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Reinforcement of natural rubber using carbon black / mineral hybrid filler

W. M .P. G. S. V. Wanasinghe and C. K. Jayasuriya*

Department of Chemistry, Faculty of Science, University of Kelaniya, Sri Lanka
**Email: jayasuc@kln.ac.lk*

Fillers improve the properties of natural rubber. Carbon black is the most abundant reinforcing filler in industry and is derived from the petroleum feed stock. There is a complex and expensive process to obtain Carbon Black from petroleum. It also causes pollution. Optimizing the mechanical properties of natural rubber by replacing part of Carbon black with minerals is therefore, very important. In this research Feldspar, Kaolin, Quartz and Rutile were used as the minerals which were more abundant in earth at low cost.

All four minerals were ground separately using TEMA mill and sieved to get particles in the range of 0-180 μm. Three series of samples were prepared by replacing Carbon black with 5 phr (parts per hundred rubber), 10 phr and 15 phr with each type of mineral. All the natural rubber vulcanizates thus prepared were analyzed using Rheometer and times obtained were used to cure the samples. Hardness, tensile strength and tear strength were measured for each series. Samples with Feldspar showed highest tear strength, hardness and minimum torque compared to the samples with other minerals. In most of the cases, properties of the samples with 10% Feldspar showed optimum values. The highest tensile strength was obtained for the sample with quartz (15 phr), which is 11.842 (± 0.544) MPa. Natural rubber vulcanizates with Rutile showed the highest properties in Maximum Torque and cure time 90%.

Further characterization was done with Fourier Transformed Infrared-Attenuated Total Reflectance spectroscopy (FTIR-ATR) and Scanning Electron Microscopy (SEM). SEM images of tensile fracture surfaces were obtained from Scanning Electron Microscopy to study the morphologies of some samples filled with Quartz and Feldspar. Those microstructural results revealed that quartz (15 phr) showed the uniform dispersion of fillers and lowest agglomerates of the natural rubber vulcanizate, which showed the highest tensile strength. The good interfacial interactions between the minerals and the rubber chains give these vulcanizates excellent tensile strength. FTIR-ATR spectroscopy was used to study the effect of mineral loading on the structure of the filled sample. Extra peaks can be seen in some spectra due to the functional groups of the minerals. However, Peaks could not be assigned accurately due to the complexity of spectra.

Keywords*:* Carbon Black / mineral hybrid filler systems, Mechanical properties, Mineral fillers, Reinforcement