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ScienceDirect

Procedia Chemistry 19 (2016) 45 – 49

Procedia Chemistry

5th International Conference on Recent Advances in Materials, Minerals and Environment (RAMM) & 2nd International Postgraduate Conference on Materials, Mineral and Polymer (MAMIP), 4-6 August 2015

Effect of different hybrid method on properties of carbon nanotubes/dolomite hybrid filled phenolic composites

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Abstract

Hybridization of multi wall carbon nanotubes (MWCNTs) with other filler in polymer matrix composites (PMC) is one of the techniques for combining different properties of fillers for making more unique composites. In this work, the hybrid filler (CNTs–dolomite) are prepared via chemical vapour deposition (CVD hybrid) and the milling method (physically hybrid). The effect of different hybrid method on properties of multi wall carbon nanotubes/dolomite hybrid filled phenolic composites were studied. Phenolic/CVD hybrid composites and phenolic/physically hybrid composites with different filler loadings were prepared using hot mounting press. The prepared samples were characterized for their thermal conductivity and hardness. The thermal conductivity was measured using the Transient Plane Source (TPS) method, using a Hot-DiskTM Thermal Constant Analyzer and the hardness was measured using Rockwell micro-hardness. The results showed that at 5% filler loading, the phenolic/CVD hybrid composites were capable of increasing the thermal conductivity and micro-hardness up to 7.22% and 101.6% respectively compared to pure phenolic.

Peer-review under responsibility of School of Materials and Mineral Resources Engineering, Universiti Sains Malaysia

Keywords: hybrid, polymer composite, carbon nanotube, chemical vapour deposition

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doi:10.1016/j.proche.2016.03.014

1. Introduction

Polymers have been used in many applications. The addition of fillers/reinforcements into polymers is a fast and cheap method to modify the properties of the polymer to suit various applications. The right combination of matrix and filler can result in new class of composite materials with enhanced properties. Various particulate reinforcements that available in the market nowadays are single compound material. Hybridization of filler in PMC is a more advance technique of combining different properties of filler for making more unique composites. Carbon nanotubes (CNTs) are one of an ideal reinforcing material in polymer composite. In literature, many research works have been investigated on the properties of CNTs reinforced polymer composites. It exhibits great mechanical, magnetic and electrical properties, as well as high aspect ratio make it as a great reinforcing material. CNTs were hybrid with the inorganic materials such as dolomite, calcium carbonate and alumina to be utilized as filler in polymer composites. The fillers were hybridized to combine the properties of the fillers as well as to enhance the capabilities of fillers to be performed in polymer composites..

The hybrids are prepared by several methods, including the simple sonication method[1], milling method [2] and Chemical Vapour Deposition (CVD) method [3]. However, the hybridation of CNTs and others filler are usually produced by milling method or physically mixing. This technique has a limitation in terms of homogeneity and dispersion of fillers in the polymer matrix. It usually creates a large amount of agglomerations due to tackiness, polarities and van der Waals interactions. It produces inefficient combinations, where some of the CNTs does not bond to the filler. This un-bonded CNTs tends to attract each other to form agglomeratation during the composite preparation. On the other hand, micrometer-sized dolomite particles will leave vacancies to be wet by resin in the composite system. To solve these problems, both nano sized CNTs and micro sized dolomite are hybridized using the Chemical vapor deposition method (CVD Hybrid) or chemically hybrid. The CNTs were grown on the dolomite surface. The combined properties of both materials will improve the dispersion and capability of fillers in polymer composites. In this study, the CNTs-dolomite were produced by using the CVD method (CVD hybrid) and the milling method (physically hybrid) and used as filler in phenolic composite.

Nomenclature

CVD	Chemical vapour deposition
CNTs	Carbon nanotubes
MWCNTs	Multi wall Carbon nanotubes

2. Experimental

2.1. Preparation of Composites Materials

MWCNTs/dolomite (CVD Hybrid) was synthesized via chemical vapour deposition (CVD) method using a nickel catalyst as the catalyst precursor and undergoing methane decomposition in accordance to previous paper[4, 5]. The MWCNTs/dolomite (physically hybrid) was produced using the physical milling method. The MWCNTs with 95% purity (supplied by SkySpring Nanomaterials Inc.) and dolomite 10-30 μm(supplied by Ipoh Ceramics Sdn. Bhd) were mixed in a ratio of 12:88 by using a ball milling machine for 48 hours at 20 rpm. Phenolic powder (Pace Technologies Inc.) was used as the polymer matrix. MWCNTs/dolomite(CVD hybrid and Physically hybrid) compound were mixed with phenolic powder and milled at 20 rpm for 24 h using a ball milling machine, with ceramic ball media ranging from 40 to 100 mm in diameter. The mixture of dolomite/phenolic powders and