ABSTRACT

The advent of renewable resources based biodegradable polymers is an important initiative for development of products for common as well as advanced applications, especially by adhering to the challenges associated with sustainability and environment. Further, the rising demand for modern-day applications necessitates the development of eco-friendly high performance polymer nanocomposites. Therefore, the entitled thesis focuses on the fabrication, characterization, performance studies and potential applications of renewable resource derived hyperbranched polyurethane and their nanocomposites with different carbon based nanomaterials. In line with the primary objective of the work, renewable resource derived hyperbranched polyurethane was synthesized using a castor oil modified polyol as a renewable resource based precursor by A_x+B_y (x, y ≥ 2) approach. The renewable resource derived hyperbranched polyurethane was developed as a biodegradable, UV-light resistant and smart material with potential for multi-faceted applications. The synthesized hyperbranched polymer was subsequently utilized for the fabrication of nanocomposite with different carbon based nanomaterials having notable attributes. Currently, numerous scientific endeavors are being pursued to exploit the unique facets of carbon based nanomaterials from industry to academia. Such nanomaterials are known to have a major impact on the material properties of polymers, as well as endow remarkable qualities in them. A variety of carbon based nanomaterials like graphene oxide, reduced graphene oxide, carbon quantum dots, graphitic-carbon nitride dots, etc. and their nanohybrids were synthesized or prepared for fabrication of hyperbranched polyurethane nanocomposites. The corresponding nanocomposites displayed significant enhancement in material properties, as well as desirable multi-faceted attributes. Hyperbranched polyurethane/aluminium hydroxide-decorated reduced graphene oxide nanocomposite was developed as high performance material with smart attributes. Hyperbranched polyurethane/silane-modified graphene oxide nanocomposite functioned as high performance material with remarkable abilities of self healing and self cleaning. A portion of the thesis also focuses on the synthesis of bimetallic-cum-carbonaceous palladium-silver-carbon quantum dot nanohybrid and its application in the field of catalysis. The nanohybrid was consequently employed in the design of hyperbranched polyurethane/palladium-silver-carbon quantum dot nanocomposite for sustainable heterogeneous catalytic applications. Hyperbranched polyurethane/graphitic-carbon nitride dot nanocomposite was developed as high performance material with applications in anti-counterfeiting, as well as heterogeneous photocatalysis.

Hence, the current work emphasized the suitability of renewable resource based hyperbranched polyurethane nanocomposites with different carbon nanomaterials in improving the material aspects of a polymeric material and further, discusses their exploration for multi-faceted applications. Among the diverse applications, the utility of the nanocomposite in smart applications augurs well for development of advanced functional materials. Likewise, suitability of the nanocomposite in catalytic applications presents a new avenue of exploration in years to come.

Therefore, the comprehensive work presented in the thesis demonstrates the utility of the synthesized renewable resource derived hyperbranched polyurethane and its fabricated nanocomposites with carbon-based nanomaterials as potential multi-faceted material in the field of material science.