Abstract

Not much is known about the effects of varying morphological and chemical constitution of nanofillers, and various dispersion methods in natural rubber (NR) nanocomposites. Thus, instead of arbitrary selection, dispersion of wide range of nanofillers, like montmorillonite, sepiolite and carbon nanofiber, was enhanced by various compatibilization and dispersion techniques. Fibrous nanofillers, sepiolite and carbon nanofiber, which illustrated the best mix of properties, were then studied in detail. Property-morphology correlation of the hybrids was performed through X-ray Diffraction, Atomic Force Microscopy and Transmission Electron Microscopy (TEM). Deeper insights into the material properties were obtained through dynamic mechanical, swelling and surface energy studies. On the basis this, a new mechanism on adsorption followed by shearing of polymer-bound nanofillers was propounded. A novel theory on polymer-filler interaction has been established by introducing Interface Area Function to account for nanofiller characteristics and extended interface region. The conformance of experimental values of Young's modulus, with those predicted by the suggested theoretical models, highlighted suitable integration of shape and aggregate effects. The effect of nanofillers on vulcanization and viscoelastic properties (shear mode), in the pre- and post- vulcanization stages, was also evaluated with an eye on characterizing their processability and usability. Tribological characteristics of the nanocomposites were quantified by sliding them against a steel blade (in a specially designed abrader), under testing parameters based on Taguchi orthogonal design. Analysis of debris and abraded surface revealed that nanofillers arrested wear significantly and specific wear rate increased beyond a critical fractal dimension of the debris. The mechanical, dynamic mechanical and tribological properties of ternary nanocomposites comprising NR/nanofiller/carbon black (CB) exhibited synergistic improvements, within the high performance window of good wet skid and low rolling resistance. TEM revealed formation of "nano-blocks" of reinforcement - close association of nanofiller and CB - driven by zeta potential differences between the fillers. This unique morphological architecture, interconnected through small CB aggregates (nano-channels) accounted for the observed synergy in these dual filler systems.

Thus, way has been paved for preparing stronger, low rolling resistance and high abrasion resistance nanocomposites with better wet grip for use in tire and other advanced applications.

Keywords: *Nanocomposite, Elastomer, Physico-mechanical properties, Abrasion, Wear, Polymer-filler interaction.*