Nano-structures Embedded Perovskite Solar Cells

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Organic-inorganic hybrid perovskite solar cells (PSCs) are now attracting tremendous attention for new-generation photovoltaic device because of their excellent power conversion efficiency (PCE) and simple fabrication process. Various researches have been carried out to increase the efficiency of PSCs. Herein, we report on the three methods for enhanced performances of PSCs based on nanoimprint lithography technology.

First, Hexagonal Array Micro-Convex (HAMC) of nanostructure substrate fabricated using nanoimprint lithography show excellent productivity and involves simple processing methods. This implies that simple processing methods can be used and excellent productivity can be retained for the HAMC of nanostructured substrate exhibited a very large increase in light diffuse trnasmittance and scattering effect, compared to that of the conventional substrate. Using this HAMC substrate, an increase in power conversion efficiency (PCE) of 14.86 %, which is mainly reason to increase of the short-circuit current density (Jsc) of 20.92 mA/cm2.

Second, to maximize the incident light harvesting, moth-eye nano patterned structure was implemented as anti-reflection layers on a glass substrate for enhancing efficiency in PSCs. By employing anti-reflecting inverted moth-eye nano patterned substrates for PSCs, the total transmittance and absorbance were increased and an enhanced PCE of 17.48 % was obtained, which is mainly due to the increase of Jsc of 21.73 mA cm^{-2}.

And third, using selectively grown single crystalline TiO_2 nanorod to increase the electron-hole separation effectively and enables the active layer to be coated thicker without electrical loss by using TiO_2 nanorod as an electron pathway. Moreover, single crystalline TiO_2 nanorods are selectively grown on the substrate to increase optical path of incident light by scattering effect and to enable smooth coating of active layer. Fabricated solar cell reports PCE of 19.86 % was accompanied with an increase in the external quantum efficiency (EQE) were achieved with Jsc of 23.13 mA/cm^2, open circuit voltage (Voc) of 1.120 V and fill factor (FF) of 76.69 %.