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Title

Dark Carriers, Trapping, and Activation Control of Carrier Recombination in Neat P3HT and P3HT:PCBM Blends

Source

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Abstract

Using flash photolysis, time-resolved microwave conductivity we report the sub-200 ns photoconductivity transients for neat poly(3-hexylthiophene), P3HT, and four associated blends containing 1%, 5%, 20%, and 50%, by weight, of the soluble fullerene, [6,6]-phenyl-c(61)-butyric acid methyl ester, PCBM. We propose a detailed kinetic scheme that when solved numerically is consistent with all the data recorded as a function of excitation density and that describes the fate of mobile and trapped carriers in the system. In the neat polymer, mobile holes are the only contributor to the photoconductance transients, which decay according to first-order kinetics at all light intensities due to the presence of a large concentration of dark carriers present in he polymer. The signal decays with a characteristic rate constant (similar to 1 x 10(7) s(-1)) that describes the re-equilibration of trapped a id mobile holes. In all four blends, the microwave absorption contains a significant contribution due to electrons in the PCBM clusters, even at the lowest blend ratio of 1%. The magnitude of the second-order rate coefficient, gamma(b), for carrier recombination in all four blends (3.25 x 10(-12) cm(3) s(-1) < gamma(b) < 10 x 10(-12) cm(3) s(-1)), and also that identified for the neat polymer, corresponds to a slow process that is not limited by diffusion but is activation controlled.