Improvement of power conversion efficiency of fullerenes-based polymer solar cells using microlens arrays

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Fullerenes-based polymer solar cells (PSC) are attracting much attention because they can be made light and flexible. However, due to low power conversion efficiency (PCE) compared to silicon-based solar cells, much research is underway to improve the PCE. In order to improve the PCE, researches have been conducted to introduce various physical structures such as microlens, wrinkle into PSC to control the optical path. Here, we fabricated the microlens of various diameter (0.5μm ~ 20um) and confirmed that the optical path and PCE can be dramatically increased with microlens array of optimum diameter.

The microlens array with various lens diameter were analyzed by UV-VIS-NIR spectrometer to examine optical properties. The total transmittance was almost the same regardless of the diameter of microlens, but the specular transmittance was decreased by increasing diameter of microlens. It indicated that the dispersed light increased with increasing microlens diameter. Specifically, we found that dispersive transmittance was similar above 7um of microlens diameter. The increase of dispersive light resulted in the enhancement of the light extinction in photoactive layer. Similar to dispersed light, the light extinction was similar from 7um or more. Then, we measured J-V characteristic under the condition of AM 1.5G, 100mW / cm2 to confirm the increase of dispersive light improve PCE in PSC. We observed that short circuit-current density (Jsc) increasesd with increasing microlens diameter. We also confirmed that the PCE increased by 12% compared with the PSC without microlens.