摘要

本研究旨在添加奈米氧化金屬粉末改善石墨粉末/酚醛樹脂之導電特性、增強機械特性及探討經過模擬使用環境後之機械強度。石墨粉末/酚醛樹脂複合材料使用於燃料電池雙極板中，可利用大量的石墨粉末有效加強導電特性，但同時會降低機械性質，造成機械強度不足，在使用高溫高溼環境及重複使用之溫度循環影響下，會加速機強度減弱。

本研究結果指出當添加 3 phr 之奈米氧化鋅粉末及奈米氧化銦/錫粉末有最佳彎曲強度(61.71 、61.27 MPa)、耐衝擊強度(0.85、0.79 lb-ft/in)及拉伸強度(39.24、39.96 MPa)，但添加 5 phr 時即造成團聚現象無法提升機械強度。隨著添加奈米氧化鋅粉末及奈米氧化銦/錫粉末增多，導電率會隨之提升至 5 phr 時分別為 74.38、78.24 S/cm，並且添加奈米氧化鋅及奈米氧化銦/錫粉末可以有效降低空孔率至 1.1358 %、1.0430 %，但其比重卻會隨著添加之奈米氧化金屬粉末而有上升到 1.6969、1.6838 g/cm^2 的趨勢。所有測試試片在氣體滲透測試下均能保持不漏氣，並且所有試片之腐蝕速率均小於 16 $\mu A/cm^2$。

在溫溼環境 85 ^{0}C/RH 85 %下，經過 168 小時吸溼飽和後之抗折強度，和未經溫溼環境比較約下降 1.5 %~4.6 %。在溫度循環-40~125 ^{0}C，循環週次 500 週後彎曲強度和未經熱循環比較下降約 10 %。

添加 3 phr 奈米氧化鋅粉末或奈米氧化銦/錫粉末時，可以提升機械性質及導電率，但添加 5 phr 以上的奈米氧化鋅粉末或奈米氧化銦/錫粉末會產生團聚現象而降低其機械性質。

Abstract

The aim of this paper focus on increasing the graphite/phenolic composite's electricity and mechanical properties by adding Nano-metal oxide particles, and it discusses the composite's mechanical properties after modified environmental test. We can take advantage of adding a large number of graphite powders to efficiently increase the electricity of the bipolar plates used in fuel cell, however they also decrease the mechanical properties at the same time. Bipolar plates decreased the mechanical properties when they are used in the environment of high temperature and high humid for a long time. Environment of thermal cycles also accelerated the crack propagation and decreased the mechanical properties.

The results of this paper pointed that adding 3 phr Nano-ZnO or ITO particle had the best flexural strength (61.71、61.27 MPa), Izod impact strength (0.85、0.79 lb-ft/in) and tensile strength (39.24、39.96 MPa), but these mechanical properties couldn't be increased when adding 5 phr Nano-metal oxide particle with the coming of the aggregation of Nano-metal oxide particle. The porosity reduced with increasing Nano-ZnO or ITO content, but the specific gravity increased with increasing Nano-ZnO or ITO content. All of these spacemen could keep gastight under the gastight test, and the corrosive current were less than 16 $\mu A/cm^2$.

The spacemen under the environment of 85 ^{0}C/RH85 % for 168 hr decreased flexural strength about 1.5~4.6 % than that in the normal environment. The spacemen after 500 thermal cycles (-40~125^{0}C) decreased flexural strength about 10 % than that in the normal environment.