Influence of Temperature on the Resistivity of Carbon Fiber / ABS Resin Composites

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Introduction

Conductive composites composed of carbon fibers and polymers have been used in many fields due to their excellent mechanical properties, variable conductivity, lower density compared with metals and good durability to environment [1]. Temperature and oxidation of carbon fibers have important influence on the material [2]. In the paper, we investigate the influence of temperature on the carbon fibers (unoxidized and oxidized) filled ABS resin composites.

Experimental

After immerged into boiled concentrated nitric acid (68%) for 60 min, polyacrylonitrile (PAN) based carbon fibers (T300) with volume resistivity of 1.8×10^{-3} Ω×cm were extracted in de-ionized water for 72 hours and dried at 120 °C under about 10 MPa vacuum for 24 hours. All carbon fibers (unoxidized and oxidized) were chopped into 6 mm. Then they were dispersed by mechanical stirring in ABS resin, which had been dissolved into paste in chloroform. The fiber filled paste then dried at room temperature. Finally, the composites were molded by hot pressing under 40 MPa at 150 °C for about 5 min. Relative to the volume of ABS resin, the volume fraction of carbon fibers in composites is 5 %, 10 %, 20 % and 30 %. The resistivity of composites with dimensions of 40×9×1 mm was measured in the direction of perpendicular to the pressure by four-probe method. The resistivity at different temperature was tested in constant temperature oven.

Results and Discussion

Fig.1 and Fig.2 show the influence of temperature on the conductive ABS composites filled with unoxidized and oxidized carbon fibers respectively. It can be seen from Fig.1 that the resistivity of composites goes up with the increasing temperature till a certain temperature. When temperature goes up beyond the temperature, the resistivity of composites decreases (Fig.1(a), (b) and (c)) or maintain a very slow increase (Fig.1(c)). Continuously increasing temperature, the composite resistivity goes up again except the sample containing 5 vol % carbon fibers. However, the inverse is true for the composites composed of oxidized carbon fibers. In Fig.2, the resistivity of composites goes down with the increasing temperature up to a minimum value at a certain temperature. Then the resistivity variance of the composites with the increase of temperature is homoplastically the samples in Fig.1.

Conclusions

The volume concentration and the oxidation of carbon fibers can affect greatly the resistivity variance of carbon fibers/ ABS resin composites when temperature increasing.

References

[1] Ahmad M.S., Zihilif A.M., and Martuscelli E. et al, The electrical conductivity of polypropylene and nickel-coated carbon fiber composite, Polymer Composites, 1992; 13: 53-57

[2] Roy D., JANA P.B., De S.K. et al, Studies on the electrical conductivity and galvanomagnetic characteristics of short carbon fibre filled thermoplastic elastomers, J.Mater.Sci, 1996; 31: 5313-5319

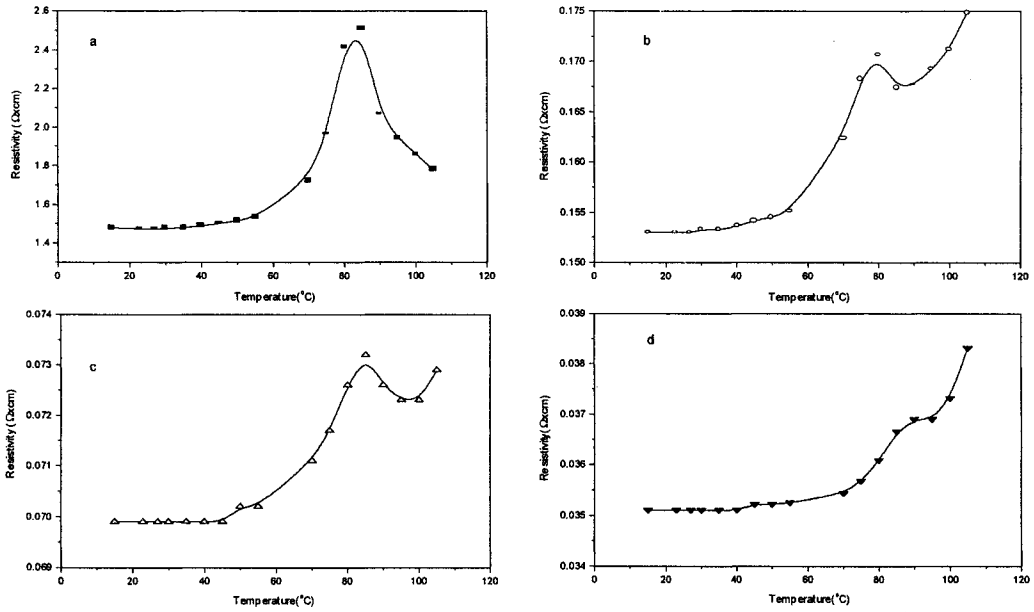

Fig.1 Influence of temperature on the resistivity of composites containing different volume fraction of unoxidized carbon fibers (a) 5 % (b) 10 % (c) 20 % (d) 30 %

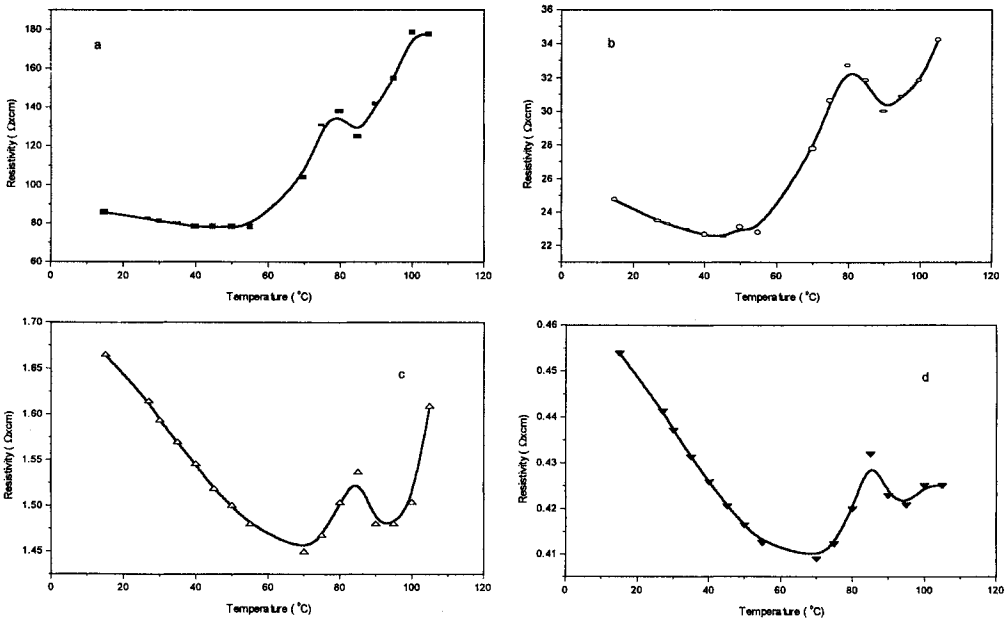

Fig.2 Influence of temperature on the resistivity of composites containing different volume fraction of oxidized carbon fibers (a) 5 % (b) 10 % (c) 20 % (d) 30 %