luminescent Coupling in Single- and 4-Junction Dilute Nitride Solar Cells
Matthew M. Wilkins, Ahmed Gabr, Anna H. Trojnar, Henry Schriemer, Karin Hinzer
University of Ottawa, Ottawa, ON, Canada

11:15 **(1024) High Efficiency Quadruple Junction, Four-Terminal Solar Cells and Modules by Transfer Printing**
Xing Sheng[1], Christopher Bower[2], Salvatore Bonafede[2], John Wilson[2], Brent Fisher[2], Matthew Meitl[2], Homan Yuen[3], Shuodao Wang[1], Ling Shen[4], Anthony Banks[1], Christopher Corcoran[1], Ralph Nuzzo[1], Scott Burroughs[2], John Rogers[1]
[1]University of Illinois at Urbana-Champaign, Urbana, IL, USA, [2]Semprius, Inc., Durham, NC, USA, [3]Solar Junction, San Jose, CA, USA, [4]China University of Mining and Technology, Xuzhou, China

11:30 **(1025) Environmental Testing of Inverted Metamorphic Solar Cells for Space**
E. M. Rehder, B. Jun, P. Chiu, S. Wierman, K. Edmondson, X.-Q. Liu, S. Mesropian, P. Pien, J. Boisvert, N. H. Karam
Spectrolab, Sylmar, CA, USA

11:45 **(1026) Thermal runaway in multijunction solar cells**
Claus Zimmermann
EADS Astrium, Munich, Germany

Area 1 - Orals

10:30 - 12:00 PM **Ballroom 1AB**

Advances in Intermediate Band Solar Cells

Chair(s): David Forbes, Antonio Marti

10:30 **(1027) Targeted Search for Effective Intermediate Band Solar Cell Materials**
Joseph T. Sullivan[1], C. B. Simmons[1], Tonio Buonassisi[1], Jacob J. Krich[2]
[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]University of Ottawa, Ottawa, ON, Canada

10:45 **(1028) Identification of trap states for two-step two-photon-absorption processes in InAs quantum structures for intermediate-band solar cells**
David Tex[1,2], Itaru Kamiya[3], Yoshihiko Kanemitsu[1,2]
[1]Institute for Chemical Research, Kyoto University, Uji, Kyoto 611-0011, Japan, [2]Japan Science and Technology Agency, CREST, Uji, Kyoto 611-0011, Japan, [3]Toyota Technological Institute, Nagoya, Aichi 468-8511, Japan

11:00 **(1029) Urbach Tail in Intermediate Band InAs/GaAs Quantum Dot Solar Cells**
Tian Li, Mario Dagenais
University of Maryland, College Park, MD, USA

11:15 **(1030) Experimental Examination of an InAs/GaAs(Sb)/AlAsSb Quantum Dot Approach to the Intermediate Band Solar Cell**
Zachary S Bittner[1], Ramesh B Laghumavarapu[2], Staffan Hellstroem[1], Diana Huffaker[2], Baolai Liang[2], Seth M Hubbard[1]
[1]Rochester Institute of Technology, Rochester, NY, USA, [2]University of California at Los Angeles, Los Angeles, CA, USA

11:30 **(1031) Electron barrier engineering in a thin-film intermediate band solar cell**
Nazmul Ahsan[1], Naoya Miyashita[1], Kin Man Yu[2], Wladek Walukiewicz[2], Yoshitaka Okada[1]
[1]The University of Tokyo, Tokyo, Japan, [2]Lawrence Berkeley National Laboratory, Berkeley, CA, USA

11:45 **(1032) Limiting Efficiency of Silicon Intermediate Band Solar Cells**
Esther Lopez, Antonio Marti, Elisa Antolin, Antonio Luque
Instituto Energia Solar - UPM, Madrid, Spain

Area 2 - Orals

10:30 - 11:45 AM **MR 502-504**

CIGS 2

Chair(s): Thomas Unold, Bill Shafarman

10:30 **(1033) Co-evaporated $CuInSe_2$: Influence of Na and Temperature on Solar Cell Performance**
Stephan Brunken, Dieter Greiner, Hengameh Allaf Navirian, Christian A. Kaufmann, Thomas Unold
Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

10:45 **(1034) Incorporation of Na In $Cu(In,Ga)Se_2$ Thin Film Solar Cells: a Statistical Comparison Between Na from Soda Lime Glass and from a Precursor Layer of NaF**
P M P Salomé, Adam Hultqvist, Viktor Fjällström, Marika Edoff
Ångström Solar Center, Solid State Electronics, Uppsala University, Ångström Laboratory, Uppsala, Sweden

11:00 **(1035) In-Se surface treatment of Cu-rich grown $CuInSe_2$**
Tobias Bertram, Valérie Deprédurand, Susanne Siebentritt
Laboratory for Photovoltaics, University of Luxembourg, Belvaux, Luxembourg

11:15 **(1036) Enhanced Performance in Cu(In,Ga) Se_2 Solar Cells Fabricated by the Two-step Selenization Process with a Potassium Fluoride Post-deposition Treatment**
Lorelle M Mansfield[1], Rommel Noufi[2], Christopher P Muzzillo[1,3], Clay DeHart[1], Karen Bowers[1], Bobby To[1], Joel W Pankow[1], Robert C Reedy[1], Kannan Ramanathan[1]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Retired, Golden, CO, USA, [3]University of Florida, Gainesville, FL, USA

11:30 **(1037) Microstructural and chemical investigation of PVD-CdS/ PVD-CuIn1-xGaxSe2 heterojunctions: a transmission electron microscopy study**
X. Q. He[1], G. Brown[2], K. Demirkan[2], N. Mackie[2], V. Lordi[3], A. Rockett[1]
[1]University of Illinois Urbana-Champaign, Urbana, 61801, IL, USA, [2]MiaSolé Hi-Tech, Santa Clara, 95051, CA, USA, [3]Lawrence Livermore National Laboratory, Livermore, 94550, CA, USA

Area 4 - Orals

10:30 - 12:00 PM **Ballroom 1EF**

Junction Technology and Gettering

Chair(s): Stuart Bowden, Frederic Dross

10:30 **(1038) High efficiency n-type PERT and PERL solar cells**
Jan Benick, Bernd Steinhauser, Ralph Müller, Jonas Bartsch, Mathias Kamp, Andrew Mondon, Armin Richter, Martin Hermle, Stefan Glunz
Fraunhofer ISE, Freiburg, Germany

10:45 **(1039) Iron Precipitation upon Gettering in Phosphorus-Implanted Czochralski Silicon and its Impact on Solar Cell Performance**
David P Fenning[1,2], Ville Vähänissi[3], Jasmin Hofstetter[1], Ashley E Morishige[1], Hannu Laine[3], Antti Haarahiltunen[3], Sergio Castellanos[1], Mallory Ann Jensen[1], Barry Lai[4], Hele Savin[3]
[1]Massachusetts Institute of Technology, Cambridge, MA, USA, [2]Department of Nanoengineering, University of California San Diego, La Jolla, CA, USA, [3]Department of Micro and Nanosciences, Aalto University, Espoo, Finland, [4]Advanced Photon Source, Argonne National Laboratory, Argonne, IL, USA

11:00 **(1040) Lithography-free Interdigitated Back-Contacted Silicon Heterojunction Solar Cells with Efficiency >21%**
Andrea Tomasi[1], Bertrand Paviet-Salomon[1], Damien Lachenal[2], Silvia Martin de Nicolas Ag[1], Martin Ledinsky[1,3], Antoine Descoeudres[4], Nicolay Sylvain[4], Stefaan De Wolf[1], Christophe Ballif[1]
[1]EPFL, Neuchâtel, Switzerland, [2]Roth&Rau Research AG, Hauterive, Switzerland, [3]Institute of Physics, Prague, Czech Republic, [4]PV center - CSEM, Neuchâtel, Switzerland

11:15 **(1041) Application of ion implantation emitter in PERC solar cells**
Jian Wu[1,2], Yunyu Liu[1,2], Xusheng Wang[1,2], Lingjun Zhang[1,2]
[1]Canadian Solar Inc, Suzhou, China, [2]Photovoltaic Research Center of Soochow University, Suzhou, China

11:30 **(1042) N-type Bifacial Cell Using Simplified Ion Doping System**
Kyotaro Nakamura[1], Tomohiro Soga[2], Yoshinobu Murakami[2], Yoshio Ohshita[3]
[1]Meiji University, Kawasaki, Japan, [2]Sumitomo Heavy Industries, Ltd., Niihama, Japan, [3]Toyota Technological Institute, Nagoya, Japan

11:45 **(1043) High-efficiency Large Area Ion-implanted *N*-type Front Junction Si Solar Cells with Screen-printed Contacts and SiO_2 Passivated Boron Emitters**
Yuguo Tao[1], Ajeet Rohatgi[1, 2]
[1]Georgia Institute of Technology, Atlanta, GA, USA, [2]Suniva Inc., Norcross, GA, USA

Area 8 - Orals

10:30 - 12:00 PM **Ballroom 2A**

Cell & Module Characterization

Chair(s): Jim Sites, Bernhard Michl, Yoshihiro Hishikawa

10:30 **(1044) Spectral Mismatch Considerations in Multi-irradiance Characterization of PV Modules**
Nicholas J. DeLong, Geoffrey D. Rich
First Solar, Inc., Perrysburg, OH, USA

10:45 **(1045) The effect of shunt resistance on External Quantum Efficiency measurements at high light bias conditions**
Vasiliki Paraskeva[1], Maria Hadjipanayi[1], Matthew Norton[1,2], Mauro Pravettoni[3], George E. Georghiou[1]
[1]FOSS Research Centre for Sustainable Energy, University of Cyprus, Nicosia, Cyprus, [2]European Commision, DG JRC, Ispra, Italy, [3]Institute of Applied Sustainability to the build Environment, University of Applied Sciences and Arts of Southern Switzerland, Canobbio, Switzerland

11:00 **(1046) Uncertainty Analysis for Maximum Power at SRC Using Hierarchical Monte Carlo Simulation**
Mark Campanelli[1], Keith Emery[1], Ryan Elmore[1], Brian Zaharatos[2]
[1]National Renewable Energy Laboratory, Golden, CO, USA, [2]Colorado School of Mines, Golden, CO, USA

11:15 **(1047) Performance Stabilization of CdTe PV Modules Using Dark Bias**
Timothy J Silverman, Michael G. Deceglie, Bill Marion, Sarah Kurtz
National Renewable Energy Laboratory, Golden, CO, USA

11:30 **(1048) Electrostatic Force and Kelvin Probe Force Microscopies on Cu(In,Ga)Se_2 Solar Cells**
Tomoaki Ishii[1], Takashi Minemoto[3], Takuji Takahashi[1,2]
[1]Institute of Industrial Science, The University of Tokyo, Tokyo, Japan, [2]Institute for Nano Quantum Information Electronics, The University of Tokyo, Tokyo, Japan, [3]Graduate School of Science and Engineering, Ritsumeikan University, Shiga, Japan

11:45 **Best Student Presentation Award Finalist**
(1049) Sensitivity of Concentrating Photovoltaics to Solar Tracking Error
Joshua Morse[1], Mark Campanelli[2], Keith Emery[2]
[1]University of Rochester, Rochester, NY, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

Area 10 - Orals

10:30 - 12:00 PM **Ballroom 1CD**

Inverter Innovations

Chair(s): Ward Bower, Mike Coddington

10:30 **Best Student Presentation Award Finalist**
(1050) Limits of Incremental Conductance for determining the Maximum Power Point under rapidly changing irradiance and an alternative technique based on fast scanning
Wenpeng Deng, Gehan A. J. Amaratunga
University of Cambridge, Cambridge, UK

10:45 **(1051) Solid State Transformer applied on Utility Scale Solar Power Plants**
Nicole Campos Foureaux[1], Sidelmo Magalhães Silva[2], Jose Antonio de S. Brito[3], Braz de Jesus Cardoso F.[2]
[1]Postgraduate Program in Electrical Engineering, Belo Horizonte/MG, Brazil, [2]Dept. of Electrical Engineering, Belo Horizonte/MG, Brazil, [3]COELBA, Salvador/BA, Brazil

11:00 **(1052) "Low Cost, Robust and Efficient Implementation of MPPT based Buck-Boost Converter for Off-grid PV Applications"**
Muhammad Nouman Qaiser, Muhammad Usama, Bilal Ahmad, Muhammad Ali Tariq, Hassan Abbas Khan
Dept of Electrical Engineering, LUMS, Lahore, Pakistan

11:15 **Best Student Presentation Award Finalist**
(1053) An APWM Soft Switched DC-DC Converter for PV and EV
K.V. Ravi Kishore[1], Naga Brahmendra[2], B. Sivaneasan[1], P.L. So[1], C.C. Chan[1]
[1]Nanyang Technological University, Singapore, Singapore, [2]Singapore Polytechnic, Singapore, Singapore

11:30 **(1054) Experimental Studies and Performance Evaluation of Solar PV Powered BLDC Motor Drive with an Integrated MPPT in Fan applications**
Veeraraghavan S, M Kumaravel, Krishna Vasudevan, Ashok Jhunjhunwala
Indian Institute of Technology Madras, Chennai, India

11:45 **(1055) Central Seven-level Current-fed Inverter with Module-integrated DC-DC Converters for Grid-connected PV Plant**
Vishal Vekhande, B. G. Fernandes
Indian Institute of Technology Bombay, Mumbai, India

Area 11 - Orals

10:30 - 12:00 PM **Ballroom 2B**

Interconnection, Power Electronics & Inverters

Chair(s): Murali Baggu, Michael Mills-Price

10:30 **(1056) Characterizing Local High-frequency Solar Variability for use in Distribution Studies**
Matthew Lave[1], Robert Broderick[2]
[1]Sandia National Laboratories, Livermore, CA, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA

10:45 **(1057) Design, Operation and Controlled Island Operation of the US DOE 2013 Solar Decathlon Microgrid**
Chuck Kurnick[1], Olga Lavrova[2], Robert Butt[1], Ian Metzger[1], Van Vagner[3], Gray Brewster[3], Greg Wiegand[4], Siva Patibandla[2], Mark Frankosky[3]
[1]National Renewable Energy Laboratory, Denver, CO, USA, [2]University of New Mexico, Albuquerque, NM, USA, [3]Schneider Electric Corporation, Troy, MI, USA, [4]4Microplanet Corporation, Woodinville, WA, USA

11:00 **(1058) Utility PV Array Planning Optimization and Investment Return for Solar Farm in Southwest Arizona**
Christopher R Lashway, Osama Mohammed
Florida International University, Miami, FL, USA

11:15 **(1059) Optimal Operation of Distribution Networks with Increased Photovoltaic Penetration**
Emiliano Dall'Anese[1], Sairaj Dhople[1], Brian Johnson[2], Georgios Giannakis[1]
[1]University of Minnesota, Minneapolis, MN, USA, [2]National Renewable Energy Laboratory, Golden, CO, USA

11:30 **(1060) Power Converter Configuration with Integrated High-Frequency Transformer for High-Voltage Grid-Connected Large-Scale Photovoltaic System**
M A Moonem, Turgay Duman, Hariharan Krishnaswami

11:45 **Best Student Presentation Award Finalist**
(1061) Impact of PV Variability and Ramping Events on Distribution Voltage Regulation Equipment
Matthew J. Reno[1,2], Kyle Coogan[1], Robert J. Broderick[2], John Seuss[1], Santiago Grijalva[1]
[1]Georgia Institute of Technology, Atlanta, GA, USA, [2]Sandia National Laboratories, Albuquerque, NM, USA

Keynote - Plenary

12:00 - 1:00 PM **Ballroom 3-4**

Closing Session

12:00 **(1062) Closing Remarks**
Richard R. King

12:05 **(1063) Technical Highlights**
Angèle Reinders

12:15 **(1064) PVSC Napkin Award Presentation**
Richard R. King

12:20 **(1065) 29th European PV Solar Energy Conference (EU PVSEC-29)**

12:24 **(1066) 6th World Conference on PV Energy Conversion (WCPEC-6)**

12:27 **(1067) 42nd IEEE Photovoltaic Specialists Conference (PVSC-42)**
Steve Ringel

12:30 **(1068) Best Poster Awards**
Kyle Montgomery, Chris Bailey

12:45 **(1069) Best Student Paper Awards**
Kyle Montgomery, Chris Bailey

1:00 **(1070) Close of Conference**
Richard R. King

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FUTURE CONFERENCES

41st IEEE Photovoltaic Specialists Conference
The 6th World Conference on Photovoltaic Energy Conversion
Kyoto, Japan

Kyoto International Conference Center
November 23-27, 2014
http://wcpec6.com

42nd IEEE Photovoltaic Specialists Conference
New Orleans, LA

Hyatt Regency New Orleans
June 14-20, 2015
http://ieee-pvsc.org