

摘要

由本研究係以三軸滾輪機將環氧樹脂(Epoxy)當作基材，以氧化鋁粉(Al_2O_3)為主填充材，多壁奈米碳管(MWCNTs)為副填充材，在固定主要填充材與基材的比例下，添加 1-5 wt.% 之 MWCNTs 利用機械剪切力混合均勻，在 140°C 下固化 3 小時，製成 MWCNTs/ Al_2O_3 /Epoxy 複合材料。後續利用 SEM、Raman、電性量測、熱傳導量測、比熱量測、抗彎測試、溫升測試來分析材料性質。實驗結果顯示，相較於 Epoxy，MWCNTs/ Al_2O_3 /Epoxy 複合材在 60°C 和 80°C 的熱傳導係數增加了 300 % (1-5 wt.% CNTs)，比熱下降了 20 % (3-5 wt.% CNTs)。而 MWCNTs/ Al_2O_3 /Epoxy (50×50×5 mm) 之複合材通 12/24W 電溫升到 60°C 只需 2 分鐘/1 分鐘，到 80°C 只需 3 分半/1 分半的時間。本研究製作出之 MWCNTs/ Al_2O_3 /Epoxy 複合材通低功率電即能快速且均勻自加熱，未來期許其能夠應用在電地暖及浴室除濕加熱磁磚系統材料上。



Abstract

In this study, composites are made by epoxy as matrix to blend with the main fillers, Al_2O_3 , as well as with the secondary fillers, multi-walled carbon nanotubes (MWCNTs), at different ratios. Firstly, epoxy, CNTs and Al_2O_3 powders are evenly mixed by three-ball milling system to form adhesives. After degassing, the adhesives are cured at $140\text{ }^\circ\text{C}$ for 3 h and pristine MWCNTs/ Al_2O_3 /epoxy composites are subsequently characterized by SEM and Raman. The glass transition temperature (T_g), mechanical, thermal and electrical properties are also measured, along with resistive heating experiments. The results show that comparing with pure epoxy, the specific heat of MWCNTs/ Al_2O_3 /Epoxy composite at $60\text{ }^\circ\text{C}$ and $80\text{ }^\circ\text{C}$ decrease 20 % (3-5 wt.% CNTs) and the thermal conductivity increase at least 300 % (1-5 wt.% CNTs) respectively. Input of low power (12-24 W) into composites ($50\times 50\times 5\text{ mm}$) produces heat and surface temperature reaches $60\text{ }^\circ\text{C}$ in 60-120 s and $80\text{ }^\circ\text{C}$ in 100-210 s respectively. Electrical heating of MWCNTs/ Al_2O_3 /Epoxy composites is low cost and is highly safety, capable of replacing existing electric floor heating systems.