ABSTRACT

Ethylene-propylene diene monomer (EPDM) rubber, containing dicyclopentadiene (DCPD) as the diene monomer, has been surface- and bulk-modified with varying concentrations (1 – 50%) of trimethylol propane triacrylate (TMPTA) over a wide range of electron beam irradiation doses (0 – 500 kGy). The surfaces of the modified rubbers have been characterized by contact angle measurements, thermodynamic work of adhesion, surface energy, infrared (IR) spectroscopy and X-ray photoelectron spectroscopy (XPS). The surface morphology has been studied with the help of scanning electron microscopy (SEM). IR studies indicate increased peak absorbances at 1730, 1260, 1120 and 1019 cm^{-1} and hence, increased >C=O and C-O-C concentrations on the surface and in the bulk. These are further supported by the XPS data. The total surface energy of the modified samples increases upto 10% TMPTA concentration at 100 kGy for the surface modified samples and upto 50 kGy radiation dose at 10% TMPTA level. The surface energy of the bulk modified samples, however, increases gradually upto 20% TMPTA concentration at 100 kGy irradiation dose and 200 kGy dose at 10% TMPTA level. For comparison purposes, EPDM containing ethylidene norbornene (ENB) as the termonomer, acrylonitrile butadiene rubber (NBR) and styrene butadiene rubber (SBR) have also been surface modified with TMPTA. The ENB-EPDM shows a higher surface concentration of the polar groups than DCPD-EPDM while NBR gives the highest surface energy amongst all the rubbers due to its own inherent polar character. DCPD-EPDM has also been surface treated with other polyfunctional monomers such as tripropylene glycol diacrylate (TPGDA) and tetramethylol methane tetracrylate (TMMT). Of the three monomers, the tetracrylate imparts the highest level of modification and surface energy to the rubber due to its large number of acrylate groups. The acrylate polymers such as diene-, chloro-, and epoxy-acrylate rubbers are not so effective in this respect. The mechanical and dynamic mechanical properties of the modified DCPD-EPDM rubbers reveal marginal changes in the tensile strength and a gradual increase in the moduli at 100% and 200% elongations at the cost of the elongation at break values. The Tg gradually shifts to higher temperatures with modification, whereas the $\tan\delta_{max}$ is lowered. The coefficient of friction of the modified rubbers is found to be a function of dose of irradiation and TMPTA level. Both the

absorption and permeation of non-polar organic solvents, viz. n-hexane, n-heptane, n-octane, etc. decrease. The peel strength increases with the increase in surface energy of the surface- and bulk-modified EPDM rubbers in the case of autohesion as well as for the joints with natural rubber (NR) and aluminium (Al). An attempt has been made to correlate all the properties with the structure of the modified rubbers.

Key Words : EPDM, Electron Beam, Irradiation, Rubber, Modification, Surface Properties, IR Spectroscopy, XPS, Contact Angle, Surface Energy, Polyfunctional Monomers, Dynamic Mechanical Properties, Friction, Barrier Property, Adhesion.