Novel Ordered Hetero Junction Organic Photovoltaics (OHJ-OPV) by multi-layered direct nanoimprint using buli-in electrode mold

Kohei Tomohiro[1], Kazuhiro Tada[2], Manabu Ishikawa[2], Naoki Nishikura[1], Hiroaki Kawata[1], Yoshihiko Hirai[1]

[1] Physics and Electronics Engineering, Osaka. Prefecture University, Sakai, Japan
[2]Toyama National College of Technology, Toyama, Japan
e-mail: hirai@pe.osakafu-u.ac.jp

Introduction

Organic Photovoltaics (OPV) is expected for electric power devices for flexibility personal electric devices. However, the power conversion efficiency is not sufficient for practical usages. To improve the conversion efficiency, Bulk Hetero Junction (BHJ) or Ordered Hetero Junction (OHJ) has been proposed[1,2)]. OHJ has advantage in eliminating electron-hole recombination due to ordered structure of PN junctions. However, organic functional material directly contacts with mold based on conventional fabrication process using nanoimprint lithography, which concerns impurity trapping or defect on P-N junction and causes degradation of power generation. We newly propose novel fabrication process to enhance power efficiency by expanding interface area of PN junction by multi-layered direct nanoimprint[3)] for novel hetero structured OPV.

Experiment and result

Figure 1 shows schematic of the proposed method. After spin coating PCBM on P3HT layer (Fig.1- a), thermal nanoimprint is performed for multi-layered PCBM/P3HT structure using novel built-in electrode mold (Fig.1-b). The mold is prepared using replicated polymer mold and metal thin films are coated on the surface. The built-in electrode polymer mold is directory imprinted to the PCBM/P3HT hetero structure as shown in Fig.1 –c). In the direct nanoimprint process, the substrate and the mold are sandwiched by thick polystyrene (PS) plate and pressed in vacuum ambient to seal the device, simultaneously as shown in Fig. 2. Using this process, junction area expansion and sealing are done at the same time and the de-molding process is skipped.

Figure 3 shows SEM view of the OHJ device after the bult-in mold is removed to confirm the device structure. The PCBM/P3HT boundary area is successfully expanded and Ordered Hetero Junction structure is confirmed.

Figure 3 and table 1 demonstrates electric characteristics of the OHJ device fabricated by this process. The current density is expanded up to 40% compared with conventional plane junction device, which is fabricated using flat built-in electrode mold without patterns.

As demonstrated above, the expanded interface structure of ordered hetero junction is successfully fabricated using multi-layered direct nanoimprint using built-in electrode mold and confirm photo current increment. The process also provides self-sealing during direct nanoimprint process under vacuum ambient without de-molding process.

References

1) D. Cheyns, et al., Nanotechnology **19** (2008) 4240161)
2) M. Zhou, et al., J. Vac. Sci. Technol. 28 (2010) C6M63.
3) T. Konishi, et al., Microelectronic Engineering 83 (2006) 869.

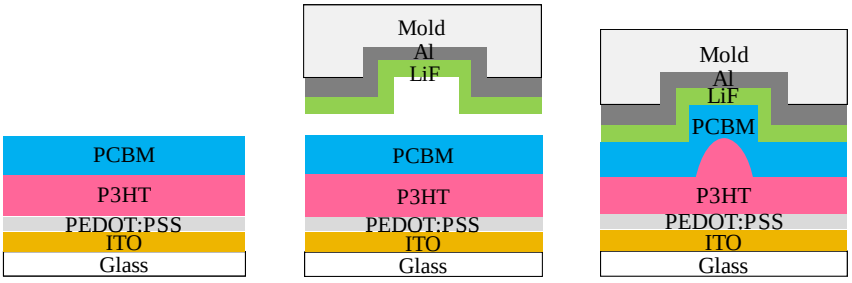

Fig.1 Multi-layered direct nanoimprint for ordered hetero junction OHJ using built-in electrode mold.

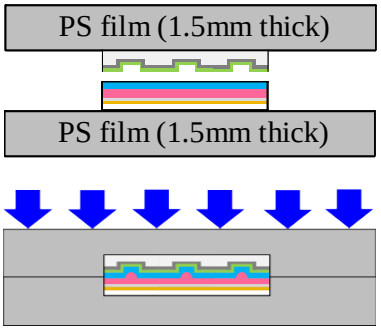

Fig. 2 Self-sealing using built-in mold.

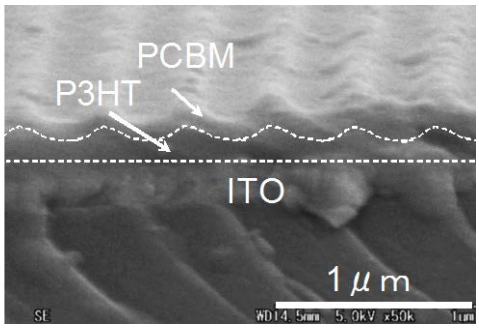

Fig.3 Cross-section of the OHJ

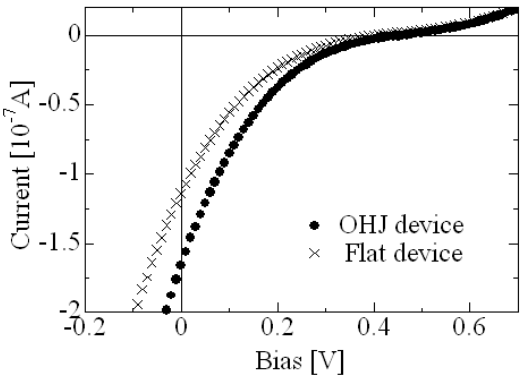

Fig.4 Electric characteristics of the OHJ-OPV

	Isc [uA]	Voc [V]	FF
Flat	1.14	0.41	0.12
Patterned	1.66	0.46	0.12

Table 1 Electric characteristics of the OHJ-OPV