

Morphological Control of an Amphiphilic Polyfluorene and the Effects on Device Performance  
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Soluble light emitting polymers are appealing for large area and low cost manufactures of light emitting devices.[1] In recent years, screen and inkjet printing have been successfully applied to this area, promising even lower cost for area lighting, patterning and display applications.[2, 3] In these processes, polymer and solvent properties are very important factors for optimizing device performance.[4-6] In this paper, poly(2,7-9,9-di(oxy-2,5,8-trioxadecane))fluorene (PFO) (Figure 1) with polar triethyleneoxide monomethyl ether side chains was synthesized to study the correlation between morphology and device performance. In this amphiphilic polymer system, the tendency of aggregation is much higher than its lipid side chain poly(9,9-dihexylfluorene). Different types of aggregation such as micelle and revised micelle can be controlled easily by changing solvent systems.[7]

The side chains and backbone of PFO will preferably aggregate in different solvents. At low concentration (<1%), the PFO polymer molecules are separated.[7] With increasing concentration, the surfactant property of selective aggregation starts to develop and form different aggregation depending on the solvent properties, which transformed into film state by spin coating or printing process. Chloroform and chlorobenzene are the two different types of solvent systems being used in this study, and they have resulted in two completely different aggregation. Chloroform is a polar solvent, which selectively solvates side chains and leaves the backbone to aggregate. In contrast, chlorobenzene is a weak polar aromatic solvent, which prefers to interact with the conjugated polyfluorene backbone through  $\pi$ - $\pi$  stacking interaction.[6] When chloroform is used, the polyfluorene backbones aggregate first and the side chains spread out in the solvent. Eventually a film was formed with backbones closely associated with the cores of agglomerate. Therefore, the conjugated backbones are isolated from other aggregates by the side chains. However, chlorobenzene promotes an opposite aggregation pattern with side chains associate first during spin coating, leaving the backbones exposed. This structural difference is mainly responsible for the different device behaviors.

The polymer light emitting diodes fabricated from PFO polymer have the configuration of ITO/PEDOT/PSS/PFO/Al. Figure 2 shows the performances of two different spin coated PFO devices using either chlorobenzene solution (chlorobenzene device) or chloroform solution (chloroform device). The chlorobenzene device gives much better light intensity and better film conductivity than the chloroform devices. When chlorobenzene is used, the aggregation of side chains forces the polyfluorene backbone to expose. This morphology ensures polymer backbones to be accessible to each other from different agglomerates. Therefore the charge and exciton movements are enhanced, lowering film resistance and decreasing the chance of excitons being trapped in any defect sites. On the contrary, the insulating side chains are exposed when chloroform is used as solvent. The side chains shield the backbone from close interactions with other agglomerates, resulting in higher film resistance. Both charges and excitons are

likely to be trapped in these aggregates, increasing the chance of non-emissive radiation

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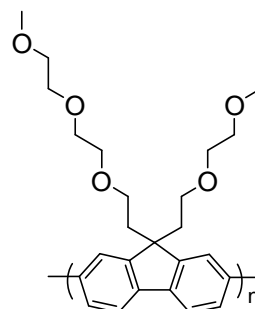


Figure 1. Molecular structure of amphiphilic PFO.

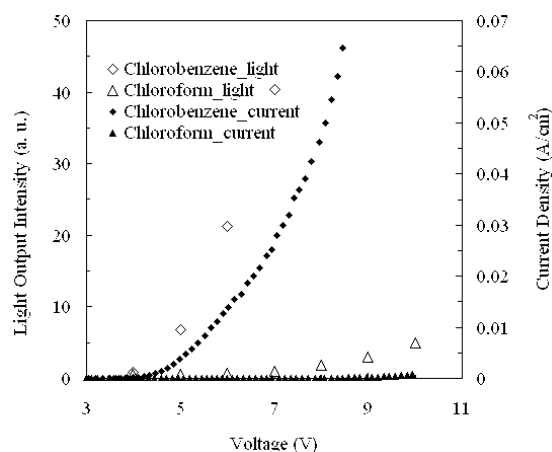


Figure 2. Current\_voltage and light output\_voltage dependences of PFO devices spin coated from chlorobenzene and chloroform solutions.

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