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PREPARATION OF CARBON NANOTUBE/GRAPHITE/EPOXY NANOCOMPOSITE BIPOLAR PLATES FOR FUEL CELLS

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Introduction

Graphite-based bipolar plates have the drawback that they are fragile due to their processing, they are poor in production and price competitiveness, are easily broken and sludge is generated. Metal-based bipolar plates are vulnerable to acidic environments and have a short shelf life due to corrosion and increase the price of corrosion-resistant coatings. Through this research, CNT carbon composite bipolar plate is light and strong against impact, and has high conductivity by CNT. In addition, it has excellent corrosion resistance and can significantly reduce manufacturing time and cost through an injection and press process. It is possible to produce bipolar plates with high electrical conductivity and high chemical resistance due to more carbon content than the existing technology. In particular, CNT bipolar plates can be lightweight compared to graphite bipolar plates. Therefore, in addition to research that combines bipolar technology for fuel cell and compound technology for CNT, extensive study on mixing and molding method for producing high performance fuel cell bipolar plate is needed.

This study investigated the effects of carbon nanotube (CNT) contents and process conditions of hot press molding on the electrical and physical properties using CNT 0~9 wt% added graphite composites in the curing temperatures range of 140~200 °C and pressure of 200~400 kg/cm^2. Electrical conductivity and flexural strength increased with increasing CNT contents, curing pressure and temperature.

Materials and Methods

The graphite and epoxy used were commercially available KS75 (Timcal Co. Ltd., USA) and YD-012(Kukdo chemical Co. Ltd., Korea), respectively. The graphite/epoxy/CNTs blend composites with various CNT contents were prepared via wet mixture using a rotary evaporator. The loading contents of CNT in this work are based on the entire blend. The hot pressing was carried out at 140~200 °C for 20 min and pressure of 200~400 kg/cm^2.

Results and Discussion

At 3 wt% of CNT, the flexural strength was 48 MPa and the content of CNT was 44 MPa at 7 wt%.

When 7% CNT was used, the carbon composite plate with the best electrical properties was obtained with an electrical conductivity of 48 S/cm and a flexural strength of 44 MPa. The graphite material showed better mechanical and electrical properties when KS75 was used than KS6. When kS75 was used, the carbon composite plate with the best electrical properties was obtained with an electrical conductivity of 102 S/cm and a flexural strength of 75 MPa.

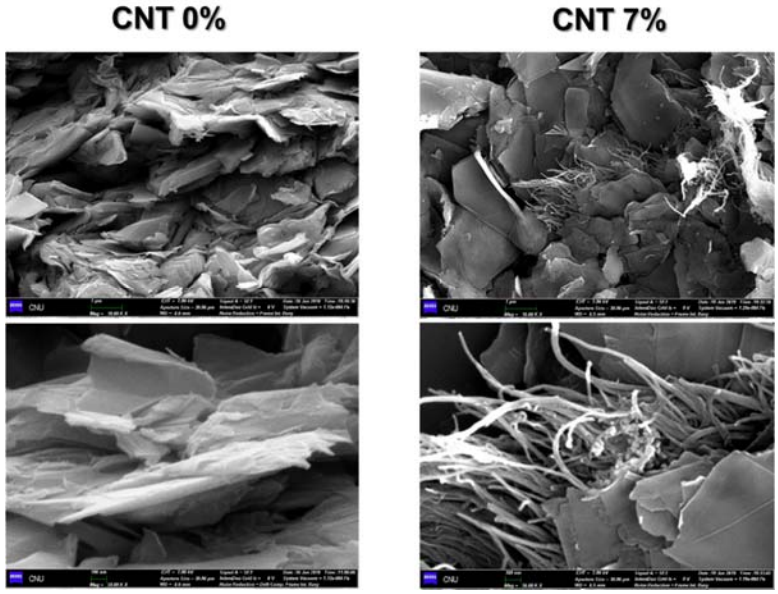

Figure 1. SEM image of CNT /graphite/epoxy nano composite bipolar plates

Conclusions

CNT is a material that greatly improves the mechanical and electrical properties of bipolar plates. A bipolar plate made of a flat plate having excellent physical properties was produced. With the 7 wt% CNT added noncomposite, the electrical resistance improved by 50% and the flexural strength increased by 20% as compared to that without CNT at the temperature of 160 °C and pressure of 400 kg/cm2.

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References

1. C Yang, Y Lin, CW Nan. (2009). Modified carbon nanotube composites with high dielectric constant, low dielectric loss and large energy density, *Carbon* 47, 1096
2. W Bauhofer, JZ Kovacs. (2009). A review and analysis of electrical percolation in carbon nanotube polymer composites, *Compos. Sci. Technol*, 69, 1486
3. JM Choi, TJ Kim, MS Hyun, DH Peck, SK Kim, BR Lee, JS Park, DH Jung. (2005). Preparation of Bipolar Plate for Fuel Cell Using CNT/Graphite Nano-Composite, *Carbon lett.*, 6, 181