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Next Generation (Nano) Photonic and Cell Technologies for Solar Energy Conversion

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Introduction

The solar energy industry has seen strong growth in the last decade. While the recent Great Recession has certainly had an impact on the photovoltaics (PV) industry, this has not been as severe as feared and the industry is seeing promising growth levels. Conventional silicon and thin film PV technologies are well developed and capable of meeting the clean energy demands of many markets. They will have even more impact as cost reduction and manufacturing technologies improve. Nevertheless, there continues to be interest within the research community in developing technologies that can simultaneously reduce cost yet also provide breakthrough performance.

To this effect, research efforts in studying and applying the unique optical, electrical, and structural/architectural properties of micro and nanostructures to solar energy applications, either as novel photonic structures or as new solar cell device structures, continue to flourish. This year's third installment of the conference devoted to this topic, Next Generation (Nano) Photonic and Cell Technologies for Solar Energy Conversion, held at SPIE Optics + Photonics in 2010 as part of the Solar Energy + Technology Symposium, once again demonstrated the strong interest in this field of research. The conference's title was slightly modified this year to include a broader class of next generation concepts and other mechanisms of solar energy conversion.

The first two sessions of the conference were focused on Nanophotonics for Solar Energy Conversion, i.e., the use of novel layers and structures for light management in solar applications. After an overview of solar cell characterization using luminescent imaging, numerous presentations on up/down-conversion, plasmonics, light trapping, and photonic bandgap structures, among other topics, were given. The third and fourth sessions were devoted to Quantum Structures for Solar Energy Conversion, featuring talks on quantum dot solar cells, intermediate bands using highly mismatched alloys, and luminescent solar concentrators. A joint session (with the Organic Photovoltaics conference) on advances in Nanostructured Organic Solar Cells was held, followed by two sessions on Nano/Micro Wires & Tubes for Solar Energy Conversion. These included application of CdS/CdTe, a-Si:H, Si, and III-V wires and pillars in novel photovoltaic devices, and nanowire-based transparent conductors. Following a third session on Nanophotonics, the final session of the conference on Advanced Photovoltaic Technologies included presentations describing advanced thin silicon wafering, direct-write metallization, and other optical enhancing mechanisms for solar modules. A collection of excellent posters on various next generation PV topics further contributed to the conference.

The conference was also highlighted by the second year of a panel discussion moderated by Prof. Sean Shaheen (University of Denver) and myself on Commercialization of Emerging Photovoltaic Technologies, in which experts from academia and industry discussed the prospects and challenges in developing novel PV technologies based on organic and inorganic materials. This year's panelists were as follows:

Christoph J. Brabec, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany)
Gavin Conibeer, ARC Photovoltaics Ctr. of Excellence, Univ. of New South Wales (Australia)
Gang Li, SOLARMER Energy, Inc. (USA)
Michael J. Naughton, Boston College (USA)
Kishore Kamath, Abound Solar, Inc. (USA)
John A. Rogers, Univ. of Illinois at Urbana-Champaign, for Semprius, Inc. (USA)
Tom Tibbits, QuantaSol Ltd. (United Kingdom).

Among the many interesting points raised by the panel, some noted that cost analysis is a critical component in analyzing the impact of a technology, though the general consensus was that this may be best left to those in business while those in research should focus on developing novel technologies through science and engineering. Some panelists argued that organic materials will play an increasing role in the future, whereas others felt that high efficiency III-V-based technologies will make an impact as new processing technologies are developed for low cost. Most agreed that crystalline silicon technology will continue be a major part of the solar market, as will thin film technologies based on CdTe and CIGS. The scale-up activities of several CdTe based companies were noted, as was the low cost position of this technology. Several members of the audience highlighted the potential for concentrator PV applications in the future.

Once again, the conference provided an excellent forum for the interchange of next generation photonic and device concepts in solar energy conversion. I would like to thank the conference program committee (Drs. A. Chatten, G. Conibeer, A. Salleo, S. E. Shaheen, W. G. J. H. M. van Sark, D. Wang, X. Xu, and E. T. Yu) for their great support, as well as the session chairs, authors, and SPIE staff for their help in making this a successful conference. The strong support of Dr. M. Symko-Davies, chair of the 2010 Solar Energy + Technology symposium, is also greatly appreciated.

Loucas Tsakalakos