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Eco-friendly ionic push-pull polythiophenes: synthesis, study and fabrication of halogen-free BHJ organic solar cells

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Recently, to solve the rising quest for green and clean form of energy, several studies have been conducted to exploit solar power as an alternative source. To make this possible with sustainable costs, organic photovoltaic solar cells (OPVs) based on polymeric photoactive layer have been extensively studied. However, it is well-known that for the design and, above all, processing of these semiconductor organic materials a large amount of aromatic and/or chlorinated solvents is usually required.1-2

In the last decades, ionic and thus water/alcohol-soluble polymeric materials have mainly found applications as biosensors, but they could also be exploited in OPV devices as electron-donor (ED) photoactive systems or charge carriers. Indeed, due to the effective combination of excellent intrinsic optoelectronic properties with unique solubilities, completely green organic solar cells could be developed. In particular, the synthesis of water/alcohol-soluble conjugated polymers containing both ED and electron-acceptor (EA) units in the main chain, represent a promising and interesting solution to the use of fullerene derivatives in Bulk Hetero-Junction (BHJ) devices. Moreover, low-bandgap materials and more favorable high-lying HOMO (highest occupied molecular orbital) and low-lying LUMO (lowest unoccupied molecular orbital) energy levels, may be obtained.3-4

A novel family of fully conjugated “in chain” D-A ionic polymers (P1a-b and P2a-b) soluble in water/polar solutions has been therefore synthesized, to obtain completely halogen-free BHJ solar cells. The chemical, optoelectronic properties and morphology of all compounds have been widely investigated by means of nuclear magnetic resonance (1H-NMR, 13C-NMR and 31P-NMR), optical spectroscopy (UV-Vis and FT-IR), electrochemistry (CV) and microscopy (AFM and SEM). We tested and confirmed the bifunctional photoactive behavior of active blends formed by the new functionalized polymers, employed as ED or EA photoactive materials with a serinol-fullerene derivative (C60-Ser) or an ionic homopolymer (PT6buP) (Figure 1), respectively, which are alcohol soluble as well.

Biography

Dr. Martina Marinelli is a Post-Doc Researcher at the University of Bologna, Department of Industrial Chemistry “Toso Montanari” and she conducts her research on Semiconducting Polymers. The main research topics concern the design and preparation of alcohol/water-soluble thiophene or fluorene-based materials (small-molecules or polymers), starting from the synthesis, full characterization and final application in organic solar cells or biomedical systems.