The Role of Oxygenated Cadmium Sulfide (CdS:O) Window Layers on High Efficiency CdTe Solar Cells

Colin A. Wolden
Department of Chemical and Biological Engineering, Colorado School of Mines, Golden, CO 80401

Record CdTe solar cell efficiency has reached 21.5%, and it is the leading thin film photovoltaic technology in terms of commercial installation, with current manufacturing exceeding 1 GW/year. However, with a Shockley-Queisser limit of ~33% there remains substantial room for additional improvements in efficiency that is required to keep pace with crystalline silicon. The quality of both the front and back contacts has substantial influence on CdTe solar cells device efficiency, impacting the current and voltage respectively. This talk will provide an overview of recent developments in CdTe technology, with a focuses on work in our lab directed at understanding the materials science of these critical interfaces and optimizing their performance.

In this talk I focus on the role of the *n*-type window layer that forms the heterojunction with CdTe. Cadmium sulfide is the most commonly employed window layer, and its properties can greatly affect cell performance through optical absorption and the quality of the CdS-CdTe junction. In this work, we develop reactive sputtering of oxygenated cadmium sulfide (CdS:O) as an alternative to chemical bath deposition of CdS for the production of to enable high efficiency CdTe solar cells. The intrinsic properties of CdS:O were studied by varying the oxygen content in the Ar sputtering ambient and correlated to device performance. We show that the optical band gap of the as-deposited material is a useful metric for process optimization, and this process helped achieve a world record 16.4% flexible solar cell. In the second part of the talk I discuss how CdS:O evolves during subsequent high temperature device processing. Two novel techniques have been developed to isolate and characterize the window layer in completed devices. It is shown that the CdS:O undergoes a remarkable transformation during device processing, providing a fundamental explanation for the observed improvement in device performance. These results illustrate for the first time the significant changes that occur to the window layer during processing that are critical for CdTe solar cells.

***Bio**: Colin Wolden is the Weaver Distinguished Professor in the Department of Chemical and Biological Engineering at the Colorado School of Mines. He received his B.S. in Chemical Engineering from the University of Minnesota and went on to obtain his MS in Chemical Engineering Practice and PhD degrees from MIT. After completing a NRC/ARO Postdoctoral Fellowship he began his academic career at CSM in 1997. His research interests are focused on the fabrication of nanostructured thin films for sustainable energy applications including thin film solar cells, membranes, opto-electronics, and functional coatings. He has co-authored 100 papers in peer-reviewed journals and has 5 patents. He is Fellow of AVS and serves as an Associate Editor of the Journal of Vacuum Science and Technology.*