Abstract

Nanoclay and graphene based thermoplastic nanocomposites have been regarded as in-demand nanocomposites to be applied in several industrial sectors such as packaging, pharmaceuticals, automotive and electronics. These nanocomposites, when applied as packaging materials, need to be highly impermeable to oxygen and water vapor. The compatibility issues between nanoclay and thermoplastic chains, as well as the poor dispersion of graphene in the matrix phase, limit their packaging applications. Functionalization of nanoclay surfaces could be an effective way to enhance the interfacial adhesion between clay particles and thermoplastics. Polyethylene like linear low density polyethylene (LLDPE) and high density polyethylene (HDPE) have been extensively used in the packaging industry. We have functionalized nanoclays with different organo-silanes and synthesized graphene derivatives like reduced graphene oxide (rGO) and silver nanoparticle decorated reduced graphene oxide (G-Ag) from graphite powder. The modified nanoclay and graphene loaded LLDPE nanocomposites were prepared by melt compounding technique. The resultant nanocomposites were evaluated in terms of their morphology, tensile, thermal, rheological and barrier characteristics. Silylation of nanoclay significantly improved nanoclay dispersion in LLDPE matrix, whereas the high aspect ratio and large surface area of graphene derivatives and graphene nanoplatelets (GNP) helped to achieve sufficient mechanical, barrier and thermal characteristics of the nanocomposites at low graphene concentration. G-Ag filled thermoplastic films have been tested against both gram-positive and gram-negative bacteria to ensure their bactericidal activity. By taking both the advantages of GNP and nano ZnO high-barrier and antibacterial thermoplastic nanocomposites were fabricated without sacrificing the tensile and thermal characteristics of the nanocomposites. The tensile properties, thermal stability and barrier properties of GNP loaded LLDPE nanocomposite films were significantly improved when exposed to electron beam (EB) irradiation owing to the tighter interactions between graphene and thermoplastic chains as well as the formation of a cross-linked network by EB irradiation. This thesis also discussed a comparative study of mechanical, barrier (oxygen and UV) and thermal characteristics of both pristine and organo-modified clay reinforced HDPE nanocomposite films. The as-prepared clay reinforced thermoplastic nanocomposites could be utilized as packaging materials whereas graphene and nano ZnO based thermoplastic nanocomposites could be potentially applied in both high-barrier antibacterial as well as food packaging applications.

Keywords: Linear low density polyethylene, High density polyethylene, Nanoclay, Graphene, Barrier properties, Antibacterial effectiveness, Packaging applications