Transient optical studies of charge recombination dynamics in PPV/C60 blends: the influence of laser intensity

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Organic bulk heterojunctions are currently attracting attention for low cost plastic photovoltaic cells. Devices fabricated from conjugated polymer / methanofullerenes blends MDMO-PPV / PCBM have been reported with energy conversion efficiencies of up to 2.5 %[1]. A key issue in the development of such devices is the blending of the electron and hole transporting materials on the nanometer scale. This blending is essential to ensure efficient charge separation, with exciton diffusion lengths in such molecular materials being of the order of 10 nm. A downside of this blending is that photogenerated electrons and holes may not spatially be well separated, resulting in recombination losses being a key factor limiting device performance.

In this paper we will employ nanosecond to millisecond transient absorption spectroscopy to monitor the recombination dynamics of photogenerated polarons in MDMO-PPV / PCBM blends at room temperature. Following pulsed laser excitation, an absorption increase is observed in the near-infrared, with a spectrum characteristic of induced absorption of positive PPV polarons. Typical decay dynamics of this photoinduced absorption are shown in figure 1. The long time decay dynamics are found to be remarkably insensitive to laser power, with both the amplitude and temporal shape of the microsecond – millisecond decay being essentially independent of laser intensities for intensities from 1 to 80 $\mu J\ cm^{-2}$ or (2.5 to 200 x 10^{12} photons cm^{-2}). In contrast, at early times (< 1 μs), the data is observed to be strongly laser intensity dependent, with a fast (< 20 ns) decay component being observed for laser intensities > 2 $\mu J\ cm^{-2}$.

In our paper, we will discuss the origin of the observed intensity dependence of the recombination dynamics. Experiments will be extended to comparison of different blend deposition conditions, blend composition, and comparison with control data on pristine MDMO-PPV, and discussed in terms of their relevance to the function of PPV/C60 based photovoltaic devices.

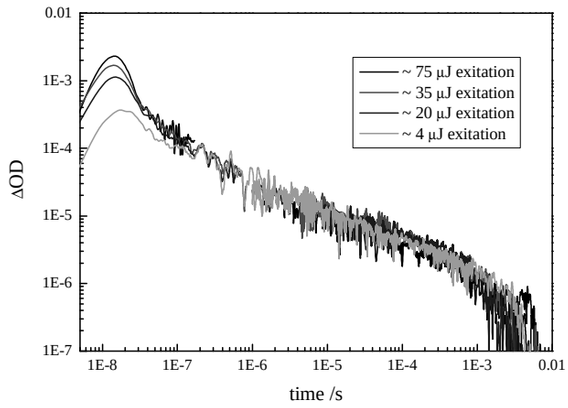

Figure 1. Transient kinetics of the photoinduced absorption change observed at 830 nm for 50:50 MDMO-PPV / PCBM films at room temperature following excitation at 500 nm. Data are shown for four different excitation intensities per cm^2 as indicated.

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References.

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