Thin Film Solar Cells from Nanocrystal Inks of Quaternary Chalcogenides

Rakesh Agrawal

School of Chemical Engineering, Purdue University, West Lafayette, IN 47907, USA

The creation of a suitable inorganic colloidal nanocrystal ink for use in a scalable coating process is a key step in the development of low-cost thin film solar cells. We have developed an innovative method of using copper indium gallium disulfide (CIGS) nanocrystals as the building block for the fabrication of bulk CIGSSe thin films. The CIGS nanocrystal ink solution is applied directly on various substrates to form a thin film coating. The CIGS nanocrystals are then consolidated into large crystalline chalcopyrite domains by a brief thermal treatment under Se vapor. Furthermore, the ability to control the composition for CIGS nanocrystals allows the unique capability to bandgap engineer the CIGSSe absorber using nanocrystals with different ratios of In/Ga. By optimizing processing conditions for the various layers in the solar cells, total area efficiency of 14.2% under AM1.5 illumination has been achieved.

Our scouting experiments based on the adaptation of CIGS method has also resulted in Cu2ZnSnS4 (CZTS) nanocrystals and the associated PV devices. Although the solar cell performance of the currently fabricated solar cells is somewhat low (total area power conversion efficiencies in the range of 8.3% to 9.3%), the results are very promising and investigation is underway to improve their chemical and structural properties.