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Morphology Control of P3HT:PCBM Blend Films Deposited by Electrospray Using High-Voltage Pulse

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Electrostatic spray deposition (ESD) technique is becoming more and more popular for preparation of nanoparticles, nanofibers, and polymer thin-films. Its capability of following even complicated surface contours provides means for establishing a whole new range of potential applications where direct integration of polymer electronic devices onto various substrates is needed. Our previous works indicate that electrospray deposited organic thin films with smooth surface facilitate the improvement of device performance [1]. Therefore, to further exploit and optimize the electrospray process, it is particularly necessary to clarify the evolution of droplets during the formation of organic films.

A high voltage pulsed power supply (Element, ETM3-20K01PN1) was utilized to generate pulsed voltage with varied intervals. A glass capillary with inner diameter of 50 μm and an indium tin oxide coated glass substrate were used as nozzle and counter electrode, respectively. P3HT:PCBM blend solution (1.2:1.0 by weight) used for electrospray deposition was prepared using *o*-dichlorobenzene (1 mg/ml).

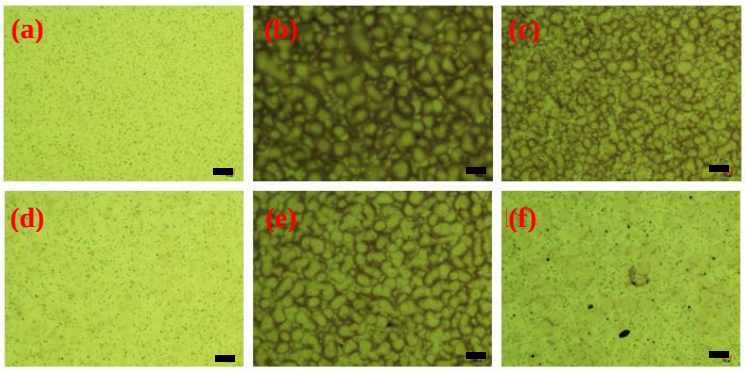

Fig. 1. Optical microscope images of P3HT:PCBM films. All the scale bars represent 20 μm. (a), (b), (c) were deposited under 4.25 kV, 4.5 kV, and 4.75 kV respectively with interval of 1 sec; (d), (e), (f) were deposited under 4.25 kV, 4.5 kV, and 4.75 kV respectively with interval of 4 sec.

Figure 1 clearly shows the effect of interval on the morphology of P3HT:PCBM films. Only some aggregates can be observed from Figs. 1(a) and 1(d), which can be attributed to the evaporation of solvent in droplet before reaching the substrate. Compared with Figs. 1(b) and 1(e), droplets tend to merged with adjacent ones to form one lager droplet during the long interval after they reached the substrate. As for Fig. 1(f), the P3HT:PCBM thin film become drier than Fig. 1(e) due to the smaller size of droplets (shown in Fig. 1(c)) produced under the higher voltage.

It is can be concluded that the puled voltage is a particularly useful tool to analyze the evaporation of solvent for the ESD process. Optical microscope images of samples deposited with different intervals provide details of the evolution for droplet before the formation of film. This study may also be applied to the investigation of morphology for multilayer structure fabricated by ESD process.

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[1]T. Fukuda, et al., Thin Solid Films vol.520 (2011) 600.