Abstract

The present work describes surface modification of vulcanized ethylene propylene diene polymethylene (EPDM) rubber by high energy irradiation namely electron beam, gamma and plasma and by chemical treatment such as trichloroisocyanuric acid. Moreover, influence of the modified EPDM rubber surfaces on adhesion between vulcanized and unvulcanized rubber joint by an 180^{o} peel test has also been addressed. Surface treatments result in surface oxidation and change in surface topography which have been characterized using different techniques like attenuated total reflection infrared (ATR-IR) spectroscopy, contact angle measurement, free sulfur estimation, energy dispersive X-ray sulfur mapping (EDX), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM) and atomic force microscopy (AFM). A substantial amount of adhesion has been achieved by the aforementioned techniques. The improvement of adhesion strength is mainly ascribed to the contribution of mechanical (surface roughness), thermodynamical (increase of polar contribution to the surface energy) and chemical (removal of abhesive substances, creation of polar groups) factors.

The effect of tackifier and nanoclay on the autohesive tack strength of EPDM rubber has been examined. Hydrocarbon (HC) tackifier shows better compatibility with EPDM rubber in comparison to coumarone-indene (CI) tackifier and consequently enhances the tack strength by modifying viscoelastic properties of the rubber matrix. In different fashion, nanoclay also increases tack strength up to 4 wt % of clay loading, beyond which it decreases. It is inferred that although nanoclays obstruct bond formation by reducing extent of diffusion of rubber chains across the interface, the bond breaking strength enhances owing to higher monomer friction coefficient, as compared to that of the unfilled sample.

Tackifier and nanoclay have also been incorporated in unvulcanized EPDM rubber. Adhesion between vulcanized EPDM rubber and unvulcanized rubber containing either tackifier or nanoclay has been addressed in this thesis. In both the systems, the extent of diffusion of rubber chains reduces due to crosslinking, but does not eliminate fully. The compatibility as well as viscoelasticity of rubber /tackifier blends play major role for substantial enhancement of peel strength. Conversely, for the system comprising of nanoclay tensile strength, viscoelasticity, polarity, micro-roughness and weak boundary layer formation contribute to the adhesion property.

Keywords: 180^{o} peel, adhesion, EPDM, high energy irradiation, nanoclay, surface energy, tackifier, viscoelasticity