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Introduction

The fourth Thin Film Solar Technology conference was held this year at the SPIE Solar Energy + Technology symposium. The program was strong with stimulating talks from various areas in the field, ensuring a well-attended and successful event. The conference included speakers from leading international academic institutions, government laboratories, and industry.

This volume features contributions from scientists and engineers in the general area of Thin Film Solar Technology, with special emphasis on Thin Film Photovoltaics (TF PV). Thin film solar technologies are a compelling alternative to conventional crystalline silicon solar technologies because they offer a cost reduction potential, driven mainly by the need for a lower amount of material, as well as the possibility of monolithic integration. It is important to note, however, that silicon pricing has continued to drop dramatically this year, challenging TF PV manufacturers to further improve the efficiency and reduce the cost of their modules. As a result, this year has seen continued shake-out in the TF PV space, leaving fewer companies in each technology area standing, as well as significant consolidation activity through mergers and acquisitions. The PV industry came out of this period of change stronger.

To illustrate the breadth of topics covered in this conference, we mention just a few of the papers presented in each session. The first session dealt with nanostructured thin film PV. Jeehwan Kim et al. from the IBM Thomas J. Watson Research Center presented a talk on the progress and challenges in three-dimensional thin film silicon PV, with a focus on nanocone-based solar cells. Ulrich Paetzold et al. from Forschungszentrum Jülich, Germany, proposed plasmonic reflection grating back contacts for thin film silicon solar cells. Vivek Shah and his colleagues from the group of Prof. Pratim Biswas at Washington University in St. Louis tackled nature-inspired nanostructures for enhanced performance using a single-step process to synthesize bio-hybrid and bio-mimetic solar PV devices. The second session focused on advances in thin film silicon PV. Jeremy Fields and coworkers from the Colorado School of Mines and MVSystems proposed synthesizing hydrogenated nanocrystalline silicon thin films using a double-pulsed PECVD process. Tanzina Khaleque from Prof. Robert Magnusson's group at the University of Texas at Arlington described experiments with resonant thin film hydrogenated amorphous silicon solar cells. Barbara Leszczynska and coworkers from the Technische Universität Dresden and the Forschungs- und Applikationslabor Plasmatechnik, Germany, described the high-rate deposition of silicon thin film layers using linear plasma sources operated at very high excitation frequencies (80-140 MHz). Chang Su Kim et al. from the Korea Institute of Materials Science described innovative amorphous silicon and organic hybrid tandem thin film solar cells.

The third session dealt with advances in crystalline silicon PV. Romain Cariou and his colleagues from the Ecole Polytechnique, France, and their collaborators from Università degli Studi di Messina, Italy, and the Indian Association for the cultivation of Science, described a novel process for the epitaxy of silicon below 200°C. Louay Eldada from Amprius described hybrid PV systems that integrated high-efficiency crystalline silicon panels, long-lifetime energy storage solutions, and back-up generators; these systems were deployed globally for rural electrification, mine exploration, irrigation, and desalination. The fourth session covered novel PV materials and characterization methods and the emerging field of CZTS (copper zinc tin sulfide/selenide) solar cells. Wei Wang et al. from the Hong Kong Polytechnic University described SnS van der Waals epitaxies on graphene buffer layer. Volker Buschmann and his colleagues from PicoQuant, Germany, and their coworkers from the Ferdinand Braun Institut and the Helmholtz Institut für Materialien und Energie, Germany, discussed the characterization and quality control of semiconductor wafers using time-correlated single photon counting. Akram Aqili from the Hashemite University, Jordan, and his collaborators from the Optics Laboratories, Pakistan and the Lawrence Berkeley National Laboratory, described the optical and structural properties of silver doped ZnSe thin films prepared by CSS and ion exchange process. Kaushik Choudhury and his colleagues from DuPont covered the topic of CZTS solar cells from inks in their talk on solution chemical routes to high efficiency Cu2ZnSn(S,Se) thin-film solar cells.

The fifth session focused on CIGS (copper indium gallium selenide) PV modeling, fabrication, and characterization. Mustafa Pinarbasi of SoloPower gave an invited talk on the processing and performance of low weight flexible CIGS cells and modules. Antonin Moreau and coworkers from the Institut Matériaux Microélectronique Nanosciences de Provence and NEXCIS, France, and the Technical University of Madrid, Spain, discussed characterizing CIGS devices using photoreflectance spectroscopy. Yu-Ting Hsu and coworkers from the National Chiao Tung University, the National University of Kaohsiung, the National Cheng Kung University and the Institute of Science and Technology, Taiwan, presented their results on studies of CIGS thin films with different pairs of CuGa/In sputtered layers. Finally, the last session of the conference, the sixth session, dealt with transparent conducting oxides. Maxwell Mageto and coworkers from Uppsala University, Sweden, and Kenya's University of Science and Technology and Moi University, discussed the electrical and optical properties of TiO2:Nb thin films prepared by the spray pyrolysis technique, and Thomas Gennett and colleagues from David Ginley's group at the National Renewable Energy Laboratory (NREL) presented an invited talk on innovative amorphous InZnO transparent conductors that improve the Epi-Si heterojunction PV performance.

Although this volume cannot include all the recent important work in the vast field of thin film solar technologies, it does cover a significant cross section of the advances happening globally, and it provides a roadmap for this fast-growing

and exciting field by presenting the cutting-edge work and the visions of leading experts who are actively inventing the future.

Louay A. Eldada