



Tuesday, June 18<sup>th</sup> the third day of the PVSC began with three outstanding plenary lectures from Areas 5, 8, and 9 that were delivered by world leaders in thin film and crystalline wafer based Silicon photovoltaics and photovoltaic power systems. The room was packed with an attentive audience. (photo below, to right)



To start the morning, Andrea Feltrin (photo to left) gave a nice overview of the recent progress in thin film silicon PV technology on an industrial and fundamental research level in the Area 5 plenary. Kaneka features an 11.7% certified initial efficiency total area large triple junction module. LG set a new record for stabilized cell efficiency with a certified 13.4% aSi/ucSi/ucSi triple junction. The latest research developments within the PVTEC consortium in Japan and the FAST TRACK program in Europe were also discussed. In the Area 8 plenary, Thorsten Trupke presented the history and current state of the art of photoluminescence in PV. Instead of a PowerPoint presentation, he utilized a very innovative and exciting means of conveying his work by going

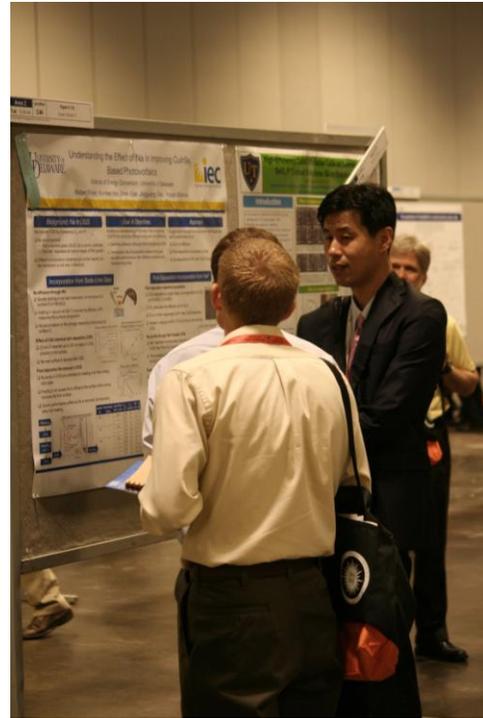
through a Facebook page. Torsten introduced the basics of luminescence techniques before showing the impressive capabilities of today's photoluminescence, which allows for an ultra fast and contact-less characterization already at the wafer level. Definitely the audience's response (photo below) can be summarized as "Like!!!". Torsten suggests you visit his site, [www.facebook.com/PLImaging](http://www.facebook.com/PLImaging) and like his page too. In the Area 9 plenary, Achim Woyte talked about the legends, challenges and solutions within photovoltaic power systems. Such large scale demonstration projects in Europe have been critical to address concerns in Europe (e.g., MetaPV).

Following the morning coffee break the attendees participated in the Tuesday Morning Poster Session and



exhibition. Philip Loper talked about his poster on Optoelectronic characterization of SiC with embedded Si nanocrystals. Robert Forest shared his work on understanding the effect of Na in improving the performance of thin-film CIGS-based photovoltaics, which has proven to be a challenge considering that Na may potentially play multiple roles during the formation of the CIGS absorber layers and operation of the devices. Noboru Yamada shared how his team has taken a unique approach to developing silicone-encapsulated CPV modules by leveraging LED packaging technology.

After lunch, Alex Zunger dazzled the Area 1 audience by unveiling, through inverse design strategies, novel compounds and architectures capable of enabling novel, higher performing PV materials and new functionalities. Aaron Martinez, a best student presentation award nominee, presented recent breakthroughs in development of silicon and SiGe clathrate powders and thin films with direct band gaps of 0.9 to 1.8 eV. Riley Brant discussed efficiency loss mechanisms in earth abundant thin films with an emphasis on copper oxide, sulfides and phosphides. He stressed the importance of TCO's with lower work functions as enabling technologies for earth abundant thin film materials.



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In Area 2, a conference focus this year is on alternative buffer layers for thin-film CIGS-based technologies such as Zn(O,S) and  $\text{In}_2\text{S}_3$ . On this subject Reiner Klenk shared design, preparation and performance aspects of CIGSS/Zn(O,S) solar cells. His team has analyzed the performance of various absorber materials and demonstrated results that are competitive with CdS based technologies, showing that a Cd-free high-performing CIGSS pathway exists. Markus Baer (photo to right) presented on the use of a high temperature anneals (200 – 250C) to drive intermixing between and CIGS/ $\text{In}_2\text{S}_3$  layers, which he showed resulted in a lower band offset and higher efficiency than pristine interfaces.



New light trapping concepts were presented in Area 5. Franz-Josef Haug talked about a process of using a lacquer to flatten an intermediate reflector and the use of a  $\text{MgF}_2$  low refractive index interlayer that ultimately resulted in an 11.9% (stabilized) efficiency micro morph tandem solar cell with low degradation. Fritz Falk shared his work developing a nano-writing process for silicon thin films on glass that generated 8.8% efficiency in a superstrate configuration. The grains were of particular interest, being crystallized with a laser and ranging in size up to 1 mm. Tao Chen reported new progress in highly transparent, highly conductive uc-SiC n-type and p-type (Al) doped window layers, which improved the short wavelength QE response of a-Si cells.

In the Area 8 afternoon session Johnson Wong presented his work developing a simulation program called “Griddler” for grid metallization optimization, which intelligently creates an optimal pattern for a specific cell design. Such a tool is most convenient when optimizing device design. Additionally, Key-Michael Guenther, a best student presentation award finalist, presented a method to characterize PV junction properties, which utilizes impedance spectroscopy to extract capacitance-voltage characteristics for multiple space charge regions simultaneously in one measurement.



The afternoon poster session comprised over 100 presentations and was well attended. Throughout the conference best poster awards are presented in each of the 10 topical areas. Fahhad Alharbi reported on his team’s progress using metallic quantum dots as sensitizers for solar cells. Alessandro Romeo discussed new approaches to



improving the reliability performance of CdTe thin film solar cells through the use of  $\text{Bi}_2\text{Te}_3$  back contacts. Georg Krugel described the use of AlN as a new means of passivating emitters in Si solar cells.

The PVSC'ers are actively engaging the vendors, which these exhibits are a great place to learn more about commercially available technologies that can enhance their research and meet with potential collaborators at various national laboratories. Congrats again to the attendees whose IEEE PVSC papers were selected to be published in the peer reviewed IEEE Journal of Photovoltaics later this year.

At the end of the day participants enjoyed the William R. Cherry reception that was held to recognize and honor Keith Emery, this year's prestigious winner. Congrats again Keith!

As a reminder and out of respect for and in support of our colleagues in the PV industry, please abide by the conference regulations, which strictly prohibit the photography and/or recording of presentations.

That wraps up the third day of the 39<sup>th</sup> IEEE PVSC conference!

