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Title of Thesis: **EVALUATION OF MECHANICAL AND TRIBOLOGICAL PROPERTIES OF MnO_2/CNT POLYMER NANOCOMPOSITES**

ABSTRACT

The present investigation deals with the development of new epoxy-based nanocomposites. The Manganese Dioxide/Multiwalled Carbon nanotube (MnO_2/MWCNT) epoxy nanocomposites were fabricated via a cost-effective and simple solution mixing technique with 0.5wt% of (MnO_2/MWCNT). The MnO_2/MWCNT was synthesized through a solution technique with 5, 10, and 15 wt% loading of MWCNT. The phase identification, thermal stability, surface morphology, and chemical composition of the nanocomposites were examined by X-ray diffractometer (XRD), Differential Scanning Calorimetry (DSC), High-Resolution Field Emission Scanning Electron Microscope (HR-FESEM), and Energy Dispersive X-ray (EDX), respectively. The XRD analysis confirmed that the formation of MnO_2/MWCNT nanopowder. HR-FESEM images of nanocomposites show that the MWCNT was coated by a thin MnO_2. The EDX spectrum of epoxy-based nanocomposites show that the presence of chemical elements Manganese (Mn) and oxygen (O) in the Epoxy based nanocomposite samples. The DSC curves indicate that the sample 0.5wt% (5wt% MWCNT/MnO_2) showed a higher glass transition temperature as compared with other samples. The thermo-gravimetric analysis indicated that the sample C6 was highly cross-linked at a higher temperature than that of other samples. Mass density analysis shows that the mass density of nanocomposites was slightly increased as compared to neat Epoxy. The microhardness analysis revealed that the microhardness of 0.5wt% (10wt% MWCNT/MnO_2) epoxy nanocomposite was highest as compared to the other samples, and the sample exhibited higher elastic recovery along the sides of the impression. The probability plots of micro-hardness data at 95% confidence interval revealed that the hardness data of the nanocomposite sample was affected by the formation of pores, agglomeration tendency of MnO_2/MWCNT nanotubes, and surface roughness of samples. The impact test results show that the energy absorption capacity of nanocomposite samples was increased with the addition of MnO_2/MWCNT in the epoxy matrix. The nanocomposite samples exhibited significantly decreased compressive properties; this might be due to the agglomeration of MnO_2/MWCNTs in the epoxy matrix and also the formation of pores during the nanocomposites fabrication process. The wear tests result at different sliding conditions under different loads indicated that the specific wear rate of nanocomposite samples was lower, i.e., the wear resistance of Epoxy was improved with the addition of MnO_2/MWCNT. The friction behavior indicated that the coefficient of friction value increased with the addition of MnO_2/MWCNT in Epoxy except at sliding velocity of 1.57 m/s under the applied load of 10 N. However, the decrease in coefficient of friction value was observed with increasing wt% loading of MWCNT in the epoxy matrix. The microhardness value was not a determining factor in the tribological characterization of CNT based polymers. The probability plots of the coefficient of friction data for different conditions showed that the friction coefficient data for all the samples were not normally distributed. The HR-FESEM images of worn surfaces of all samples at a sliding velocity of 1.57 m/s under 10 N normal load showed that the fatigue wear mode seems to be the most dominating wear mode as compared to other modes of wear. The optical microscopic images of all the samples under different conditions revealed that the material removal process from the surface of samples was due to the propagation of cracks and the formation of pits. Therefore, the fatigue wear

mode was the most dominating wear mode in the failure of all the developed samples under different conditions. The specific wear rate and coefficient of friction of the samples are dependent on different wt% fraction of MWCNT/MnO_2, load, and sliding velocity.

THESIS FINDINGS

In this study, MnO_2/MWCNT epoxy nanocomposites were successfully synthesized by using a simple solution method. The XRD analysis confirmed the formation of MnO_2/MWCNT nanopowder. HR-FESEM images and EDX results show the MWCNT was coated by a thin MnO_2 layer. Thermo-gravimetric analysis indicated that the sample 0.5wt%(10wt%MWCNT/MnO_2) epoxy was highly cross-linked. The mass density is increased due to the addition of MnO_2/MWCNT. The percentage of increase in the microhardness value for the sample 0.5wt% (10wt% MWCNT/MnO_2) epoxy is 5.5% as compared with neat epoxy. The energy absorption capacity enhanced with the addition of MnO_2/MWCNTs. The compressive properties were decreased with addition of MnO_2/MWCNT. The wear tests result at different sliding conditions indicated the wear resistance of neat epoxy was improved with the addition of MnO_2/MWCNT. The friction behavior indicated that the coefficient of friction value increased with addition of MnO_2/MWCNT except at sliding velocity of 1.57 m/s under 10 N. The HR-FESEM images of worn surfaces of all samples at sliding velocity 1.57 m/s under 10 N loads also indicate that the fatigue wear mode seems to be the most dominating wear mode. The optical microscope images show that the fatigue wear mode is the most dominating wear mode of failure.