World Academy of Science, Engineering and Technology
International Journal of Mechanical and Materials Engineering
Vol:9, No:01, 2015

Absorption Kinetic and Tensile Mechanical Properties of Swollen Elastomer/Carbon Black Nanocomposites using Typical Solvents

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Abstract : The effect of physico chemical properties of solvents on the transport process and mechanical properties in elastomeric nano composite materials is reported. The investigated samples are formed by a semi-crystalline ethylene-co-butyl acrylate polymer filled with hard spherical carbon black (CB) nano particles. The swelling behavior was studied by immersion the dried samples in selected solvents at room temperature during 2 days. For this purpose, two chemical compounds methyl derivatives of aromatic hydrocarbons of benzene, i.e. toluene and xylene, are used to search for the mass and molar volume dependence on the absorption kinetics. Mass gain relative to the mass of dry material at specific times was recorded to probe the absorption kinetics. The transport of solvent molecules in these filled elastomeric composites is following a Fickian diffusion mechanism. Additionally, the swelling ratio and diffusivity coefficient deduced from the Fickian law are found to decrease with the CB concentration. These results indicate that the CB nano particles increase the effective path length for diffusion and consequently limit the absorption of the solvent by occupation free volumes in the material. According to physico chemical properties of the two used solvents, it is found that the diffusion is more important for the toluene molecules solvent due to their low values of the molecular weight and volume molar compared to those for the xylene. Differential Scanning Calorimetry (DSC) and X-ray photo electron (XPS) were also used to probe the eventual change in the chemical composition for the swollen samples. Mechanically speaking, the stress-strain curves of uniaxial tensile tests pre- and post- swelling highlight a remarkably decrease of the strength and elongation at break of the swollen samples. This behavior can be attributed to the decrease of the load transfer density between the matrix and the CB in the presence of the solvent. We believe that the results reported in this experimental investigation can be useful for some demanding applications e.g. tires, sealing rubber.

Keywords : nanocomposite, absorption kinetics, mechanical behavior, diffusion, modelling, XPS, DSC
Conference Title : ICMME 2015 : International Conference on Mechanical and Materials Engineering
Conference Location : Jeddah, Saudi Arabia
Conference Dates : January 26-27, 2015