Nanostructures for High Efficiency Photovoltaics

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Photovoltaics (PV) technology is currently enjoying substantial growth and investment, owing to worldwide sensitivity to energy security and the importance of renewable energy as a means to mitigate carbon emissions. There are many options in photovoltaic cell design and fabrication, but the key performance metric is the cost per Watt of PV-generated electricity. While solar cells are semiconductor devices like integrated circuits, the processing cost/area must be several orders of magnitude less expensive than for microelectronic integrated circuit chip processing. Thus while most current solar cell manufacturing is done with crystalline silicon wafers, the future of photovoltaics could see the large-scale development of inexpensive thin film and nano-structured devices and processes. To achieve substantial market growth to the point where photovoltaics is able to seriously contribute to the overall energy supply, high solar conversion efficiency will be critical, as will be the use of earth-abundant materials in thin film cells. I will discuss promising new approaches to ultrahigh efficiency thin film multi-junction solar cells, options for earth-abundant materials, semiconductor nanowire-based solar cells and plasmonic structures for enhanced light absorption that open up new design approaches to very thin photovoltaic devices.