Supramolecular Semiconductor Materials for Organic Electronics

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Over the past decades, organic semiconducting materials (OSMs) have been actively investigated as an alternative to conventional inorganic materials in many optoelectronic applications. In order to replace inorganic semiconductors, OSMs need to render high photoluminescence and fluorescence quantum yield in the solid state, as well a better balance between the injection and transport of electrons and holes. Although tremendous effort has been devoted to tune OSMs's photophysical and charge-transport properties through molecular design, undesirable intermolecular interactions, considerably limit the application of these materials. The construction of mechanically interlocked assemblies such as pseudopolyrotaxane and polyrotaxane architectures has been employed as a powerful method to control the intermolecular interactions and to optimize OSMs optical and electronic properties [1-3]. These supramolecular architectures diminish the aggregation tendency and offer a way of constructing a better protective sheath around the conjugated chains.

Herein, we continue to provide extensive insights into the effect of macrocyclic encapsulations on the photophysical, surface morphology, wetting properties, as well as film forming ability of poly(3,4-ethylenedioxythiophene) (PEDOT), conjugated polyazomethines (PAMs), polythiophenes (PTs), and polyfluorenes (PFs) homo- or copolymers. The reported results have shown the beneficial effect of encapsulation resulting in the diminishing of interchain interactions and packing in insulated molecular wires. For the sake of comparison, the photophysical properties of these supramolecular OSMs were compared to those of their nonthreaded homologs. These findings provided a clear information about improvements of photophysical and transport properties of such encapsulated compounds relevant to applications where the prevention of luminescence quenching without hindering charge transport is essential. Meanwhile, recent achievements obtained by exploiting these supramolecular materials in optoelectronics will be highlighted.

With this study, we hope to provide further evidence and an opportunity to accurately quantify the effect of encapsulation on the solubility, photophysical and transport properties of OSMs, which exhibit a crucial importance for further development of organic electronics and represent a key bottom-up strategy to build and process relatively soft functional materials.

Keywords: Organic semiconductors, polyrotaxanes, quantum efficiency, surface morphology, monolayers, optoelectronics

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