The Effect of Different AR Nanostructures on the Optical Performance of Organic–Inorganic Halide Perovskite Semiconductor Solar Cell

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Abstract: Nanostructures exhibit excellent antireflection (AR) properties allowing for broadband antireflection and increasing the light incoupling in solar cells. In this paper, the optical effect of different nanostructures on the front side of an organic–inorganic halide perovskite semiconductor solar cell is studied. The transfer matrix optical simulation method (TMM) will be used to model and simulate the solar cell while using the effective medium theory (EMT) to model the effective refractive indices of the nanostructures. By optimizing the height of each nanostructure, it was found that the moth-eye nanostructure had the best performance, reducing the reflection by ~ 7.8%, thus enhancing the optical current density by ~ 13.5% and increasing the overall efficiency by 2.22%. Additional optical analysis methods were used to analyze and characterize the effect of the added AR nanostructures such as the solar-weighted reflectance (SWE), the solar absorptance enhancement (SWR), current density loss analysis (JlossJloss), and finally, the spectral photovoltaic output (SPV).