ABSTRACT

The ever-expanding use of polyurethane (PU) in varied application demands for continuous improvements in mechanical, optical, biological, abrasion resistance properties, so as to endure increasingly stringent conditions. However, its poor thermal stability, barrier properties, high combustibility, solvent resistance and insulating behavior restricts its application. Therefore, more investigations are needed to overcome these limitations. In view of this, the present work is focused on the development and characterization of PU nanocomposites and nanoblends by incorporating layered double hydroxide (LDH), polypyrrole and gold nanoparticles.

The work involved the investigations on the effect of organomodifier (dodecyl sulfate-DS and stearate-St), extent of dispersion and amount of LDHs on various physicochemical properties of PU/LDHs nanocomposites prepared by solution intercalation and *in-situ* polymerization methods. The exfoliated PU/St-LDH and partially exfoliated PU/DS-LDH nanocomposites are developed in both preparative methods. All these PU/LDH (DS as well as St) nanocomposites exhibit relatively higher improvements in the mechanical, thermal, flame retardant and adhesive properties compared to neat PU. PU/DS-LDH nanocomposites show the maximum enhancements in mechanical and adhesive properties, whereas thermal stability and limiting oxygen index are maximum improved in PU/St-LDH. The interlayer spacing of organomodified LDHs (DS and St) is further enhanced by isocyanate grafting and accounts for the development of unilamellar exfoliated PU nanocomposites. As a result, the remarkable improvements are observed in mechanical and thermal properties and shifting of glass transition temperature compared to individually grafted as well as organomodified LDH/PU nanocomposites suggesting their significant synergistic effect. Another new and cost effective approach involved the preparation of DS-LDH filled PU/nitrile butadiene rubber (NBR) (50:50) blend nanocomposites with their enhanced properties compared to neat blend and individual NBR or PU.

The compatibility of PU with polypyrrole (PPy) has been overcome by incorporating dodecyl benzene sulfonic acid (DBSA) as dopant in PPy to form the nanoblends of PU/PPy by *in-situ* (IS) and solution blending (SB) methods. It is observed that the PU/PPy (70:30) SB nanoblend exhibits significant improvement in electrical conductivity and thermal stability than IS nanoblend.

The separation of bioconjugate materials from the reaction medium has also been an emerging area. In this regard, a simple facile synthetic route for the fabrication of trypsin immobilized gold nanoparticle assembled PU microsphere biocatalyst is reported. The biocatalyst exhibits excellent reusability and adaptability to pH and harsh thermal environments compared to free trypsin.

Keywords: Layered double hydroxide; Polyurethane; Nanocomposites; Nanoblends