

The influence of ZnO nanostructures on the structure, optical and photovoltaic properties of organic materials

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Abstract

Hexagonally shaped zinc-oxide (ZnO) nanorods were synthesized by a simple hydrothermal route. These nanorods were incorporated in a polymer matrix to study the optical and structural properties, improved nanoscale morphology, charge transfer and photovoltaic properties of the poly(3-hexylthiophene) P3HT:ZnO blended films using light harvesting by UV-vis analysis, X-ray diffraction analysis, atomic force microscopy examination, photoluminescence and device efficiency measurements under the optimal conditions. A significant red-shift on the extinction coefficient peak and an improved absorption were demonstrated upon incorporating the nanorods in the polymer matrix indicating enhanced photon harvesting. Photoluminescence studies revealed an incomplete charge transfer for the 1:2 and 1:4 weight ratios, while a complete charge transfer was demonstrated for the 1:1 wt. ratio due to improved interfacial area between the polymer and ZnO materials in the active layer. The formation of "cone-like" structures on the film surfaces enhances the contact area between active layer and metal electrode in the active layer and subsequently, contributes to increased light absorption and improved carrier mobility. The photovoltaic device structure fabricated from the 1:1 wt. ratio exhibits power conversion efficiency as high as 1.40% under AM 1.5 illumination with 100 mW/cm² light intensity.