

Comparative study: the effect of annealing conditions on the properties of P3HT:PCBM blends

David E. Motaung · Gerald F. Malgas · Steven S. Nkosi · Gugu H. Mhlongo ·
Bonex W. Mwakikunga · Thomas Malwela · Christopher J. Arendse ·
Theophilus F. G. Muller · Franscious R. Cummings

Abstract

This paper presents a detailed study on the role of various annealing treatments on organic poly(3-hexylthiophene) and [6]-phenyl-C61-butyric acid methyl ester blends under different experimental conditions. A combination of analytical tools is used to study the alteration of the phase separation, structure and photovoltaic properties of the P3HT: PCBM blend during the annealing process. Results showed that the thermal annealing yields PCBM “needle-like” crystals and that prolonged heat treatment leads to extensive phase separation, as demonstrated by the growth in the size and quantity of PCBM crystals. The substrate annealing method demonstrated an optimal morphology by eradicating and suppressing the formation of fullerene clusters across the film, resulting in longer P3HT fibrils with smaller diameter. Improved optical constants, PL quenching and a decrease in the P3HT optical band-gap were demonstrated for the substrate annealed films due to the limited diffusion of the PCBM molecules. An effective strategy for determining an optimized morphology through substrate annealing treatment is therefore revealed for improved device efficiency.