CALL FOR PAPERS

Technical Program

THE 42nd IEEE PHOTOVOLTAIC SPECIALISTS CONFERENCE
June 14-19, 2015
Hyatt Regency New Orleans
New Orleans, Louisiana, USA

Late News Abstract deadline: April 10, 2015
Late News Call for Papers

As a testimony to PVSC’s premier international conference dimension and as a part of our regular call for paper we received over 1000 submissions from 44 countries. The Program Committee has already selected and scheduled more than 900 presentations across 102 Keynote, Plenary, Oral and Poster sessions.

Now and on behalf of the Program Committee, it is my pleasure to invite you to submit an abstract on your post-regular deadline achievements in photovoltaics to the 42nd IEEE PVSC and to seize a unique opportunity to share and discuss these developments in a timely and influential forum.

This year, in addition to offering authors of high quality “Late News” abstracts with presentation opportunities in our highly interactive poster sessions, the Program Committee has set aside few openings to make the option for an oral presentation available to authors of exceptional breakthroughs.

To have your paper considered for a “Late News” presentation at the 42nd PVSC, please submit a 3-page evaluation abstract, and a short abstract of no more than 300 words in length for display on the PVSC website. Evaluation abstracts are expected to be detailed enough to allow a competent technical review. Please follow the suggested format, a template has been provided at the conference website for your convenience. Abstract submission is via the 42nd PVSC website at “www.ieee-pvsc.org/PVSC42/login” by using your user name and password. Please carefully follow the instructions provided to upload your abstract successfully.

We are also continuing the option of offering authors who submit particularly high quality Late News evaluation abstracts an opportunity to directly submit a manuscript to the IEEE Journal of Photovoltaics. This path allows authors to enjoy both the PVSC conference experience as well as publishing their work in a high impact journal.

The deadline for electronic submission of the Late News abstracts is April 10th, 2015 at midnight Pacific Standard Time (UTC - 8 hours). Late News contributing authors will be notified of the acceptance status of their papers after April 20th, 2015. For visa applications, an invitation letter will be issued at that time. We will also ask authors to confirm that they will be able to present their work at the conference and upload their manuscript by the due date of June 1, 2015 for publication in the conference proceedings.

I look forward to welcoming you to the 42nd IEEE-PVSC in New Orleans.

Warmest Regards,

Alexandre Freundlich,
Program Chair, 42nd IEEE-PVSC
Program Committee and Technical Areas

Program Chair
Alex Freundlich (University of Houston)

Deputy Program Chair
Sarah Kurtz (National Renewable Energy Laboratory)

Area 1. Fundamentals and New Concepts for Future Technologies
Seth Hubbard
(Rochester Institute of Technology)

Area 2. Chalcogenide Thin Film Solar Cells
Sylvain Marsillac
(Old Dominion University)

Area 3. III-V and Concentrator Technologies
Paul Sharps
(Emcore Corporation)

Area 4. Crystalline Silicon Photovoltaics
Mariana Bertoni
(Arizona State University)

Area 5. Thin Film Silicon Based PV Technologies
Arno Smets
(Delft University of Technology)

Area 6. Organic, Perovskite, and Hybrid Solar Cells
Woojun Yoon
(Naval Research Laboratory)

Area 7. Space Technologies
David Wilt
(AirForce Research Laboratory)

Area 8. Characterization Methods
Angus Rockett
(University of Illinois)

Area 9. PV Modules, Manufacturing, Systems and Applications
Clifford Hansen
(Sandia National Laboratory)

Area 10. PV Deployment and Sustainability
Annick Anctil
(Michigan State University)

Area 11. PV and System Reliability
Charlie Hasselbrink
(SunPower Corporation)
42\textsuperscript{nd} IEEE PVSC Keynote and Invited Speakers Include:

- **Paul Basore**, National Photovoltaic Center, NREL, USA
- **Jeremy Legget**, SolarCentury, United Kingdom
- **Andreas Bett**, Fraunhofer ISE, Germany
- **Laurent Lombez**, IRDEP_CNRS, France
- **Robert W. Collins**, University of Toledo, USA
- **Robert M. Margolis**, Washington DC office of NREL, USA
- **Andres Cuevas**, Australian National University, Australia
- **Albert Polman**, FOM Institute AMOLF, Netherlands
- **Raffi Garabedian**, First Solar, USA
- **Susan Schorr**, Helmholtz Zentrum Berlin, Germany
- **Rebecca Jones-Albertus**, DOE- EERE, USA
- **Henry Snaith**, Oxford University, United Kingdom
- **Sarah Kurtz**, National Renewable Energy Laboratory, USA
- **Pierre Verlinden**, Trina Solar, China
Area 1: Fundamentals and New Concepts for Future Technologies

Area Chair: Seth Hubbard, Rochester Institute of Technology, USA
Co-Chairs: Jessica Adams, MicroLink Devices, USA
Gavin Connibeer, University of New South Wales, Australia
Antonio Marti, Universidad Politecnica de Madrid, Spain
Peichen Yu, National Chiao Tung University, Taiwan

Area 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. Papers are sought 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 1.1: Fundamental Conversion Mechanisms
Sub-Area Chair: Louise Hirst (Naval Research Laboratory)

Sub-Area 1.1 attempts to capture both experimental and theoretical work exploring new paradigms for photovoltaic energy conversion. Papers submitted to this sub-area would explore the fundamental physics or initial experimental demonstrations related to novel energy conversion mechanisms. In addition, papers on modeling and simulation of new device architectures to enable these conversion mechanisms are encouraged. Examples of new mechanisms of interest are non-conventional PV conversion processes based on, but not limited to, quantum confined or nanostructured concepts, intermediate band concepts, multiple exciton generation (MEG), thermophotonics or hot-carrier effects. Also of interest
are concepts and demonstration of new materials and material science related to energy conversion. Finally, cross-cutting science approaches involving novel physics, innovative device structures, and modeling and simulation are solicited.

**Sub-Area 1.2: Quantum-well, Wire, and Dot-Architectured Devices**  
*Sub-Area Chairs: Christopher Bailey (Old Dominion University)*

Sub-Area 1.2 focuses on the bandgap engineering of photovoltaic devices via the inclusion of quantum structures, and the science involved in the photogeneration, recombination and carrier transport mechanisms in these devices. This is a particularly exciting time in this technical area as these novel architectures are at the cutting edge of photovoltaic research. Such device designs offer a multitude of realistic technological paths to attaining solar cells with efficiency in excess of 50%. To continue the momentum in the field, papers are sought on both the theoretical and experimental progress in the development of quantum-structured materials and devices. Submissions including novel designs, new material compositions, implementation of new uses of quantum confinement, and the exploitation of varying dimensionality of confinement are encouraged. Ideal submissions will range from studies of fundamental physics to examples of working devices.

**Sub-Area 1.3: Hybrid Organic/Inorganic Solar Cells**  
*Sub-Area Chair: Gergely Zimanyi (University of California Davis)*

Hybrid solar cells are designed to exploit the unique interfacial electronic properties at the organic-inorganic boundary. This class of devices is rooted in nanostructured TiO₂ or ZnO integrated with conjugated polymers (P3HT), but is rapidly expanding to include many other organic and inorganic materials including single and polycrystalline Si and GaAs, organic small molecules, nanostructured carbon allotropes such as carbon nanotubes and graphene, as well as colloidal nanostructures including quantum wires, rods, and dots. Papers are sought which leverage the unique electronic and optical properties and functionality afforded by integrating organic and inorganic materials, and those which utilize quantum confined nanostructures to enhance charge transport and fine-tune the spectral sensitivity range. This sub-area has potential overlap with Sub-Area 6.3, and a joint session may be implemented.

**Sub-Area 1.4: Advanced Light Management and Spectral Shaping**  
*Sub-Area Chair: Jeremy Munday (University of Maryland)*

In order to achieve high power conversion efficiency, a solar cell must effectively utilize most of the incident solar spectrum. This process involves the efficient coupling of the incident light into the solar cell with minimum loss and the most effective use of the energy imparted by each photon. This sub-area will focus on novel concepts for advanced anti-reflection coatings, spectrum splitting, textured light trapping surfaces, luminescent (fluorescence) and nano-scale concentrator systems, and advanced photonic and plasmonic structures. In addition, ways to modify the spectrum of the incident sunlight using techniques such as up and down conversion either in planar layers or in waveguide structures will be considered. Papers submitted to this sub-area should address one or more of these themes and may be theoretical or experimental in nature.
Sub-Area 1.5: Novel Material Systems
Sub-Area Chair: Ian Sellers (University of Oklahoma)

Sub-Area 1.5 covers progress on the development of novel inorganic materials and processing techniques for improving the performance, functionality, reliability, and scalability of PV devices. Such materials, combinations, and processes may find application in single-crystalline, thin film, multijunction, and nanostructured PV devices or may enable an entirely new device class on their own. Papers are sought that describe theoretical and/or experimental development of materials displaying novel properties, including but not limited to semiconductors, substrates, coatings, barriers, transparent conductive oxides (TCOs), pseudomorphic and metamorphic photovoltaic materials. Developments in the field of graphene and carbon nanotubes are of interest in this sub-area. Advances in growth, synthesis, deposition, doping and passivation schemes as well as new architectures that have the potential to lower material quality constraints are also solicited.

Sub-Area 1.6: Joint Topic to Areas 1, 3, 4 and 7 on Technologies for III-V Materials and Devices on Silicon and other Low-Cost Alternative Substrates
Sub-Area Chair: Tyler Grassman (Ohio State University)

This sub-area is being jointly sponsored between Areas 1, 3, 4 and 7.* Papers are solicited on technologies related to growth or deposition of III-V materials and solar cells on silicon substrates. Growth of crystalline and polycrystalline III-V materials on substrates "beyond silicon", such as engineered metal foils and polycrystalline templates are solicited as well. Papers are also sought regarding defect characterization and defect reduction in highly mismatched and heterovalent epitaxial growth. New cell designs and architectures for III-V materials on alternate substrates, such as the active Si ("Si-plus") architecture, are also of interest to this sub-area. As well, submissions on wafer bonding of III-V materials to silicon are encouraged.

(*Submit your abstract under the area that best matches the nature of your investigation

Sub-Area 1.7: Joint Topic to Areas 1, 3, 7 and 9 on Mobile Solar Power/ High Efficiency Flexible lightweight PV
Sub-Area Chair: Rao Tatavarti (Microlink Devices)

Sub-Area 1.7 is a shared sub-area between Areas 1, 3, 7 and 9 and covers progress on the development of Mobile Solar Power (MSP) systems and their applications.** The MSP system development includes high efficiency (>20% demonstrated), flexible and lightweight solar cells, and sheets. Papers are sought that describe the development of cell technologies based on III-V materials and Silicon. Papers describing advances in novel methods of thin cell fabrication including epitaxial growth, fabrication and testing are solicited. Papers covering developments of flexible solar sheet fabrication methods, studies on improvement of sheet durability; ruggedness and overall efficiency are invited. Papers discussing cost reduction technologies for both cell production and cell integration are encouraged. Developments of systems applications of photovoltaic sheets such as battery charging, portable power, powering flexible electronics and solar UAV covering both the commercial and deployed soldier power application are of interest in this sub-area.

(**Submit your abstract under the area that best matches the nature of your investigation
Sub-Area 1.8: *Joint Topic to Areas 1, 3, 7 and 8 on Characterization of Single Crystalline Photovoltaic Materials and Devices*

*Sub-Area Chair: Thorsten Trupke (University of New South Wales)*

This sub-area is being jointly sponsored between Areas 1, 3, 7 and 8.*** Papers focusing on characterization of emerging materials and devices where the single crystalline nature of the material is paramount to device performance should be submitted here. Characterization of fundamental properties of multi-crystalline materials and devices also belongs in this area as the crystals are so large as to typically be effectively single crystals.

(***)Submit your abstract under the area that best matches the nature of your investigation
Area 2: Chalcogenide Thin Film Solar Cells

Area Chair: Sylvain Marsillac, *Old Dominion University, USA*
Co-Chairs: William Shafarman, *Institute of Energy Conversion, USA*
Charlotte Platzer-Björkman, *Uppsala University, Sweden*
Takashi Minemoto, *Ritsumeikan University, Japan*

**Area description**
Area 2 of the 42nd 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 invite contributions discussing solar cells based on \( \text{Cu(In, Ga)} \text{Se}_2 \), \( \text{Cu}_2\text{ZnSn(S, Se)}_4 \), \( \text{CdTe} \), and related materials. These materials include the highest efficiency thin film solar cells, now over 21%. 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. 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. We are looking forward to an exciting conference with fruitful discussions.

**Sub-Area 2.1: Absorber Preparation and Material Properties**
*Sub-Area Chair: Alex Redinger (University of Luxembourg)*
*Mike Scarpulla (University of Utah)*

Subarea 2.1 addresses progress in understanding the nature of chalcogenide thin film formation and the influence of processing on basic material properties and device performance. Relevant aspects include: morphology, microstructure, opto-electronic and transport properties, influence of substrate, phase contents, compositional gradients and homogeneity, the effect of material purity/contaminants, how these are interrelated and affected by the deposition process itself, and what their impact on PV performance is. An important topic is the effect of the deposition process on the surface/interface formation with respect to the PV device. Furthermore, the development of growth models and numerical simulations of individual material aspects are of high relevance for this subarea.
Sub-Area 2.2: Contacts, Buffers, Substrates and Interfaces
*Sub-Area Chair: Negar Naghavi (IRDEP, France)
Vikash Ranjan (NSG, USA)*

In the chalcogenide technologies, the composition and processing of the buffers and back contacts have significant effects on the device properties. Submissions describing advances in understanding the function of buffer layers and contacts and their impact on device performance and stability, as well as novel materials and processing are welcome. Progress in understanding the fundamental properties of these materials is encouraged. We also solicit papers on progress in the cross-cutting areas of transparent conductors as windows and moisture barriers and of new or improved substrates.

Sub-Area 2.3: Device Characterization and Modeling
*Sub-Area Chair: James Sites (Colorado State University)*

Subarea 2.3 addresses the device operation and defect characterization of chalcogenide solar cells. Contributions may focus on: measurement and analysis that elucidate device operation, one-, two- and three-dimensional modeling that gives guidance for further experimental exploration and performance improvement, defect characterization and influence from defects on device properties.

Sub-Area 2.4: Manufacturing Progress
*Sub-Area Chair: Markus Gloeckler (First Solar)*

In Subarea 2.4, we solicit contributions addressing module manufacturability. Emphasis is on the importance of cost and reliability (in addition to performance) as key drivers for developing a viable, thin-film module manufacturing capability. We encourage the community to share their experience and knowledge in areas focused on reducing the cost/watt of PV modules including higher throughput/yield and more energy and cost-effective processing, improvements in thin-film uniformity, improved cell integration and module architectures, important quality control metrology/diagnostics and information management applied during semiconductor deposition, integration, packaging, and reliability testing. Papers are also sought in the area of cell and module reliability, in particular field and laboratory-test procedures and results, qualification testing, degradation mechanisms, and transient behavior.

Sub-Area 2.5: Joint Topic to Areas 2, 5, 6 and 8 on Characterization of Polycrystalline or Amorphous Thin Film Photovoltaic Materials
*Sub-Area Chair: Angus Rockett (University of Illinois)*

This sub area is being jointly sponsored between Areas 2, 5, 6 and 8* and is intended for papers focusing on characterization of thin film Chalcogenides Materials.

(*) Submit your abstract under the area that best matches the nature of your investigation.
Area 3: III-V Solar Cells and Concentrator Photovoltaics

Area Chair: Paul Sharps, Emcore Photovoltaics, USA
Co-Chairs: Frank Dimroth, Fraunhofer ISE, Germany
           Masakazu Sugiyama, University of Tokyo, Japan

Area Description
Area 3 will focus on both III-V solar cells and concentrator photovoltaics. Multi-junction solar cells made from III-V compound semiconductor materials have achieved the highest conversion efficiency of any photovoltaic device. III-V solar cells with efficiencies in excess of 45% under concentrated sunlight have been demonstrated, and have been incorporated into commercially available concentrator photovoltaic modules. Area 3 covers the science and engineering of III-V single- and multi-junction solar cells, from theoretical modeling to growth related issues, material characterization, photon management, device processing and solar cell reliability. Materials science is the basis for continuous improvements in the understanding and further development of III-V solar cell structures. Novel device designs for achieving high conversion efficiency are also considered. The specific topic of III-V solar cells on silicon substrates will be covered in joint sessions with Area 1: Fundamentals and New Concepts for Future technologies, Area 5: Thin Film Si Based PV Technologies, and Area 7: Space Technologies. Growth of crystalline and poly-crystalline III-V materials on silicon and on substrates "beyond silicon", such as engineered metal foils and polycrystalline templates, are solicited. Wafer bonding on silicon, defect characterization, and new cell designs and architectures are of interest. The cost of III-V devices has prevented their widespread use in terrestrial applications, despite their high conversion efficiency. Papers addressing the cost of III-V devices and work being done to reduce cost while maintaining performance are particularly welcome.

In addition, Area 3 will also provide a venue for concentrator photovoltaics, both for high, medium, and low concentration devices and systems. 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. Combined heat and power systems and new applications of CPV in buildings, rural electrification or for the production of hydrogen or methane are highly welcome. In
the field of low and medium concentration, high efficiency silicon solar cells offer interesting applications. Contributions are welcome featuring silicon solar cells and corresponding module technology designated for concentrator applications.

**Sub-Area 3.1: III-V Solar Cells – Modeling, Epitaxial Growth, Materials, Processing, Reliability**
*Sub-Area Chair: Minjoo Larry Lee (Yale University)*

This sub-area covers all aspects of the development of III-V multi-junction solar cells for terrestrial applications. This includes (but is not limited to): epitaxial growth, theoretical modeling, material development, solar cell architectures, photon management, new manufacturing technologies, device processing, characterization, and reliability. Papers covering specific aspects of the growth and technology of III-V solar cells on silicon (for 1-sun and under concentration) are highly welcome and will be included in a joint session with Areas 1, 5, and 7. Papers covering both space and terrestrial solar cell development aspects will be included in a joint session with Area 7.

**Sub-Area 3.2: Lower Cost III-V Solar Cell Devices**
*Sub-Area Chair: Aaron Ptak (National Renewable Energy Laboratory)*

This sub-area covers the cost of III-V devices and efforts being made to reduce the cost of power generated by III-V devices. Topics include: novel device designs, alternative growth substrates and templates, lower cost growth and deposition, processing, testing, and integration technologies, and any other efforts being made to reduce the cost of III-V devices while maintaining device performance.

**Sub-Area 3.3: High Concentration PV – Solar Cells, Receivers, Optics, Modules, and Systems**
*Sub-Area Chair: Scott Burroughs (Semprius, USA)*

This sub-area covers all research and development aspects of high-concentration (> 300 suns) photovoltaic modules and systems. Such systems use lenses or mirrors to focus the sunlight onto typically III-V multi-junction solar cells. Papers are expected in the field of CPV modules, primary and secondary optics, system components, solar cell receivers, trackers, power plants, power rating, reliability, bankability, cost prediction, project development and financing, as well as aspects of grid integration and storage. Combined heat and power systems and new applications of CPV in buildings, rural electrification or for the production of hydrogen are highly welcome.

**Sub-Area 3.4: Low and medium concentration PV – Si Concentrator Cells, Modules and System components**
*Sub-Area Chair: Karin Hinzer (University of Ottawa)*

The low and medium concentration range in CPV extends from 3 to approximately 300 suns and is typically marked by the use of silicon solar cells. Conventional solar cells are often redesigned for the application under concentrated sunlight. This sub-area covers both the engineering of Si solar cells for applications in the 3-300x range, as well as all aspects of the module and system components. One-axis tracking is sufficient for many low concentration CPV systems. Improvements and/or reports on promising alternative
approaches are also welcome. The challenge is to find configurations which lead to cost reduction compared to conventional flat-plate PV.

Sub-Area 3.5: Joint Topic to Areas 1, 3, 7 and 9 on Mobile Solar Power/ High Efficiency Flexible lightweight PV
Sub-Area Chair: Rao Tatavarti (Microlink Devices)
Sub-Area 3.5 is a shared sub-area between Areas 1, 3, 7 and 9 and covers progress on the development of Mobile Solar Power (MSP) systems and their applications.* The MSP system development includes high efficiency (>20% demonstrated), flexible and lightweight solar cells, and sheets. Papers are sought that describe the development of cell technologies based on III-V materials and Silicon. Papers describing advances in novel methods of thin cell fabrication including epitaxial growth, fabrication and testing are solicited. Papers covering developments of flexible solar sheet fabrication methods, studies on improvement of sheet durability; ruggedness and overall efficiency are invited. Papers discussing cost reduction technologies for both cell production and cell integration are encouraged. Developments of systems applications of photovoltaic sheets such as battery charging, portable power, powering flexible electronics and solar UAV covering both the commercial and deployed soldier power application are of interest in this sub-area.

(*)Submit your abstract under the area that best matches the nature of your investigation

Sub-Area 3.6: Joint Topic to Areas 1, 3, 4 and 7 on Technologies for III-V Materials and Devices on Silicon and other Low-Cost Alternative Substrates
Sub-Area Chair: Tyler Grassman (Ohio State University)
This sub-area is being jointly sponsored between Areas 1, 3, 4 and 7.** This subarea covers progress in the area of III-V solar cells on silicon. Papers are solicited on technologies related to growth/deposition of III-V materials and solar cells on silicon substrates. Abstracts are also sought regarding defect characterization and reduction in highly mismatched, heterovalent epitaxial growth and polycrystalline III-V materials. New cell designs and architectures for III-V materials on alternate substrates, such as the active Si ("Si-plus") architecture, are also of interested to this sub-area. Submissions on wafer bonding of III-V materials to silicon are also encouraged.

(**)Submit your abstract under the area that best matches the nature of your investigation

Sub-Area 3.7: Joint Topic to Areas 1, 3, 7 and 8 on Characterization of Single Crystalline Photovoltaic Materials and Devices
Sub-Area Chair: Thorsten Trupke (University of New South Wales)
This sub-area is being jointly sponsored between Areas 1, 3, 7 and 8.*** Papers focusing on characterization of materials and devices where the III-V single crystalline nature of the material is paramount to device performance should be submitted here. Characterization of large grain multi-crystalline and polycrystalline III-V materials and devices also belongs in this area as the crystals are so large as to typically be effectively single crystals.

(***Submit your abstract under the area that best matches the nature of your investigation
Area 4: Crystalline Silicon Photovoltaics

Area Chair: Mariana Bertoni, Arizona State University, USA
Co-Chairs: Stefan Glunz, Fraunhofer ISE, Germany
Ivan Gordon, IMEC, Belgium

Area Description
Crystalline silicon photovoltaics is the dominating solar cell technology with a market share higher than 85%. Silicon is non-toxic and abundantly available in the earth crust and silicon PV modules have shown their long-term stability over decades of testing on the field. The price reduction of silicon modules in the last 30 years can be described very well by a learning factor of 20% and this positive trend continues to go on. Due to the strong competition, this price decline was even stronger in the last years resulting in module prices falling well below $1/Wp. 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 costs of the silicon wafer. Aside from improved production technology, the efficiency of the cells and modules is the main leverage to bring down cost even more. Area 4 of the 42nd IEEE PVSC invites contributions reporting on all aspects of crystalline silicon technology, from fundamentals and device physics to processing and module integration.

Sub-Area 4.1: Silicon Material: Technology and Analysis
Sub-Area Chair: Frederic Dross (Hanwha SolarOne)
This sub-area covers the first part of the value chain from feedstock through crystallization to wafering, including kerf-less technologies. Additionally, abstracts addressing the mechanical and electrical characteristics of the resulting wafers, including material quality, defects and defect engineering steps (e.g. gettering) of the silicon material are welcome.

Sub-Area 4.2: Junction Formation
Sub-Area Chair: Nils-Peter Harder (Total New Energies USA, Inc)
The formations of p-n and high-low junctions are fundamental steps of the silicon solar cell process. This sub-area covers all the different technologies that enable junction formation like gas phase diffusion, heterojunction approaches, laser and thermally activated doping
from deposited films and/or implantation. A special focus is set on structured doping needed for advanced cell structures like back-junction solar cells and passivated contact technologies.

**Sub-Area 4.3: Surface Passivation and Light-trapping**
*Sub-Area Chair: Giso Hahn (University of Konstanz)*

With increasing quality of the silicon material, the surfaces of the solar cells are becoming more and more important. This sub-area welcomes abstracts covering all aspects of surface passivation like dielectric layers, contact passivation, organic/inorganic interfaces, surface cleaning and passivation mechanisms. Another important aspect related to the surfaces of silicon solar cells is improved light-trapping. This sub-area also welcomes submissions addressing enhanced photon absorption by classical, diffractive and plasmonic mechanisms.

**Sub-Area 4.4: Contact Formation and Module Integration**
*Sub-Area Chair: Radovan Kopecek (ISC Konstanz Germany)*

The final step of cell processing is the formation of contacts. This sub-area welcomes manuscripts covering all current and novel techniques for contact formation, including but not limited to printed metallization, plating, evaporation, conductive adhesives, soldering, laser and thermal alloying of metals, and transparent electrodes. The contacts are also the interface to the subsequent module integration. Therefore topics like mechanical adhesion, multi-wire technologies and the interconnection of advanced cell structures like back-contact cells are also addressed in this sub-area.

**Sub-Area 4.5: Device Physics and Analysis**
*Sub-Area Chair: Keith McIntosh (PV Lighthouse)*

The development of advanced solar cell architectures requires an in-depth understanding of the underlying device physics. This sub-area covers aspects like device characterization and numerical simulation as well as the analysis of novel cell concepts.

**Sub-Area 4.6: Joint Topic to Areas 1, 3, 4 and 7 on Technologies for III-V Materials and Devices on Silicon and other Low-Cost Alternative Substrates**
*Sub-Area Chair: Tyler Grassman (Ohio State University)*

This sub-area is being jointly sponsored between Areas 1, 3, 4 and 7.* Papers are solicited on technologies related to growth/deposition of III-V materials and solar cells on silicon substrates. Abstracts are also sought regarding defect characterization and reduction in highly mismatched, heterovalent epitaxial growth and polycrystalline III-V materials. New cell designs and architectures for III-V materials on alternate substrates, such as the active Si ("Si-plus") architecture, are also of interested to this sub-area. Submissions on wafer bonding of III-V materials to silicon are also encouraged.

(*)Submit your abstract under the area that best matches the nature of your investigation
Area 5: Thin film silicon based PV technologies

Area Chair: Arno Smets, Delft University of Technology, Netherlands
Co-Chairs: Nikolas Podraza, University of Toledo, USA
Matthias Meier, Forschungszentrum Jülich, Germany

Area 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. In addition, papers are welcomed that cover novel concepts or applications like thin-film silicon based PV/photoelectrochemical devices.

Sub-Area 5.1: Amorphous and nanocrystalline silicon
Sub-Area Chairs: Takuya Matsui (AIST, Japan)
Amorphous and nanocrystalline silicon materials have demonstrated their suitability for large-area fabrication and operation in the field. Nevertheless, a better understanding of light induced degradation of the former and the workings of the internal interfaces in the latter remain challenging topics. This sub-area will discuss the latest results on material science and device design.

Sub-Area 5.2: Thin crystalline silicon-films
Sub-Area Chairs: Ivan Gordon (IMEC, Belgium)
Thin-films of crystalline silicon promise to combine high efficiencies known from wafer-based cells with advantages of large-area manufacturing. This sub-area will discuss “bottom-up” approaches like recrystallization and “top-down” strategies like epitaxial lift-off as well as device results.
Sub-Area 5.3: Light management

*Sub-Area Chairs:* Franz-Josef Haug (Ecole Polytechnique Federal de Lauzanne)

Owing to the indirect bandgap of crystalline silicon related materials, and to the small absorption volume in thin-film silicon cells, light management is important to all cell architectures of Area 5. Absorption enhancement is traditionally introduced by growing on textured light-scattering electrodes. More recent approaches separate this functionality into dedicated layers realized by novel technologies like nano-imprinting, or they employ innovative scattering strategies like dielectric and plasmonic nano-particles. In addition to applications inside Area 5, we plan a joint session with Area 2 on approaches that allow us to reduce the absorber thickness below the absorption length.

Sub-Area 5.4: Manufacturing

*Sub-Area Chairs:* Rutger Schlatmann (Helmholtz Zentrum Berlin)  
Baojie Yan (UniSolar)

Amorphous and nanocrystalline materials are successfully used in module production. In order to reduce manufacturing cost and to increase industrial throughput, it is necessary to explore regimes with high deposition-rate and controlled levels of contamination. This applies not only to the silicon films but also to supporting films like the electrodes. Moreover, all aspects must be integrated into the tight schedule of module fabrication.

Sub-Area 5.5: *Joint Topic to Areas 2, 5, 6 and 8 on Characterization of Polycrystalline or Amorphous Thin Film Photovoltaic Materials and Devices*

*Sub-Area Chair:* Angus Rockett (University of Illinois)

This sub area is being jointly sponsored between Areas 2, 5, 6 and 8* and is intended for papers focusing on characterization of thin film micro/nano-crystalline or amorphous materials and devices.

(*) *Submit your abstract under the area that best matches the nature of your investigation.*
Area 6: Organic, Perovskite, and Hybrid Solar Cells

Area Chair: Woojun Yoon, U.S. Naval Research Laboratory, USA
Co-Chair: Moritz Riede, University of Oxford, United Kingdom

Area Description
This focus area of the 42nd IEEE Photovoltaic Specialists Conference (PVSC-42) covers the latest scientific and technical progress of organic, perovskite, and hybrid solar cells. These emerging photovoltaic (PV) technologies have shown an incredible progress in the past years. As a consequence, the title and the subject of Area 6 are updated to reflect recent developments. Solar cell efficiencies have rocketed to well above 15% and extrapolated lifetimes have reached more than 10 years for some of these technologies. Based on abundant materials and scalable coating technologies, these emerging PV technologies show potential for low-cost, lightweight, and flexible solar power generation on a large scale. Based on these prospects, many companies around the world are putting considerable efforts towards their commercialization. This kind of solar cell – 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 in the highly interdisciplinary subareas outlined below. Furthermore, Area 6 will offer a unique possibility to strengthen interactions and integration between researchers from these emerging PV technologies and the greater PV community, something everyone will benefit from. These goals will be supported by a set of tutorials on the first day of the conference.

Sub-Area 6.1: Organic Solar Cells
Sub-Area Chair: Eszter Voroshazi (IMEC, Belgium)

Sub-Area 6.1 focuses on all-organic solar cells. Concurrent efforts in novel material and device architecture development have led to efficiencies above 10% in recent years.
Therefore, this sub-area welcomes a broad range of submissions from first principles design and synthesis of new donor and acceptor materials, methods of how to influence and characterize their microstructure in thin films up to device optimization. A better understanding of how the molecular structure influences the optoelectronic properties of solar cells is often considered as key for more targeted synthesis of improved absorbing and performing molecules. Additionally, optimal device design requires insight into the process of free charge carrier generation, recombination and extraction as well as modeling of opto-electronic device properties. Hence, we invite submissions linked to all these device aspects.

**Sub-Area 6.2: Perovskite Solar Cells**
*Sub-Area Chair: Samuel Stranks (University of Oxford)*

Sub-Area 6.2 covers the latest developments in organic-inorganic hybrid perovskite based solar cells. The rapid progress in this material class for solar cells has come as a surprise to many and power conversion efficiencies of perovskite solar cells are already approaching those of established thin film technologies. The materials are highly tunable, making them attractive for a range of applications including building-integrated photovoltaics and tandem solar cells. Nevertheless, there are ongoing challenges for these devices to become commercially viable. Further improvements in performance and stability as well as accurate characterization will require better understanding of device behaviour and material properties. We invite contributions from the broad range of topics relating to organic-inorganic perovskite-based photovoltaics.

**Sub-Area 6.3: Hybrid Solar Cells**
*Sub-Area Chair: Mingjian Yuan (University of Toronto)*

Sub-Area 6.3 covers progress on the development of hybrid solar cells based on novel materials, such as colloidal nanomaterials (nanocrystal quantum dot, nanorod, nanowires, nanotubes) as well as the progress of conventional dye-sensitized solar cells. This includes the topic of understanding the photo-generation, transport and recombination process during the device operation. This sub-area has potential overlap with Sub-Area 1.3 and depending on the number of abstracts, a joint session will be considered.

**Sub-Area 6.4: Device Stability**
*Sub-Area Chair: Martin Hermenau (Heliatek GmbH)*

PV technologies of sub-areas 6.1-6.3 have shown very encouraging efficiencies and accelerated lifetime testing shows the potential of lifetimes of more than 10 year operating. However, this is still far away from the targeted 20 years that conventional silicon PV guarantees. On the one hand, the understanding of the various degradation pathways has to be improved. On the other hand, a major challenge is reliably predicting solar cell and module operating lifetimes for the constantly changing materials sets and stack designs being investigated. Sub-Area 6.4 invites contributions on operating lifetime studies and concepts to improve the device stability, from more stable materials to high quality encapsulation.
Sub-Area 6.5: Scale-Up and Applications
Sub-Area Chair: Jan Gilot (TNO, Netherlands)
It is clear that on the way to large-scale production, correspondingly large-scale synthesis based on abundant materials and fast coating processes need to be developed. With the first real production systems in the final development phase, first markets like building integrated PV and mobile energy are likely to be targeted first. Given the unique form factors, there are many more applications for these novel PV technologies, especially in areas where conventional PV reaches its limits. Sub-Area 6.5 deals with the challenges of scaling up their production and ways to access an affordable terawatt capacity that the technology should allow for. This sub-area has potential overlap with Area 9 on PV Modules and Manufacturing. Depending on the number and nature of submitted abstracts, a joint session will be considered.

Sub-Area 6.6: Joint Topic to Areas 2, 5, 6 and 8 on Characterization of Polycrystalline or Amorphous Thin Film Photovoltaic Materials and Devices
Sub-Area Chair: Angus Rockett (University of Illinois)
This sub area is being jointly sponsored between Areas 2, 5, 6 and 8* and is intended for papers focusing on characterization of thin-films and devices based on organic, perovskite, and hybrid materials.

(*) Submit your abstract under the area that best matches the nature of your investigation
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Area 7: Space Technologies

Area Chair: David Wilt, Air Force Research Laboratory, USA
Co-Chairs: Claus Zimmerman, EADS Astrium, Germany
Mitsuru Imaizumi, JAXA, Japan

Area Description
Area 7 seeks papers related to space photovoltaics including: fundamental cell and material technologies, panel/blacket technologies, array technologies and on-orbit flight performance. Virtually all spacecraft are powered by PV generators and thus advances in space PV technologies contribute significantly to improvement of spacecraft performance. In addition, failures of space power systems are among the largest contributors of on-orbit anomalies, costing an estimated $9 billion dollars between 1990 and 2013. The failures in space power systems are frequently due to components other than the solar cells, thus we are particularly interested in papers that cover other important space PV technologies, such as solar cell interconnects, electrostatic discharge control technologies, panel and blanket materials technologies, contamination control approaches, novel rigid and flexible planar solar array technologies as well as advances in space solar concentrator array technologies. We highly encourage contributions, particularly from students who are working in relevant research areas. We invite your papers on any subjects related to space PV described above, and look forward to your contribution!

Sub-Area 7.1: Development of advanced solar cells, including radiation effects
Sub-Area Chair: Maria Gonzalez (Naval Research Laboratory)
Wolfgang Guter (Azur Space Solar Power)

This sub-area focuses on novel photovoltaic device approaches and recent developments in high performance photovoltaic materials and devices for space applications. Radiation hardening technologies that enable longer on-orbit capability are also sought. Papers on characterization and modeling of solar cells, including concentrator solar cells are welcomed.
Sub-Area 7.2: Development of advanced solar panel and blanket technology
Sub-Area Chair: Ted Stern (Alliance Space Systems)
This sub-area focuses on technology developments associated with integrating space solar cells into rigid panels and flexible blankets. This area also includes technologies required for electrostatic discharge control and contamination mitigation. This area also includes the development of space solar concentrator technologies, incorporating both the optical concentrating element as well as the solar cell thermal control element.

Sub-Area 7.3: Development of advanced solar arrays and structures
Sub-Area Chair: Bao Hoang (Space Systems Loral)
Jeremy Banik (Air Force Research Laboratory)
This sub-area is new for PVSC42 and aims to bring together the individuals who are developing advanced solar array structures with the traditional photovoltaic technologists, in hopes that a fuller understanding of the mutual design restrictions will aide in developing higher reliability, higher performance space solar arrays.

Sub-Area 7.4: Flight experience of space photovoltaic power systems
Sub-Area Chair: Phil Jenkins (Naval Research Laboratory)
Stephen Taylor (European Space Agency)
Results from on-orbit experimentation and operation of PV power systems and their analyses will be presented in this sub-area. Papers examining solar cell degradation, either due to particle irradiation or contamination along with its modeling and flight prediction are encouraged. Papers covering cell and power system testing on-board CubeSats are encouraged.

Sub-Area 7.5: Joint Topic to Areas 1, 3, 7 and 9 on Mobile Solar Power/ High Efficiency Flexible lightweight PV
Sub-Area Chair: Rao Tatavarti (MicroLink Devices)
Sub-Area 7.5 is a shared sub-area between Areas 1, 3, 7 and 9 and covers progress on the development of Mobile Solar Power (MSP) systems and their applications.* The MSP system development includes high efficiency (>20% demonstrated), flexible and lightweight solar cells, and sheets. Papers are sought that describe the development of cell technologies based on III-V materials and Silicon. Papers describing advances in novel methods of thin cell fabrication including epitaxial growth, fabrication and testing are solicited. Papers covering developments of flexible solar sheet fabrication methods, studies on improvement of sheet durability; ruggedness and overall efficiency are invited. Papers discussing cost reduction technologies for both cell production and cell integration are encouraged. Developments of systems applications of photovoltaic sheets such as battery charging, portable power, powering flexible electronics and solar UAV covering both the commercial and deployed soldier power application are of interest in this sub-area.

(*)Submit your abstract under the area that best matches the nature of your investigation
Sub-Area 7.6: Joint Topic to Areas 1, 3, 4 and 7 on Technologies for III-V Materials and Devices on Silicon and other Low-Cost Alternative Substrates

Sub-Area Chair: Tyler Grassman (Ohio State University)

This sub-area is being jointly sponsored between Areas 1, 3, 4 and 7.** Papers are solicited on technologies related to growth or deposition of III-V materials and solar cells on silicon substrates. Growth of crystalline and poly-crystalline III-V materials on substrates "beyond silicon", such as engineered metal foils and polycrystalline templates are solicited as well. Papers are also sought regarding defect characterization and defect reduction in highly mismatched and heterovalent epitaxial growth. New cell designs and architectures for III-V materials on alternate substrates, such as the active Si ("Si-plus") architecture, are also of interest to this sub-area. As well, submissions on wafer bonding of III-V materials to silicon are encouraged.

(**)Submit your abstract under the area that best matches the nature of your investigation

Sub-Area 7.7: Joint Topic to Areas 1, 3, 7 and 8 on Characterization of Single Crystalline Photovoltaic Materials and Devices

Sub-Area Chair: Thorsten Trupke (University of New South Wales)

This sub-area is being jointly sponsored between Areas 1, 3, 7 and 8.*** Papers focusing on characterization of materials and devices where the single crystalline nature of the material is paramount to device performance should be submitted here.

(***Submit your abstract under the area that best matches the nature of your investigation
Area 8: Characterization Methods

Chair: Angus Rockett, University of Illinois, USA
Co-Chairs: Keith Emery, National Renewable Energy Laboratory, USA
          Thorsten Trupke, University of New South Wales, Australia
          Ewan Dunlop, Joint Research Center, Ispra, Italy
          Marina Leite, University of Maryland, USA
          Michael Gostein, Atonometrics, USA

Area Description
It is impossible to understand innovation in science without considering the support from measurements and characterization. The primary focus of Area 8 is on novel characterization techniques and talks where the focus is on the ability to characterize rather than a focus on the detailed properties of a particular material specific to that technology. However, joint sessions are planned with other areas for papers that are heavily characterization focused but with application to one area of technology.

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 fundamental to engineering photovoltaic materials. 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. We encourage members of the PV community to submit their contributions addressing the full range of scientific and technological challenges in the field of characterization, including the following topics:

Sub-Area 8.1: Characterization Tools & Instrumentation
Sub-Area Chair: Michael Gostein (Atonometrics)
This subarea is intended to showcase the application of commercial techniques for characterization of photovoltaics and to demonstrate their capabilities. Papers submitted to this sub-area should be science or technology focused with strong technical content,
rather than advertisements. Papers are sought which either present new characterization tools or which provide an overview and update on the state-of-the-art application of a particular technique or type of instrumentation. Papers should demonstrate the capabilities of the instrumentation, describe its operating principles, and/or relate how the technique extends existing measurement limitations.

**Sub-Area 8.2: Novel Characterization Techniques -- Devices**
*Sub-Area Chair: Angus Rockett (University of Illinois)*

This subarea focuses on methods to study photovoltaics as electronic devices rather than the materials that make them up or their optical properties. Submit papers here, which address the challenge of characterizing devices broadly. Examples include but are not limited to: capacitance methods, study of device transients, methods to understand metastability and instability in device performance, degradation of device performance, etc.

**Sub-Area 8.3: Novel Characterization Techniques -- Materials**
*Sub-Area Chair: Marina Leite (University of Maryland)*

The focus of sub-area 8.3 is on novel methods to study photovoltaic materials, their structure, properties, and how these relate to processing and performance, with a focus on the materials. Examples of topics that would fit into this area include novel scanning probe techniques, such as variants of atomic force microscopy, scanning microwave microscopy, Kelvin probes, and advanced x-ray or photoemission methods, among others. Methods such as spectroscopic ellipsometry that characterize materials using optical methods could fit into this area but could also fit with sub-areas 8.4, 8.6, or others. Likewise topics such as capacitance methods could be here or in sub-area 8.2.

**Sub-Area 8.4: Novel Characterization Techniques -- Optoelectronic Properties**
*Sub-Area Chair: Thorsten Trupke (University of New South Wales)*

Sub-area 8.4 is intended for papers describing the characterization of optoelectronic properties primarily. Examples might include papers on ellipsometry focused on the optoelectronic properties rather than on the materials properties. Luminescence or absorption based methods may fit best in this sub-area.

**Sub-Area 8.5: Novel Characterization Techniques -- Modules & Systems**
*Sub-Area Chair: Ewan Dunlop (DG Joint Research Center)*

Development of novel methods to characterize modules or systems should be submitted to this sub-area. This may include solar simulators, module reliability characterization methods, and accelerated lifetime testing methods. In this case the focus should be on the technique rather than the application. For example, papers describing how to obtain improved spectrum simulation, temperature control, etc. would belong here while papers focusing on application of such methods to specific devices or systems should be submitted to sub-area 8.10 or to Area 9 generally.

**Sub-Area 8.6: In-situ Process Control and Monitoring**
*Sub-Area Chair: Michael Gostein (Atonometrics)*
One of the key problems in manufacturing is to identify and correct process excursions that can affect device quality or performance. Advanced manufacturing plants typically employ automated sampling of materials and/or devices in order to provide feedback to process control systems. This sub-area is intended for papers describing how to monitor PV materials or devices during manufacturing. Papers are sought which describe measurement techniques and/or data analysis methods that are particularly suited for identifying manufacturing process excursions or that provide other manufacturing-related benefits.

**Sub-Area 8.7: Testing Standards**  
*Sub-Area Chair: Keith Emery (NREL)*

A key component of characterization, especially of modules and systems, is testing standards. This sub-area is intended for submissions related to standard approaches to characterization. For example, standards for light flux measurement, calibration methods for simulators, testing temperatures, and other fundamental parameters of characterizations could be submitted here. Papers describing calibration of microanalysis instruments such as ion yield in a secondary ion mass spectrometer, would be better submitted to sub-areas 8.2 to 8.5.

**Sub-Area 8.8: Joint Topic to Areas 2, 5, 6 and 8 on Characterization of Polycrystalline or Amorphous Thin Film Photovoltaic Materials and Devices**  
*Sub-Area Chair: Angus Rockett (University of Illinois)*

This sub-area is being jointly sponsored between Areas 2, 5, 6 and 8* and is intended for papers focusing on characterization of thin film polycrystalline or amorphous materials and devices of inorganic and organic materials and where the application is specific to a given technology. Papers submitted to this sub-area will be organized into sessions with the Area chairs of the relevant technology. Papers relevant to large grain multi-crystalline Si characterization should be submitted to sub-area 8.9 or area 4.

(*) *Submit your abstract under the area that best matches the nature of your investigation.*

**Sub-Area 8.9: Joint Topic to Areas 1, 3, 7 and 8 on Characterization of Single Crystalline Photovoltaic Materials and Devices.**  
*Sub-Area Chair: Thorsten Trupke (University of New South Wales)*

This sub-area is being jointly sponsored between Areas 1, 3, 7 and 8.** Papers focusing on characterization of materials and devices where the single crystalline nature of the material is paramount to device performance should be submitted here.

(**) *Submit your abstract under the area that best matches the nature of your investigation.*

**Sub-Area 8.10: Joint Topic to Areas 8 and 9 on Characterization of Photovoltaic Modules and Systems**  
*Sub-Area Chair: Keith Emery (National Renewable Energy Laboratory)*

This sub-area is being jointly sponsored between Areas 8 and 9.*** Papers focusing on characterization of complete modules and systems where the nature of the device is dominated by the ensemble of microscopic behaviors distributed throughout a large area
rather than the understanding of individual microscopic behaviors. For example, papers in this sub-area could focus on methods such as LBIC or electroluminescence specifically as applied to understanding module performance rather than the same methods applied to small areas of device. Other examples of papers relevant to this area include adaptation of existing methods to characterize modules from emerging technologies such as perovskites or addressing the characterization of degradation mechanisms of modules or systems of those materials. Papers focusing primarily on the characterization technique or standard method for applying it should be submitted to sub-areas 8.5 or 8.7, respectively. Papers describing methods for extracting model parameters from measurements should be submitted to sub-area 9.3.

(***) *Submit your abstract under the area that best matches the nature of your investigation.*
Area 9: PV Modules, Manufacturing, Systems and Applications

Chair: Clifford Hansen, Sandia National Laboratory, USA
Co-Chairs: Joshua Stein, Sandia National Laboratories, USA
           Nils Reich, Fraunhofer ISE, Germany

Area Description
Advances in PV module engineering and manufacturing have been remarkable and their impact in lowering levelized cost of energy (LCOE) is significant. New materials for PV modules are introduced on a regular basis and new assembly technologies are proposed. Customers require better energy prediction methods and confidence in energy yield estimates. We solicit papers that describe advancements in PV module design and manufacture, new research regarding solar resource measurement and modeling and advances in module and system modeling. We particularly invite papers related to methods for system performance testing and strategies and techniques for system monitoring and maintenance. We welcome papers describing advancements in technology and modeling for balance-of-system components such as trackers, inverters, and power optimizers, as well as innovative deployment and application of PV technologies, and invite submissions for a Joint Session discussion mobile power applications. In each sub-area, greatest interest is for papers reporting completed work accompanied by validation from field or laboratory testing, or comprehensive modeling.

Sub-Area 9.1: Module Materials, Design, Manufacture, and Production
Sub-Area Chair: Alex Bradley (DuPont)

In Sub-Area 9.1, abstracts describing new materials and methods for producing modules are invited. Of interest are: new materials for backsheets, encapsulants, glass, and interconnects; new techniques for module assembly to reduce cost, increase efficiency or enhance reliability; methods for materials characterization; and novel module electrical configurations. In coordination with Sub-Area 11.4, we particularly welcome submissions describing state-of-art methods or new methods for module manufacturing quality control, including: quality assurance of module materials and subcomponents; statistical process control; automation of module assembly; and module quality assurance.
*Sub-Area Chair: Matthew Lave (Sandia National Laboratories)*  
Sub-Area 9.2 welcomes abstracts describing new technology and methods for measuring, modeling or forecasting the solar resource. Of particular interest are abstracts describing: comparative evaluations of ground-based instruments; new methods for or evaluations of satellite-based irradiance modeling; measurement and/or models for solar spectrum; and analyses of irradiance forecasting techniques for solar power applications.

Sub-Area 9.3: Models for Energy Prediction  
*Sub-Area Chair: Ken Sauer (Yingli Americas)*  
Sub-area 9.3 focuses on PV module modeling and energy prediction. Abstracts related to mechanical, thermal and electrical modeling of PV modules and systems will be accepted, including methods for determining parameters for these models. Of particular interest are abstracts describing: methods for determining model parameters from laboratory and/or outdoor characterization; models for the effect of solar spectrum on module output; and methods for estimating system losses due to module and/or temperature variation across arrays.

Sub-Area 9.4: System Performance Rating and Monitoring Strategies  
*Sub-Area Chair: Kendra Passow (First Solar)*  
Sub-Area 9.4 welcomes abstracts reporting improved techniques for system performance testing and novel methods and technologies for system monitoring during operations. We welcome abstracts describing: advances in or evaluations of methods for determination of performance metrics of plant performance; procedures for conducting commissioning and acceptance tests; and analyses describing data collection and quality assurance for such testing. We particularly invite abstracts reporting efforts to compare and/or harmonize among the various standards for system testing. Abstracts describing new methods for system monitoring are welcome, and in particular, research describing novel analysis strategies to extract knowledge regarding system health and performance from available monitoring data.

Sub-Area 9.5: Power Electronics, Energy Storage and other BOS Components  
*Sub-Area Chairs: Jack Flicker (Sandia National Laboratories)  
Sudipta Chakraborty (National Renewable Energy Laboratory)*  
In Sub-Area 9.3 we invite abstracts describing advancements in the application of inverters, battery/energy storage, and other balance of system components to PV systems. Recent inverter development trends include new inverter functionality to meet expanding utility requirements, higher DC voltages for central and string inverters, increased reliability and operational durability to meet demands for high DC/AC ratio plant designs. Storage technology and product development is on the rise again in response to grid stability issues for grid islands such as Puerto Rico and Hawaii. Development of other balance-of-system (BOS) components is moving quickly to meet increasing demands for arc-fault and enhanced ground fault detection. We welcome papers demonstrating innovation and implementation in each of these areas.
Sub-Area 9.6: Building Integrated Photovoltaics and Novel Applications
Sub-Area Chair:     Wilfried van Sark (Utrecht University)

Sub-Area 9.6 welcomes abstracts describing advances in materials for, design of, and manufacture of building-integrated PV (BIPV) systems. The rapid market growth in net-zero buildings and energy self-sufficiency encourages incentives to architects and building owners alike to find new and innovative BIPV solutions. We welcome abstracts reporting newer innovations, visions for future development, and advanced analyses of the cost reduction potential for BIPV. We particularly invite abstracts reporting advances in building design tools with integrated PV modeling functionality, and reports of BIPV system performance in the field.

In this sub-area we also welcome abstracts describing recent advances in off-grid PV systems, hybrid systems, mini-grids, DC end-use systems, and other advanced applications. We are particularly interested in results from fielded or demonstration installations, but also welcome topics covering design and engineering advances, and results from system simulations. We welcome papers covering innovative use of PV in non-traditional applications – for product integrated PV, DC link applications such as uninterruptible power supply (UPS) or server supply systems.

Sub-Area 9.7: Joint topic to Areas 1, 3, 7 and 9 on Mobile Solar Power/ High Efficiency Flexible lightweight PV
Sub-Area Chair:     Rao Tatavarti (MicroLink Devices)

This sub-area is shared between Areas 1, 3, 7 and 9 and covers progress on the development of Mobile Solar Power (MSP) systems and their applications.* The MSP system development includes high efficiency (>20% demonstrated), flexible and lightweight solar cells, and sheets. Papers are sought that describe the development of cell technologies based on III-V materials or/and Silicon. Papers describing advances in novel methods of thin cell fabrication including epitaxial growth, fabrication and testing are solicited. Papers covering developments of flexible solar sheet fabrication methods, studies on improvement of sheet durability; ruggedness and overall efficiency are invited. Papers discussing cost reduction technologies for both cell production and cell integration are encouraged. Developments of systems applications of photovoltaic sheets such as battery charging, portable power, powering flexible electronics and solar UAV covering both the commercial and deployed soldier power application are of interest in this sub-area.

(*) Submit your abstract under the area that best matches the nature of your investigation.

Sub-Area 9.8: Joint Topic to Areas 8 and 9 on Characterization of Photovoltaic Modules and Systems
Sub-Area Chair:     Keith Emery (NREL)

This sub-area is being jointly sponsored between Areas 8 and 9.** Papers focusing on characterization of complete modules and systems where the nature of the device is dominated by the ensemble of microscopic behaviors distributed throughout a large area rather than the understanding of individual microscopic behaviors. For example, papers in
this sub-area could focus on methods such as LBIC or electroluminescence specifically as applied to understanding module performance rather than the same methods applied to small areas of device. Other examples of papers relevant to this area include adaptation of existing methods to characterize modules from emerging technologies such as perovskites or addressing the characterization of degradation mechanisms of modules or systems of those materials. Papers focusing primarily on the characterization technique or standard method for applying it should be submitted to sub-areas 8.5 or 8.7, respectively. Papers describing methods for extracting model parameters from measurements should be submitted to sub-area 9.3.

(**) Submit your abstract under the area that best matches the nature of your investigation.
Area 10: PV Deployment and Sustainability

Area Chair: Annick Anctil, Michigan State University, USA
Co-Chair: Arnulf Jaeger-Waldau, European Commission, Italy

Area Description
The PV Deployment and Sustainability area provides an opportunity to discuss aspects required to ensure the long-term success of the PV industry. It represents an extension of the traditional scope of the conference where current concerns and strategies to increase the adoption of PV as a major electricity source will be discussed. A joint session between Area 9 and 10 focusing on the manufacturing aspects is possible. Authors should submit to the area of their choice; abstracts that are relevant to two areas will be reviewed by both areas and will be considered for inclusion in all relevant sessions.

Sub-Area 10.1: Interconnections
Subarea Chair: Michael Coddington (National Renewable Energy Laboratory)
This Subarea addresses challenges associated with the undergoing transition from primary energy sources connected to an aging grid to a modernized grid that incorporates new technologies such as variable renewable energy sources.

Sub-Area 10.2: Government/Policy/Financing
Subarea Chair: Kristen Ardani (National Renewable Energy Laboratory)
This topic focuses on strategies to sustain or accelerate high growth rates and rapid cost reductions through government policy and financing models which are critical to the success of PV deployment.

Sub Area 10.3: Sustainability
Sub Area Chair: Gabrielle Gaustad (Rochester Institute of Technology)
This area seeks submissions that look in all aspects of sustainability into all stages of PV, from raw material extraction to disposal, to assess the environmental, social and economic impact of PV deployment.
Area 11: PV and System Reliability

Chair: Charlie Hasselbrink, SunPower, USA
Co-Chair: Tony Sample, European Commission, DG JRC, Ispra, Italy

Area Description
The PV industry now attracts billions of dollars & euros of investment annually; thus it has become increasingly critical to have confidence in the long-term performance and reliability of these systems. This Area considers the Reliability of all types of PV and Systems technologies as well as process impacts throughout the value chain. Topics especially critical to the success of the PV industry include: up-to-date understanding of what is being observed for deployed products, the physics of degradation/failure modes, the development of accelerated tests and the validation of those tests’ ability to correlate with outcomes in the field, best practices in Design-for-Reliability and manufacturing QA; and the development and industry acceptance of standards and test protocols to ensure safety and reliability of PV systems. We note that papers on “reversible” degradation mechanisms, such as soiling, are highly encouraged. Submissions are invited for all types of PV technologies.

This area may host joint sessions with other Areas. Area 11 has been divided into five subareas, as presented below. Submission of papers on detailed scientific research studies as well as visionary papers addressing the full range of these topics are invited.

Sub-Area 11.1: Reliability Field Experience
Sub-Area Chair: Kent Whitfield (Sun Edison)
This subarea focuses on statistics of types of failures, data analysis techniques for field data, analysis of mechanisms of observed degradation and failures, electrical and mechanical impacts of failures, degradation models, and long-term operation models of PV plants. Submissions may include (but are not limited to) observations and analysis of observations from deployments of all PV technologies, methods of analysis of such data, and models or reviews that paint the big picture of what is happening in the real world. Papers on soiling are particularly encouraged.
Sub-Area 11.2: Physics of Failure and Predictive Modeling  
Sub-Area Chair: Glenn Alers (University of California Santa Cruz)

Submissions are encouraged on experimental elucidations and modeling of the chemistry and physics of metastabilities and degradation, including photochemical reactions, potential induced degradation, moisture susceptibility, diffusion and reaction, electromigration, device reverse-bias behavior, hot-spot formation and breakdown, and aging of packaging materials such as encapsulants and backsheets. This Sub-Area also includes predictive modeling platforms and their validation.

Sub-Area 11.3: Accelerated Testing and Correlation with Field Experience  
Sub-Area Chair: John Wohlgemuth (National Renewable Energy Laboratory)

This subarea focuses on identification of failure modes observed in the field that can be duplicated using accelerated stress tests, quantitative determination of acceleration factors for those failure modes, modeling of failure rates and wear-out as functions of localized weather conditions and/or accelerated stress test conditions, and fundamental physics and chemistry studies that can lead to quantitative modeling of module and device reliability and durability.

Sub-Area 11.4: Design and Manufacturing for Reliability and Quality  
Sub-Area Chair: Vivek Gade, (Jabil Corporation), Masaaki Yamamichi (AIST – Advanced Industrial Science and Technology)

What are the elements of Design-for-Reliability, Design-for-Manufacturing, and Manufacturing-for-Reliability and Quality Assurance programs that avoid field returns over the product life cycle? This subarea focuses on qualification of materials and components including development of test methods and specifications, process control, in-line diagnostic techniques, product sampling/testing, warranty return experience, standardization, and other technical aspects of Design for Reliability and Quality Assurance programs that are needed to avoid PV product recalls/returns. Submissions to this area will be also considered in coordination with Sub-Area 9.1.

Sub-Area 11.5: Certification and Safety Standards for Modules and Systems  
Sub-Area Chair: Chris Flueckiger (Underwriters Laboratories)

This subarea focuses on standards for reliability as well as fire prevention, arc detection/mitigation, shock hazards, ground and series arc faults, mechanical integrity, and inspection procedures and other safety issues. Submissions may address mitigating or testing for the full range of safety issues at the module and/or system level. Submissions focusing on how module or system safety might be affected by system degradation are also an area of interest. Papers reviewing the development of standards in large emerging markets for PV are also encouraged.