論文の要旨

題名　Development of carbon nanofiber sheet for thermal interface materials and its thermal and mechanical properties

(カーボンナノファイバーを用い熱界面材料用シートの開発とその熱的特性と機械的特性の評価)

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The continuous development of the electronics industry demands for a rapid increase in the heat flux density of electronic components. Without efficient heat dissipation, malfunctions occur in junctions or modules of electronic components because of heat concentration. Thermal interface materials (TIMs), which are used to fill the air gaps between electronic components and heat sinks, reduce the thermal contact resistance and are considered important for improving the heat dissipation efficiency of electronic devices. The development of new TIMs become extremely significant for the heat management of advanced electronic products.

Chapter 1 reviews the scientific background, types of traditional TIMs and advanced carbon TIMs were introduced, and their fabrication method and disadvantages were discussed. A brief introduction to the thermal simulation examples of current study of TIMs was also introduced. Moreover, from the problems of traditional TIMs and previous studies, the idea of a new carbon nanofiber(CNF) sheet with a simple and low-cost fabrication method for developing TIMs was proposed.

Chapter 2 introduced the development of the polyvinyl alcohol(PVA)-based vapor grown carbon nanofiber(VGCF) sheet. A simple and low-cost solution casting method was used as fabrication method. The microstructure, porosity, thickness, density, hardness and thermal conductivity were discussed. In addition, high temperature and humidity test was measured in this chapter.

Chapter 3 describes PVA-VGCF sheet with polytetrafluoroethylene(PTFE) particle additions. The effects of PTFE additions on microstructures, porosity, thickness, density and hardness of composites were investigated, as well as the thermal conductivity before and after the high temperature and humidity test. Fourier-transform infrared spectroscopy (FT-IR) analysis was also carried out to investigate the changes in CNF sheet before and after the high temperature and humidity test.

In chapter 4, thermal simulation was measured with five types of microstructure models: pure PVA, horizontally arranged VGCF in PVA matrix, vertically arranged VGCF in PVA matrix, randomly arranged VGCF in PVA matrix and pure VGCF. The theory of thermal simulation in ANSYS student software was also introduced. The temperature and heat flux distributions of five models were evaluated and compared. Moreover, the thermal conductivity was calculated by using thermal simulation data, which offers a new possible method to predict the thermal conductivity of composite materials.

The results from above chapters were summarized in Chapter 5.