

Abstract

Measurements of Spin-Dependent Exciton Formation Cross-Sections in pi-Conjugated Oligomers and Polymers

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The spin dependent exciton formation cross-sections are directly related to the singlet exciton yield in organic LEDs (OLED), which determines the maximum quantum efficiency for OLEDs. We report on an experimental study of the ratio $r = \sigma_S/\sigma_T$. Here σ_S is the formation cross-section of the singlet exciton channel and σ_T is the cross-section of any one of the three triplet exciton channels in the charge-transfer reaction between spin 1/2 positive and negative polarons. We developed an all-optical technique for measuring r , which combines steady state photoinduced absorption (PA) and a spin-dependent recombination technique, namely PA-detected magnetic resonance (PADMR). Upon magnetic resonance the PADMR spectra generally show a reduction of polaron and triplet populations, and a single positive band that we assign to enhanced singlet population. This directly demonstrates that $r > 1$ in pi-conjugated polymers. Moreover the fractional reduction, d_n/n in polaron density, n is directly related to r . We have obtained r for a large variety of pi-conjugated oligomers and polymers and studied the dependencies of r on optical gap and conjugation length, CL. We use a direct and universal spectroscopic method, which we developed, to determine the average CL of a polymer. Our main result is the discovery of a universal relationship between r and CL largely independent of backbone and sidegroup structure. Our results also show that polymers have an advantage over small molecules for their use in OLED. We advance possible explanations for the universal dependence $r(\text{CL})$.

[¶]Presenter