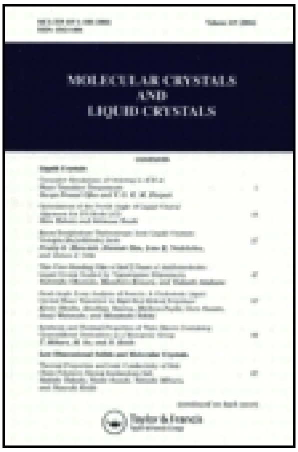

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Temperature Dependence of the Electrical Conductivity of Thermoplastic Polymer/Polyaniline Blend

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Thermally processible polyaniline (PANI) was chemically synthesized by one-step polymerization and blended with various thermoplastic polymers, leading to the blends with the specific volume resistivities ranging from10^2 to 10^4 Ω-cm. PANI blends with the crystalline polymers clearly showed both the positive temperature coefficient (PTC) and the negative temperature coefficient (NTC).

Keywords Thermally processible polyaniline; Electrically conducting polymer blend; Positive temperature coefficient (PTC); Negative temperature coefficient (NTC)

INTRODUCTION

Several researchers have studied the temperature-dependent electrical conductivities of electrically conducting carbon black/polymer blends. The increase and the decrease of resistivity upon heating are called the positive temperature coefficient (PTC) and the negative temperature

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coefficient (NTC), respectively [1-2]. In this work, we report temperature dependence of the electrical conductivity of thermoplastic polymer/polyaniline blends with high electrical conductivity.

EXPERIMENTAL

Thermally processible polyaniline (PANI) was synthesized by one-step chemical polymerization using various concentrations of dodecylbenzene sulfonic acid (DBSA) and ammonium persulfate (APS) as a dopant and an oxidant, respectively. Thermoplastic polymer/PANI blends were then prepared by the conventional melt blending using a Haake Rheomixer. Polymers used as the matrices were HDPE, PP, PS, or ABS. The temperature-dependence of the electrical conductivity of the blend was investigated by monitoring the change of the specific resistivity of the blend upon heating at a rate of 5°C/minute.

RESULTS AND DISCUSSION

We figured out the oxidant concentration was the most important factor to give processibility of the resulting PANI. PANI synthesized with high oxidant concentration lost its processibility. Polymerization using DBSA of 1 mole ratio and APS of 0.75 mole ratio to aniline produced PANI with not only the highest conductivity but also superior processibility, with which electrically conducting blends could be readily obtained. Figure 1 shows the specific resistivities of the PANI blends as a function of PANI content, where specific resistivities were in the range of 10^2 to 10^{10} Ω-cm.

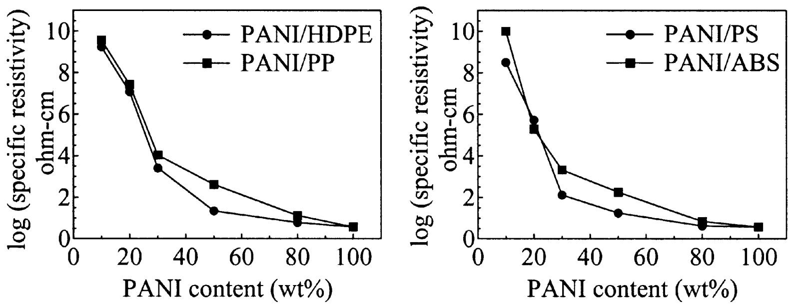

FIGURE 1. Specific resistivities of the blends as a function of PANI content.

The specific volume resistivities of crystalline polymer/PANI blends showed NTC as well as PTC behaviors as shown in Figure 2. The resistivities dramatically increased near their melting temperatures, after which they decreased rapidly with the temperature. The increase of the resistivity at the melting point must be due to separation of PANI particles, resulting from sudden volume expansion of the crystalline polymers during transition from crystalline to amorphous state. The rapid decrease of the resistivity after melting can be explained by formation of a new conducting path through recombination of PANI particles in the polymer matrix.

In the other hand, the blends with amorphous polymers showed less significant PTC and NTC behaviors as shown in Figure 2. PS/PANI blend exhibited a small PTC effect near the glass transition temperature and absence of NTC. The small PTC must result from separation of PANI particles due to gradual volume expansion during transition from glassy to leathery state. PANI particles could not be recombined after PTC effect since the high viscosity of the matrix polymer prevented PANI particles from moving to form a new conducting path, resulting in absence of NTC behavior.

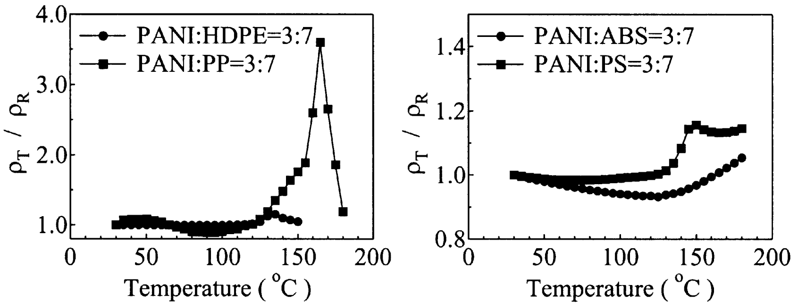

FIGURE 2. Resistivities of the blends normalized with respect to the resistivity at room temperature as a function of temperature.

CONCLUSIONS

In this study, thermally processible PANI were synthesized and blended with various thermoplastic polymers, giving rise to electrically conducting polymer blends. The blends with crystalline polymers showed significant both PTC and NTC effects with increasing temperature.

Acknowledgment

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