Abstract

The subject of gel and gel filled elastomer is an important area of research. The thesis reports preparation and characterization of tailor made quasi-nano gels, nanogels and nanocomposite gels having tunable properties, and their effect on the properties of virgin elastomers. Chemically crosslinked quasi-nano sized natural rubber (NR) gels and nano-sized styrene butadiene rubber (SBR) gels were prepared from sulfur prevulcanization of NR and SBR latices using different sulfur to accelerator ratios. These gels were characterized by solvent swelling, dynamic light scattering, atomic force microscopy (AFM), tensile stress-strain measurements and dynamic mechanical analysis. Well characterized gels were introduced in the virgin elastomers at various concentrations. Addition of gels altered the viscosity of the virgin elastomer in different ways according to their nature and crosslink density and resulted in a unique rheological behavior. The die swell of the virgin elastomer decreased steadily with the increase in gel loading. Introduction of gels also registered noticeable improvement in tensile and dynamic mechanical properties of the virgin elastomers. The reinforcement behavior of these nano-sized gel particles was described with the help of a new empirical relation. For comparison purpose, electron beam crosslinked NR latex gels were prepared, which exhibited a similar effect on the properties of virgin NR. The gel-matrix intermixing was carried out to envisage the role of dissimilar gel-matrix interaction on properties. The morphology of such intermixed gel filled systems was studied using X-ray dot mapping, transmission electron microscopy (TEM) and AFM. Introduction of NR gels greatly improved the green strength of SBR, while addition of SBR nanogels in virgin NR led to better thermal stability for the latter. Contemporary particulate reinforcement models were employed to understand the reinforcement behavior of these gels. Moreover, the effect of gel-matrix intermixing on the rheological and capillary extrusion behavior of virgin NR and SBR was studied extensively. Additionally, nanocomposite (NC) gels from NR and SBR latices were prepared by using a unique latex blending technique with pre-exfoliated unmodified montmorillonite clay and subsequently characterized. The X-ray diffraction and TEM studies of as-prepared NC gels revealed the existence of predominantly exfoliated morphology which was credited for their enhanced physical properties. Addition of NC gels in the elastomer matrix resulted in a significant improvement in tensile strength, Young's modulus, storage modulus and thermal stability of the virgin elastomers. The synergistic reinforcement exhibited by NC gels was superior to that of quasi-nano gels and nanogels. Finally, the dynamic stress relaxation behavior of gel filled elastomer systems was also studied extensively.

Keywords: *Gels; Nanogels; Nanocomposite gels; Elastomer; Latex; NR; SBR; Morphology; Rheological properties; Mechanical properties; Stress relaxation behavior*