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Preparation and Characterization of Treated MWCNT-Muscovite Filled Epoxy Nanocomposites

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Abstract

This paper presents the surface treatment of multiwalled carbon nanotube (MWCNT)/muscovite (MUS) hybrid nanomaterial. The hybrid compound was synthesized by chemical vapor deposition (CVD) using methane as the carbon precursor. Morphological characterization of treatment and pristine MWCNT-MUS hybrid was conducted using Field Emission Scanning Electron Microscope (FESEM) and X–ray diffraction (XRD). The surface treatment of MWCNT/MUS hybrid nanomaterial was successfully carried out which the basal spacing of (001) plane $d_{(001)}$ of MCNT/MUS was enlarged from 21.00 Å to 27.20 Å after first stage after first stage and was further enlarged to 29.28 Å after second stage of CTAB treatment. This MCNT-MUS hybrid filler was incorporated into epoxy resin at different filler loadings (0.5, 1.0, and 1.5 wt %). Thermal properties of the treated Epoxy/MWCNT-MUS was determined to have lower properties compared to pristine Epoxy/MWCNT-MUS.

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1. Introduction

Recently, hybrid filler for polymer nanocomposites increased attention due to their unusual property combinations and unique design for advanced applications such as aerospace, automotive, electronics and biotechnology. This is due to their improvement in mechanical, solvent resistance, fire retardant and thermal properties of the composites. Natural materials such as clay based mineral, lignocellulosic fibers and chyrstolite were highlighted to be one of the possible materials uses to overcome the environmentally problem[1]. Carbon nanotubes (CNT) are commonly used as one of the potential combination to fabricate the hybrid filler as they have excellent properties with high thermal conductivity, excellent electrical capacity and good thermal stability[2]. However, it was difficult to fabricate CNT-based composites as they are tend to agglomerate among themselves and entangled with strong van der Waals interaction[3]. Previous researcher had demonstrated the interfacial strength between the filler and matrix by growing the CNT onto surface of alumina, carbon fibers and clay[4].

In the present work, the MWCNT-MUS hybrid filler was synthesized by chemical vapor deposition (CVD). Surface treatment is propose on the surface of the MWCNT-MUS hybrid filler to improve the performance of epoxy nanocomposites by produces homogeneous dispersion of CNT in the epoxy matrix. Furthermore, the treatment was carried out to improve the interfacial reaction between filler and matrix. The effect of surface treatment on the MWCNT-MUS filler were analyzed by morphological and thermal stability.

2. Experimental

2.1 Preparation of MWCNT-MUS Hybrid Filler

MWCNT-MUS hybrid filler was synthesized by chemical vapour deposition (CVD). The CNT were grown on the muscovite particles using nickel as the catalyst. The catalyst was prepared using precipitate method by precipitating the nickel nitrate and muscovite powder with the present of water in NaOH solution. The reduction of the catalyst was performed under hydrogen at 400°C for 2 hours. Then, it was reacted in CH_4/N_2 mixture at 800°C for 30 minutes[5].

2.2 Surface Treatment of MWCNT-MUS hybrid filler

Ion exchange treatment of MWCNT/MUS hybrid filler was divided into two stages; 1) ion exchange treatment was carried out by replacing the K^+ with Li^+ using $LiNO_3$ treatment and 2) Intercalated of Cetyltrimethylammonium cations (CTA^+) into silicate interlayers of Li-Muscovite which the Li^+ was replaced by CTA^+.

2.3 Characterization of Pristine and treated MWCNT-MUS hybrid filler

The morphologies of pristine and treated MWCNT-MUS hybrid filler were analysed using Field Emission Scanning Electron Microscope (FESEM-Leo Supra 35VP). The morphologies of pristine MWCNT-MUS hybrid filler were carried out using High Resolution Transmission Electron Microscopy (HRTEM), Model Philip TECNAI 20. The dispersion state of the MWCNT-MUS particles before and after treatment was evaluated using X-Ray Diffraction (XRD) measurement using Siemens D5000 at 40 kV. The basal spacing was calculated using the Bragg's Law:

$$n\lambda = 2d \sin\theta \tag{1}$$

Where,
n = an integer determined by the order given
λ = the wavelength of x-ray and moving electrons, protons and neutrons
d = the spacing between the planes in the atomic lattice
θ = the angle between the incident ray and the scattering plane.