Enhanced Performance of Inverted Organic Solar Cell with Patterned Aluminum Foils via Anodization

Shih-Hsiang Tai,[1] Cherng-Rong Ho,[1] Kun-Tong Tsai,[1,2] Po-Kang Yang,[1] Der-Hsien Lien,[1] Yuh-Lin Wang[2] and Jr-Hau He[1*]

[1]Institute of Photonics and Optoelectronics, and Department of Electrical Engineering, National Taiwan University, Taipei 106, Taiwan
[2]Institute of Atomic and Molecular Sciences, Academia Sinica, Taipei, Taiwan

In recent years, the progress in molecular engineering has brought out a series of potential advantages of organic solar cells (OSCs) that might excel the silicon-based solar cells. However, up to now, the conversion efficiency of the OSCs is still much lower than the conventional solar cells and hence how to enhance it becomes the most urgent issue needed to be dealt with. To shorten the carrier collection pathway by optimizing the morphology of active layer is an effective way to improve the carrier-collection efficiency, e.g., fabricating an ordered bulk heterojunction structure.[1,2] In this study, we used nanoscale-pattern aluminum foil as rear electrode OSCs via a scalable anodization approach using DC current and subsequently wet etching to enhance the performance of OSCs. The geometry of the device is shown in Fig. 1. These three-dimensional nanostructures (Fig. 2) have been widely explored for efficient light trapping and strong light absorption.[3] Moreover, the employment of patterned aluminum electrode also decreases the amount of dead ends in the heterojunction area (donor or acceptor domains those are isolated and not connected with the electrodes), thus efficiently suppressing the carrier recombination rate. Moreover, we employed Chromium (Cr) as electrodes in inverted OSCs. It has been reported that for OSCs with inverted layer sequence, the material of the electron contact has a significant influence on the long term stability as compared with that employing usual layer sequence.[4] Accordingly, the device has demonstrated superior performance with the lower reflectance, improved conversion efficiency, and better stability as compared to the device using conventional sequence.

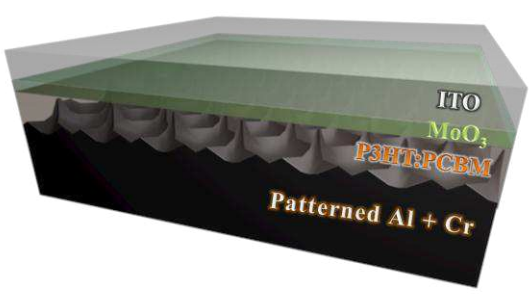

Figure 1. An illustration of the device geometry. The OSCs were fabricated using P3HT:PCBM as the active later, MoO_3 as the hole transport layer, Al and Cr as the rear electrode, and ITO as the top electrode.

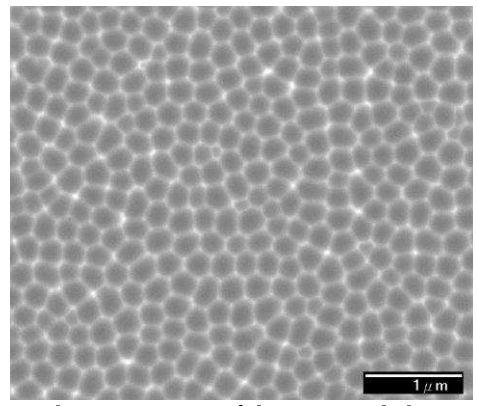

Figure 2. The SEM image of the patterned aluminum foil.

References

[1] J. H. Lee, D. W. Kim, H. Jang, J. K. Choi, J. Geng, J. W. Jung, S. C. Yoon, and H.-T. Jung, Small, 5, 2139–2143 (2009).

[2] J. E. Allen and C. T. Black, ACS Nano, 5, 7986–7991 (2011).

[3] R. Yu, K. Ching, Q. Lin, S. Leung, D. Arcrossito, and Z. Fan, ACS Nano, 5, 9291–9298 (2011).

[4] B. Zimmermann, U. Würfel, M. Niggemann, Sol. Energy Mater. Sol. Cells 93 491–496 (2009).