Spatially resolved imaging of photocarrier generation and band alignment at the perovskite/PbI_2 heterointerfaces of perovskite solar cells by using light-modulated scanning tunneling microscopy

Organic-inorganic hybrid perovskite materials have recently shown remarkable power conversion efficiencies of up to 20% in photovoltaic applications. The inherent polycrystallinity of perovskite films is expected to significantly affect charge generation and transport efficiency under light illumination. Although it is known that an optimally thin PbI_2 layer on perovskite crystals may enhance device performance, a detailed understanding of local electronic information regarding carrier generation and transport at the heterointerfaces of perovskite crystal grains and passivation layers still has not been achieved. In this work, a light-modulated scanning tunneling microscopy (LM-STM) technique was used to reveal the correlation between the nanoscale compositional distributions and interfacial electronic structures of the heterointerfaces between $CH_3NH_3PbI_3$ perovskite crystals and PbI_2 passivation layers. The unique advantage of the LM-STM technique is that it enables, for the first time, direct visualization of spatially resolved mapping images of electron and hole carrier photogeneration and photoinduced interfacial band bending of both valence and conduction bands at the PbI_2/perovskite interface of perovskite crystals under light illumination. In an investigation of the interfacial electronic configurations of individual perovskite grains under illumination, enhanced photogenerated carrier separation and reduced back recombination were observed when an optimal interfacial PbI_2 passivation layer with a thickness of less than 20 nm was applied to perovskite crystal grains. This work was published in *Nano Letters* (17, 1154-1160, 2017) as a collaboration between Professor Ya-Ping Chiu's group in the Department of Physics at NTU and Professor Chun-Wei Chen's group in the Department of Materials Science and Engineering at NTU.

Reference

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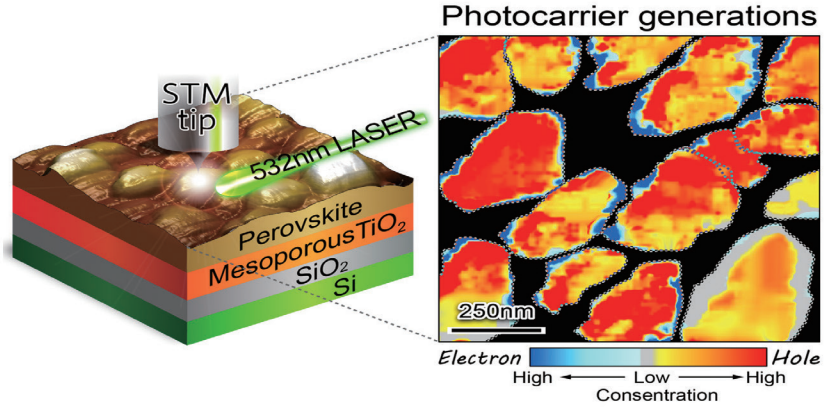

Photocarrier generation by perovskite solar cells, as determined by light-modulated scanning tunneling microscopy (LT-STM) measurements under illumination.