ABSTRACT

This thesis aims to develop a bromobutyl (BIIR) based rubber blend nanocomposite which contains nanofillers or nanofillers combinations for achieving a high air impermeability for various barrier applications. The blends of BIIR with various elastomers such as epoxidized natural rubber (ENR) and hydrogenated acrylonitrile butadiene rubber (HNBR) were developed and both blend based composites were reinforced with different nanofillers combinations for enhancing the air impermeability. The influence of various rubber blends on the development hybrid nanostructures and its structure-property relationship was investigated. All the rubber nanocomposites were prepared by using industrially accepted simple melt mixing process. The developed rubber nanocomposites were characterized for rheological, mechanical, and barrier properties. Blends of BIIR with ENR 25 and ENR 50 (epoxidized natural rubber with 25 and 50 % epoxidation respectively) were prepared and characterized for physical as well as barrier properties. There after the developed blends where reinforced with platelet type graphene nanoplatelets (GNP) by replacing a part of carbon black and investigate the influence of epoxidation level on the dispersion of GNP. The influence of epoxidation for the formation of nanostructures in both blends have evaluated using FT-IR studies and TEM photomicrographs revel the formation of microstructures in BIIR-ENR 50 blend based GNP nanocomposites and the same composite shows improved air impermeability compared to BIIR-ENR 25 blend based composites. We investigated the effect of hybrid nanofillers systems such as GNP-Graphene oxide, GNP - Nanoclay, GNP - Nanosilica on the dispersion in BIIR-ENR 50 blends and studied with special reference to barrier properties. The AFM and TEM images shows that the composite contain hybrid nanofillers system gives a better dispersion pattern compared to the composite contain only GNP. Dispersion of nanofillers is pivotal in enhancing the physical as well as barrier properties of the nanocomposites. With the introduction of hybrid nanofillers systems an enhanced mechanical as well as barrier properties were obtained for BIIR-ENR 50 based nanocomposites. The replacement of carbon black with other nanofillers helps to develop a sustainable rubber product with less dependency on petroleum industries. The effect of carbon black structure on the permeability properties were investigated in developed BIIR-ENR 50 blends using three different carbon blacks with different di butyl phthalate (DBP) value. In tyre industries, general-purpose furnace black (GPF N660) with a particle size ranging from 40 to 50 nm is generally used for improving the mechanical properties of the tyre inner-liner. We focus both on the relation between the carbon black structure on dispersion and barrier properties in the BIIR-ENR 50 rubber blend. It is noticed that there is a reduction in the air loss for the developed BIIR-ENR 50 composites with low structured carbon black. High performance, cost-effective BIIR-HNBR rubber blends were also developed for various barrier applications. Extensive insight on the effect of various types of nanoclays and its structure-property relationship in the rubber blend based nanocomposites were analysed systematically. The presence of layered silicates in BIIR-HNBR rubber blend reduces the air permeability drastically. In a nutshell, rubber nanocomposites with improved permeability as well as physical properties were developed which can be used in various barrier applications such as tyre inner liners, tubes, and membranes.

Keywords: BIIR, ENR, HNBR, Blends, Nanocomposites, Hybrid Nanostructures, TEM, AFM, Morphology, Air permeability, Barrier Applications, Mechanical Properties.