Towards highly stable and low-temperature hybrid nanostructure Si solar cells

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Silicon nanostructured based hybrid solar cells have attracted much attention due to their potential advantages of extremely simple device fabrication and the cost-effectiveness of their hybrid structure [1]. These hybrid solar cells open a new research direction in new-generation photovoltaics. Hybrid solar cells made of PEDOT:PSS poly (3,4-ethylenedioxythiophene):poly(styrenesulfonate) and nanostructured silicon have been extensively investigated for the recent development of low-cost solar cells due to their light trapping abilities [2] and simple solution processes [3]. However, the performance of hybrid organic/Si nanostructure solar cells is hindered due to long-term stability and poor coverage of organic material PEDOT:PSS on nanostructure surfaces. There is a growing demand for the development of alternative materials with high-stability and high-conductivity ‘metal-like’ organic molecules.

In this report, we have demonstrated the creation of high-efficiency, long-term air-stable Si nanotip/TEDs (zwitterionic tetrathiafulvalene-extended dicarboxylate radicals) heterojunction solar cells. The zwitterionic radical TED has significantly higher stability than does PEDOT:PSS in contact with Si nanostructure hybrid solar cells. Figure 1 shows the energy band diagram and J-V curve of TED-Li hybrid device. Solar cells with TED-Li/Si-nanotip heterojunctions exhibit a Jsc of 33.93 mA/cm^2, Voc of 0.466 V, FF of 0.55%, and highest PCE of 8.8%. The TED-Li device showed much higher stability than the PEDOT:PSS device. The TED-Li device shows only a 10% loss in the PCE until a month, whereas the PEDOT:PSS device showed rapid decay and poor stability (88% loss) in PCE after 400 hours. The single-molecular TED component enables a low-temperature process, higher stability, and a higher performance device, based on solution process techniques. These developments open a new path to new-generation solar cell devices and cost-effective production techniques.

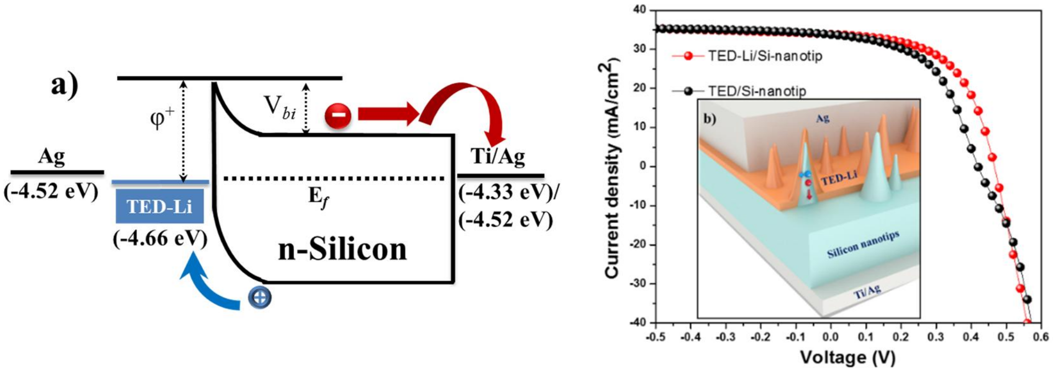

Figure 1. a) Energy band diagram and b) J-V characteristics of TED and TED-Li/Si nanotip hybrid solar cells. Inset picture shows that schematic diagram of hybrid solar cells.

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