

Electric field-induced modification of photoluminescent properties in polyfluorene thin films

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Poly(9,9-dioctylfluorene), i.e., polyfluorene (PFO) and its derivatives have emerged as especially attractive conjugated polymers due to their strong blue light emission (blue OLEDs) and excellent electronic properties, which bears large extinction coefficient, high fluorescence quantum yield and high hole mobility, that show great prospect for device application. Such applications rely on injection and transport of charge carriers.

Electroabsorption (E-A) and electrophotoluminescence (E-F) spectra of thin films of blue-light-emitting PFO have been measured at temperatures ranging from 25 to 295 K to examine both the optical property and excitation dynamics of these films in the presence of external electric fields of 0 - 1.2 MV cm⁻¹. The applied electric field induces a spectral shift of absorption and photoluminescence (PL) spectra of PFO to yield a line shape represented by the first derivative of absorption and the PL spectra, respectively, indicating that the molecular polarizability is different between the excited and ground states. Electric field effects on excitation dynamics depend on not only applied field strength but also excitation wavelength and temperature (Figs 1-3). With excitation into lower excited states (i.e. at 344 nm or 402 nm excitation), the PL intensity is unaffected by F when the applied field strength is as low as 0.4 MVcm⁻¹(Fig. 1), indicating that the relaxation rate of the emitting state are unaffected by F . At low electric fields, only the Stark shift was observed. As the applied field becomes stronger, however, the PL of PFO films is quenched by F even with excitation into

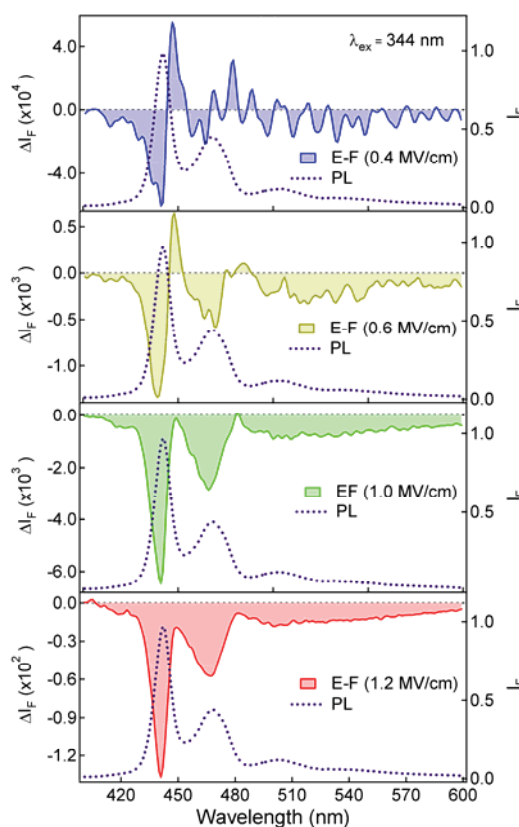


Fig. 1: E-F spectra as well as PL spectra of PFO film obtained with 344-nm excitation at different field strengths in the region of 0.4 - 1.2 MV cm⁻¹. The maximum PL intensity is normalized to unity in every case.

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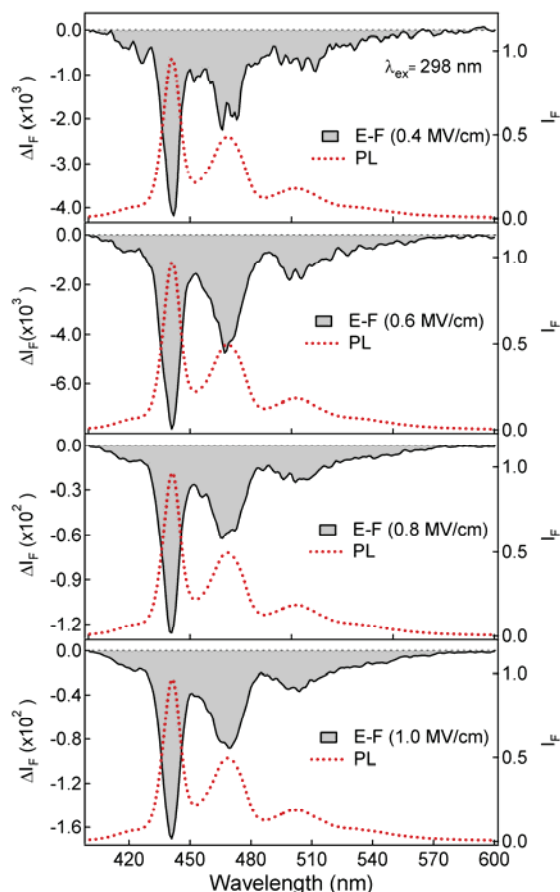


Fig. 2: E-F spectra as well as PL spectra of PFO film obtained with 298-nm excitation at various field strengths in the region of 0.4 - 1.0 MV cm⁻¹. The maximum PL intensity is normalized to unity in every case.

PL quenching at higher excited states is nearly independent of temperature. The direct measurements of the field-induced change in emission decay profile confirm that fluorescence quenching arises from a decreased initial population of the emitting species in both mechanisms. The present study is strongly related to a quest for high performance of molecular devices, e.g., for the design and development of efficient and stable light-emitting devices.

References: M.S. Mehata, C.S Hsu, Y.P. Lee, N. Ohta, *J. Phys. Chem. C*, 113 (2009) 11907. M. S. Mehata, T. Imori, N. Ohta, *Chem. Phys. Lett.* 457 (2008) 62.

low excited states. This quenching is ascribed to the field-assisted generation of hole-electron pairs followed by efficient charge transport. With excitation into higher excited states (Fig. 2), i.e. at 298 nm excitation, the PL of PFO is quenched even when the applied field is weak, and the magnitude of the quenching increases with increasing field strength, which could be ascribed to the electron-transfer from highly excited state through the orbital-overlap.

The field-induced quenching of PL at the low excited state is less efficient with the decrease of temperature (Fig. 3), whereas the

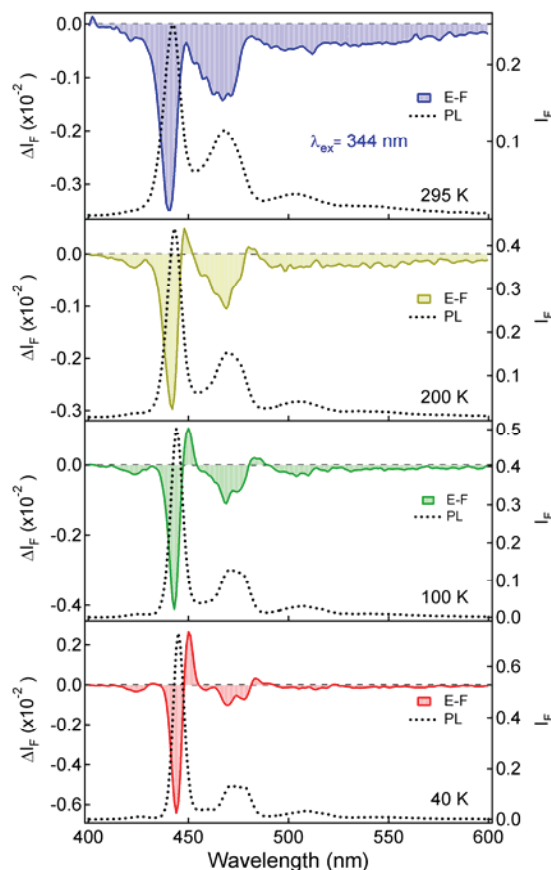


Fig. 3: E-F spectra as well as PL spectra of PFO film obtained with 344-nm excitation at various temperatures. The applied field strength is 1.2 MV cm⁻¹.