**Carbon nanotube/Polydimethylsiloxane nanocomposites with enhanced O2 impermeability, dielectric and EMI shielding properties**

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**ABSTRACT**

Silicon elastomers are widely used in many industrial (electrical appliances, sensors, coatings etc.) and biomedical (facial prostheses, catheters, stents, respiratory aids etc.) applications. Despite their elasticity, good biocompatibility, chemical and thermal stability, silicone elastomers exhibit inadequate mechanical properties. In order to overcome this drawback, polydimethylsiloxane (PDMS) is usually reinforced with silica, titania, carbon-based and other reinforcing agents. In this study, composites of PDMS reinforced with multiwall carbon nanotubes (MWCNTs) were prepared by solution mixing in tetrahydrofuran (THF) with the assistance of sonication, in order to achieve efficient dispersion [1]. The prepared nanocomposites (0.02, 0.05, 0.1, 0.2, 0.5 & 1 phr MWCNTs in PDMS) were characterized for their thermomechanical and dielectric properties, permeability in O2 and electromagnetic interference shielding effectiveness (EMI SE). Differential Scanning Calorimetry (DSC) revealed a decrease in crystallization temperature (Tc) of the elastomeric matrix at low CNTs content (0.05 & 0.1 phr) and an increase at higher loadings (0.2-1 phr), whereas the crystallinity of PDMS decreased at all the examined loadings. Thermogravimetric Analysis (TGA) showed that thermal degradation of specimens started at lower and the phenomenon was completed at higher temperatures, in comparison to the unfilled elastomer. Εnhancement in tensile strength, Young’s modulus and elongation at break of the composites was recorded, especially at higher filler content [2]. Swelling after immersion in toluene decreased for all MWCNT/PDMS composites, compared to the pristine PDMS. Membranes made of MWCNT/PDMS composites showed significant decrease in O2 permeability. Dielectric Relaxation Spectroscopy (DRS) showed that the percolation threshold was reached at low CNT’s content, specifically in the range of 0.02-0.05 phr. The increase of CNTs content in the composites led to increased conductivity up to a level where saturation was reached [3]. The EMI SE of the prepared MWCNT/PDMS membranes -recorded in the X-band (8-12 GHz) frequency range- was strongly dependant on the CNTs loading. Thus, the membranes with thickness of ~1.5 mm exhibited SE of 5 and 10 dB for the loading of 0.5 and 1.0 phr, respectively. Based on the above-mentioned results, it is concluded that MWCNT/PDMS composites prepared by solution mixing present improvement in their performance in many crucial properties, even at very low reinforcement.

**KEYWORDS:** Polydimethylsiloxane, Carbon nanotubes, O2 permeability, Thermomechanical properties, EMI shielding

**REFERENCES**

1. Song Y, Yu J, Yu L, Alam F, Dai W, Li C, Jiang N. (2015). *Mater. & Design*. 88:950-957.
2. Wang Z, Liu S, Wu S, Wang W, Zhang L. *(2010). Phys. Chem. Chem. Phys. 12:*3014-3030.
3. Saji J, Khare A, Choudhary R, Mahapatra S. (2015). *J. Elastomers Plast.* 47(5):394-415.