Organic-based optoelectronic devices, such as organic photovoltaics (OPVs) promise as low-cost, large-area electro-optical devices and renewable energy sources. However, further improvement in efficiency remains a daunting challenge due to limited light absorption in conventional OPVs. To overcome this limitation, lightwave manipulation by using nanostructures is a promising strategy for enhancing the light absorption of thin photoactive layers in OPVs. In our previous study, we have reported a method for nanopatterning the multiple interfaces in bulk heterojunction (BHJ) OPVs by using soft imprint lithography at room temperature\cite{1}. The interfaces in the OPVs were separately modified in the front ZnO layers and the back metal electrodes with a grating pattern. Each nanopattern increased the light absorption and the power conversion efficiency of the OPVs by 7.7–32.5%. Moreover, the nanopatterning at both the front and the back cumulatively increased the light absorption, resulting in the highest efficiency increase of 10.2–38.5%. Even though, we achieved a high efficiency by introducing a nanopattern at both layers, we did not optimize a size of grating structure.

In this study, we introduced nanopatterns with various pattern pitch to investigate the effect of nanogratings in OPVs. Each nanopattern on photoactive layer which has a different pattern pitch increased the light absorption and the power conversion efficiency of the OPVs by 4.4–7.4% in PTB7:PC\textsubscript{71}BM system. Moreover, the nanopatterning at both the front and the back cumulatively increased the light absorption, resulting in the efficiency increase of 13.3–18.4%. Detailed analysis by using the absorption spectra, external quantum efficiency (EQE) spectra and optical simulations indicated that the origins of the optical gains from the nanopatterns on the front and the back are different. The front pattern increases the transmittance and the back pattern increases the scattering and excites the surface plasmon polaritons.

Reference