Solar energy harvesting scheme utilizing three-dimensional hierarchical nanostructures

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Hierarchical nanostructures were used to enhance the energy harvesting based on photo-solar and thermal-solar in my group. In this talk, I will report fabrication of a large area Cu(In,Ga)Se_2 nanotip arrays (CIGS NTRs) by using one step Ar+ milling process without template. By controlling milling time and incident angles, the length of CIGS NTRs with adjustable tilting orientations can be precisely controlled. The CIGS NTRs have very low reflectance < 0.1 % at incident wavelengths between 300 nm to 1200 nm. In contrast to CIGS thin film solar cell with efficiency of 3.2 %, the nanostructured CIGS NTRs can have efficiency enhancement of ~160 % due to the higher light absorption ability because of the nanostructure. Another part of my talk, a reactive mold-assisted chemical etching (MACE) process through an easy-to-make agarose stamp soaked in bromine methanol etchant to rapidly imprint larger area micro- and nano- arrays on CIGS substrates was demonstrated. The microstructure arrays integrated into standard CIGS solar cells with thinner thickness can still achieve an efficiency of 11.22 %, yielding an enhanced efficiency ~18 % compared with that of their planar counterpart due to an excellent absorption behavior confirmed by the simulation results, which opens up a promising way for the realization of high-efficiency micro- or nanostructured thin-film solar cells.