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Enhanced solar energy harvesting scheme utilizing nanostructures

Yu-Lun Chueh

Department of Materials Science and Engineering, National Tsing-Hua University, Hsinchu, Taiwan, R.O.C

*E-mail: ylchueh@mx.nthu.edu.tw

Solar energy is mainly a daytime energy source, a possible candidate for renewable energy. Energy harvesting from solar energy can be divided into two parts, namely energy harvesting from photo energy (photo-solar) and energy harvesting thermal heating from solar energy (thermal-solar). The photo-solar means that the energy harvesting is based on collection of photo energy collected by solar cell while the thermal-solar means storage of the solar energy as thermal energy by solar-thermal power plant. In this talk, hierarchical nanostructures were used to enhance the energy harvesting based on photo-solar and thermal-solar in my group. In the first part of my 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. Open circuit voltage and short circuit current of CIGS NTRs solar cell were measured to be ~390 mV and ~22.56 mA/cm^2, yielding the filling factor and the efficiency of 59 % and 5.2 %, respectively. 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. In the secondary part of my talk, an enhanced heat capacity of modified HITEC molten salt by doping of metal NPs will be reported. We encapsulate the Tin alloy into Sn/SiO_x core-shell NPs to prevent mixture with salt when operation temperature is higher than the melting point of Tin. The SiOx shell layer can protect the Sn NPs to be oxidized and maintains a melted status during the heat cycles, providing a stable leant heat value of 28.36 J/g. Besides, effective heat capacity of HITEC salt with Sn/SiOx core-shell NPs can be enhanced to be 30 % a mixture percentage of 5 wt%. The merits of this approach show a low-cost and easy way to enhance the thermal properties of current molten salt without complicated manufacturing.

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