Title: Molecular Engineered Conjugated Polymers for High-Performance Light-Emitting Diodes (LEDS)

Type: Student

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Description: The operation of polymer LEDs involves the injections of both holes and electrons from opposite electrodes, their transport in the bulk material, recombination to form excitons, and the radiative decay of the singlet excitons. Since the mobility of electrons and holes in most conjugated polymers are quite different, under a high operating electric field (> 10^5 V/cm), a large percentage of the higher mobility carriers can be swept through the polymer without forming excitons, resulting in a low light emission. Therefore, an important task for achieving efficient LEDs is to maximize the recombination of injected charge carriers before they get discharged at the electrodes. In an effort to improve charge capture efficiency, a series of fluorine based copolymers (PF9-DTS, PF19-DTS, PF9-TCNPT, PF9-FCNPF, PF-TCNPT-CNP) with a small amount (less than 10 mol-%) randomly distributed electron-deficient low bandgap moieties were developed. These lower-energy moieties with electron-deficient nature are designed to increase electron-affinity of the resulting polymers and to facilitate charge recombination through their function as charge trapping sites for both holes and electrons. In addition to direct or sequential trapping of electrons and holes on these lower-energy sites, the excitons formed on higher-energy segments will also transfer to these lower-energy sites via the Förster energy transfer process. This will increase the device efficiency by read-shifting the emission band to achieve lower self-absorption loss. Typically, the maximum distance for Förster energy transfer to occur is 3-5 nm. In order to have efficient Förster energy transfer, the distance between the higher-energy segments and lower-energy segments should fall within this range. In our studies, the incorporation ratios of the lower-energy monomers were fine-tuned to optimize the charge trapping, charge transporting, and energy transfer properties. Bright green emission was obtained from these copolymers, which could be attributed to the efficient Förster energy transfer and balanced charge injection and transport.