

Laser - combined STM study on bulk - hetero junction organic solar cell

T. Ochiai, N. Takeuchi, S. Yoshida, O. Takeuchi, H. Shigekawa

Institute of Applied of Physics, University of Tsukuba,

<http://dora.bk.tsukuba.ac.jp>

Solar-power-conversion efficiency of the bulk-heterojunction (BHJ) organic solar cell is largely governed by the nanoscale morphology of their active layer region. Therefore, simultaneous measurement of photoelectrical property and nanoscale morphology is crucial for optimizing their performance. In this study, we used “light modulated scanning tunneling spectroscopy” [1] to investigate the nanoscale photoelectrical property of a BHJ solar cell. This technique reveals local current-voltage characteristics of sample under illuminated and dark conditions with a nanoscale spatial resolution. A prototypical PCBM/MDMO-PPV BHJ solar cell was used for a sample. Figure 1 shows the sample structure. Active layer consisting of PCBM clusters and MDMO-PPV matrix, was formed by spin-coating on a PEDOT:PSS layer.

Figure 2 shows a dark current image of the sample obtained under a reversely biased condition ($V_s = -3.7V$). Due to the rectification of the p-n junction formed between PCBM and MDMO-PPV areas, no dark current flowed in the PCBM areas. Thus the dark areas correspond to PCBM clusters whose sizes are 200~300nm in diameter. In contrast, a photocurrent image under zero bias condition (Fig. 3) shows a large photocurrent in PCBM areas, which corresponds to the amount of carriers generated by the charge separation of excitons at the interface of MDMO-PPV/PCBM. The photocurrent variation observed in different PCBM clusters indicates a microscopic variation in solar cell performance caused by nanostructures. Furthermore, we observed photocurrent variation inside individual PCBM clusters. The result suggests that photocarrier extraction efficiency is varied with the lateral position of STM tip inside PCBM area.

[1] O. Takeuchi, S. Yoshida and H. Shigekawa, *Appl. Phys. Lett.* 84, 3463 (2004).

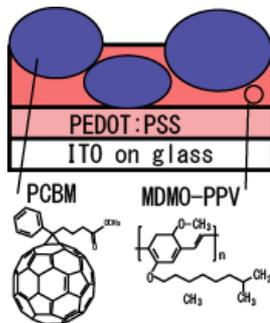


Figure 1 Schematic image of PCBM/MDMO-PPV BHJ.

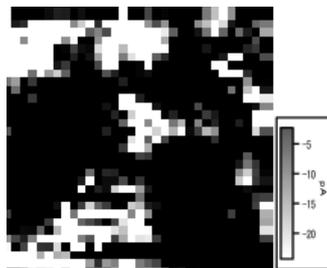


Figure 2 Dark current mapping for $V_s = -3.7V$.

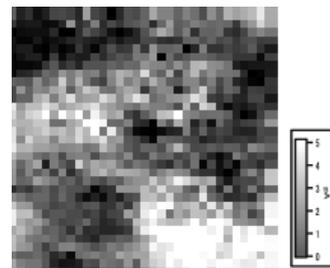


Figure 3 Photo current mapping for $V_s = 0V$