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A soluble and fluorescent new type thienylpyrrole based conjugated polymer: optical, electrical and electrochemical properties

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Recently, increased attention has been focused on the synthesis of soluble and processable conducting polymers due to interest in their potential application. For this purpose a new type electroactive 2,5-di(2-thienyl)pyrrole derivative was synthesized and its novel solution-processable and fluorescent polymer, namely poly(*N*-(2,5-di(thiophen-2-yl)-1*H*-pyrrol-1-yl)-3,4,5-tris(dodecyloxy)benzamide) (P(TPDOB)), was electrochemically synthesized. Characterization of the monomer and the polymer was performed by ^{1}H-NMR, ^{13}C-NMR, cyclic voltammetry, and UV-vis and fluorescence spectroscopy. This soluble polymer has very well-defined and reversible redox processes in the acetonitrile–lithium perchlorate (ACN/$LiClO_4$) couple. Moreover, P(TPDOB) shows multielectrochromic behavior: blue in the oxidized state, caesious in the intermediate state and greenish in the neutral state. Also the copolymer consists of EDOT and TPDOB was synthesized by cyclic voltammetry. A copolymer film has superior electrochromic and electrical properties when compared with a homopolymer. Furthermore, the fluorescence features of the monomer and the polymer were investigated. Although the monomer is a violet light emitter, its polymer is a yellow light emitter. Synthesis of this new type solution-processable and fluorescent conducting polymer is an alternative to the conventional synthesis of soluble conducting polymers which allows the direct application of the conductive polymer to any desired surface for potential technological applications.

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1. Introduction

There has been great interest in the area of conjugated polymers (CPs) which display a wide range of applications during the last three decades. Among these, polythiophenes, a versatile class of CPs, are still of growing interest due to their potential applications in the development of new materials such as light emitting diodes (LEDs),[1,2] photovoltaics[3] and transistors.[4] In particular, they have been envisioned as one of the most useful electrochromes for high performance innovative devices,[5] sensors,[6] electrochromic devices,[7–9] smart windows,[10] mirrors[11] and camouflage materials.[12]

Although conducting polymers have various potential applications, the lack of solubility is an impediment in their direct application.[13,14] So, their insolubility and infusibility restricted their use. This essential problem has been overcome by preparing hybrid materials in which the properties of different compounds could be combined.[13] With the discovery of soluble derivatives, conjugated polymers have become one of the major research topics. For instance, Ferraris *et al.* obtained soluble and conducting polymers *via* various techniques of α-linked thienylpyrrole ring systems with alkyl substituents on the position of the central pyrrole ring.[15] The following studies of Ferraris *et al.* and Toppare *et al.* mainly focused on the elucidation of both the electrochemical and optical properties of *N*-substituted polythienylpyrroles.[16–18] Electropolymerizations of monomers derived from 2,5-di(2-thienyl)-pyrroles are also frequently reported by other authors.[19,20] The corresponding conducting polymers containing aromatic tailoring

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