

Abstract

The research on π -conjugated semiconducting and luminescent polymers have attracted much attention in the recent past due to their emerging smart applications such as chemosensing towards heavy and toxic metal ions and biological analytes, photovoltaic solar cells (BHJ and DSSC), organic field-effect transistors (OFETs) and organic light emitting diodes (OLEDs). Fascinated by the current research trend on this exciting field, a series of π -conjugated homopolymers and A-*alt*-B type copolymers consisting of benzothieno-imidazole and carbazole moiety have been designed and developed for the selective and sensitive recognition of heavy metal ions including Cu^{2+} and toxic Hg^{2+} with a sub-micromolar detection level. The transition metal ions (Cu^{2+} and Fe^{3+}) coordinated metallopolymer show high selectivity towards amino acids and adenosine 5'-triphosphate (ATP) through fluorescence *turn-on* strategy as a result of stable Cu(II)-amino acid binary complex and stronger electrostatic interaction between positively charged Fe^{3+} -coordinated metallopolymer with ATP (than that of ADP or AMP). The limit of detection of the metal containing π -conjugated probes towards amino acid and ATP was found to be in ppb level with high association constant in the order of 10^5 M^{-1} . The detail sensing study has been demonstrated to understand the insight of the sensing mechanism. Most interestingly, 1,2,3-triazole functionalized polythiophene based π -conjugated emissive polymers have been successfully explored for trace detection of nitroaromatics (NACs) both in solution and solid state. The reversible fluorescent probes exhibit *nanomolar* detection of picric acid in contact mode by naked eye, demonstrating its practical utility as quick and inexpensive way detection of trace NACs. Furthermore, diketopyrrolopyrrole and perylene diimide based A-*alt*-B type π -conjugated alternating copolymers have been designed and synthesized for the polymer sensitized solar cells (PSSCs). All the D- π -A based π -conjugated polymers exhibited high reproducibility with power conversion efficiencies upto 3% with good stability up to 60 h. Moreover, the inclusion of fluoroalkyl side chain enhances the internal dipole moment within the polymer backbone, providing less charge recombination and higher photovoltaic performance. The design and synthesis of the soluble π -conjugated polymers developed in this doctoral thesis will certainly help to further development of new functional smart materials in sensory and optoelectronics application.

Keywords: π -Conjugated polymer, GRIM polymerization, A-*alt*-B type copolymer, Benzodithieno-imidazole, Triazole, Diketopyrrolopyrrole (DPP), Perylene-diimide (PDI), Fluorescent probes, *Turn-off* sensing, NACs detection, Amino acid detection, Toxic metal ion detection, Pyrophosphate recognition, Selectivity and sensitivity, Trace detection, Repeatability, *Molecular wire* effect, D- π -A, Polymer sensitized solar cells (PSSC), Low-band gap, IPCE.