Design and Development of High-Efficiency PV Modules based on CIGS/Silicon Tandem Thin-Film Solar Cell

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Abstract

This research project proposes a numerical optimization of novel architectures for light trapping in complete CIGS/Silicon Tandem Thin-Film solar cells, with efficiencies greater than 25% expected. The proposed thin-film tandem solar cell consisting of a top Cu ($In_{1-x}Ga_x$) Se_2 cell and a bottom Silicon cell. The CIGS top cell in the tandem uses light in the UV-visible part of the solar spectrum, while the light in the near-IR spectrum that passes through the CIGS cell is harvested by the underlying Silicon cell. The upper cell must be transparent so that infrared light can reach the lower cell and be converted into electricity more efficiently. The ideal band gaps should be about 1.6-1.7 eV and 1 eV for both cells, respectively. In this way, the tandem cell significantly outperforms the stand-alone CIGS and Silicon cells. Moreover, CIGS cells will be an ultrathin-film solar cell, paving the way to high efficiency flexible solar cells, reducing manufacturing costs, and building integrated photovoltaic solutions. The research project aims to accelerate the development of CIGS-Silicon tandem technology from fundamental studies of manufacturing processes, materials, and interfaces, to the design of complete devices, their characterization, and their optimization. The research findings will be compared with other research work in order to identify the gap and innovation needed to improve the properties and performance of CIGS/Silicon Tandem Thin-Film solar cells and modules.