Polymer Nanostructures for Nanostructured Organic Solar Cell Applications

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The synthesis and application of nanostructures in organic solar cells have attracted much attention caused by the potentially low manufacturing cost and by the flexibility of the cells.

It is expected that nanostructured solar cells will have some advantages over standard bulk-heterojunction solar cells such as a full control over the structure, wide interface area between the active materials, proper exciton dissociation interface without sacrificing path for carriers collection, spatially uninterrupted paths to electrodes, reduction of charges carriers lost by recombination, light trapping approaches can significantly enhanced of the absorption. The advantages mentioned previously allows to improve the electrical characteristics of device (i.e. open circuit voltage, fill factor, current density and power conversion efficiency) [1-3].

Different synthesis methods have been proposed for the fabrication of polymer nanostructures, such as template-assisted, nanoimprinting, nanolithography and electro-spinning. Among them, template-assisted is an easy, low cost and highly versatile method. In this work, we have used nanoporous anodic alumina (NAAs) as hard-template. The nanoporous anodic alumina templates is a material widely used because the self-ordered nanopore arrangement can be easily transferred to other materials, the geometric characteristics can be easily tuned (e.g. pore diameter, pore length, and porosity) and offer a higher thermal and mechanical stability [4-5].

The fabrications of NAATs were prepared by two-step anodization process of aluminium in a phosphoric acidic solution [5-6]. The polymeric materials used to fabricate the nanostructures were P3HT, PBDTTT-CF and PTB1. The polymer nanostructures were deposited on glass / ITO (indium tin oxide) / PEDOT:PSS (Poly-(Ethylene dioxythiophene) doped with Poly-(Styrene Sulphonic acid) with thickness of 120 nm and 30 nm, respectively. The resulting nanostructures were analyzed in detail through of environmental scanning electron microscopy (ESEM), photoluminescence and UV/visible absorption spectra. The polymeric nanostructures presents an average support base between 260 nm and 300 nm, the height pillar from 380 nm to 500 nm, diameter of pillar from 150 nm to 200 nm and the distance interpore from 450 nm to 500 nm. Figure 1 shows the top and cross section view for each type of polymeric nanostructured fabricated. The resulting P3HT, PBDTTT-CF and PTB1 nanostructures were used to fabricated nanostructured polymer solar cells. The polymer nanostructures will have great potential applications in the fields of optoelectronic and sensor devices.

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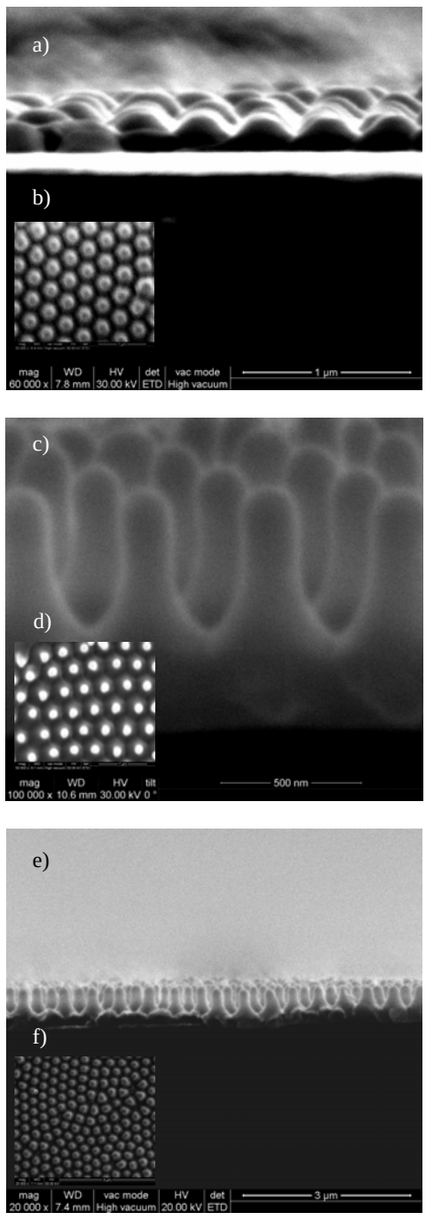

Fig. 1. ESEM images of cross-sectional (a, c, e) and top view (b, d, f) of the nanostructures P3HT, PBDTTT-CF and PTB1, respectively. These nanostructures were placed on prepared layers of PEDOT:PSS/ITO substrates.

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