

Nanostructure Designing of C₆₀/Poly(3-hexylthiophene) Supramolecular on Au(111) Surfaces via Iodine Modification

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The performance of organic semiconductor devices depends to a great extent on the arrangement and conductivity of molecules adsorbed on metal substrate surfaces. A major challenge in the creation of well-ordered, supramolecular nanostructures are strong interactions between adsorbent and metal which often lead to poorly ordered adlayer phases. It, therefore, is very important to develop new techniques to produce organic semiconductor films with desired properties. We could succeed to fabricate well-ordered, supramolecular C₆₀/poly(3-hexylthiophene) (P3HT) nanostructures on Iodine-modified Au(111) surfaces. A bottom-up strategy to halide-pretreated single-crystal electrodes in the solution phase has been used because it is a simple and effective approach to fabricate defect-free, nanostructured, and bicontinuous composite-monolayers with exceptional conductivity. The p-type semiconductive polymer, P3HT, has widely been studied, but it has a problem to form randomly oriented and/or curvy-wire morphology on a bare Au(111) electrode. To overcome these problems, we have used iodine-modified Au(111) substrates to let the polymer chains stack and fold into well-organized arrays of two-dimensional, linear architectures with large, ordered domains. At sufficiently negative electrode potentials, electrons transfer from P3HT to iodine leading to iodine desorption and p-doping of the P3HT adlayer. As a consequence, the Fermi level shifts 0.16V toward the HOMO position. This p-doped P3HT monolayer exhibits strong donor-acceptor interactions with n-type materials, like C₆₀. Therefore, a stable C₆₀/P3HT supramolecular nanostructure could be fabricated on Au(111) surfaces. It exhibits high conductivity which can resist a comparatively large potential change from 1V to 0V. In contrast to previous studies, the nanostructures produced by the present method have a high degree of ordering. Furthermore, the preparation from the solution phase is cost-effective, easy to perform and fast compared to the UHV technique commonly employed in the literature. These results clearly demonstrate the potential for the synthesis of highly ordered supramolecular nanostructures in three dimensions.