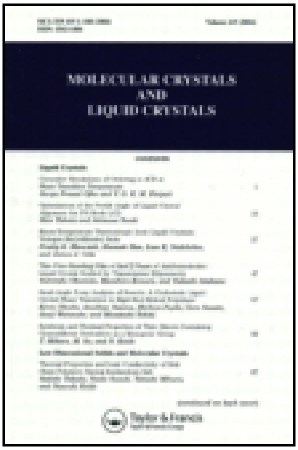

Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Electrically Conducting Polymer Blends with Thermally Processable Polyaniline

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Version of record first published: 24 Sep 2006

Mol. Cryst. and Liq. Cryst., 2001, Vol. 370, pp. 399-402

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Thermally processable polyaniline (PANI) was synthesized by one-step chemical oxidation of aniline, whose electrical conductivity was in the range of 10^{-2} to 1 S/cm. Various kinds of thermoplastic polymers were thermally blended with the processable PANI, giving rise to the electrically conducting polymer blends with the specific volume resistivity of 10^{2} to 10^{10} Ω-cm.

Keywords Thermally processable polyaniline; Thermal blending; Electrically conducting polymer blends

INTRODUCTION

A number of researches [1-4] have been carried out to give electrical conductivity to electrically insulating thermoplastics by applying intrinsically conducting polymers (ICP), since the thermoplastics may cause many serious problems such as accumulation of static electric charge or poor shield of electromagnetic interference. However, insoluble or infusible nature of ICP's has limited their applications.

In this study we report one-step synthesis, characteristics of thermally processable polyaniline (PANI) and the properties of the thermoplastic polymer/PANI blends.

EXPERIMENTAL

PANI was synthesized by a chemical oxidation of aniline using ammonium persulfate (APS) as an oxidant and dodecylbenzene sulfonic acid (DBSA), p-toluene sulfonic acid (p-TSA), anthraquinone sulfonic acid (AQSA) or their mixtures as the dopant. Synthesis conditions are summarized in Table 1. Thermal processability of PANI was evaluated by direct observation of viscous flow when simple shear was applied to the PANI powder on a plate heated at 150℃.

PANI was thermally blended with various thermoplastic polymers and electrical conductivity of the blend was expressed in terms of the specific volume resistivity.

RESULTS AND DISCUSSION

As shown in Table 1, PANI (B, C) doped with only p-TSA or AQSA did not exhibit thermal processability, while PANI doped with DBSA (A) or a mixture of DBSA and p-TSA (E) possessed good thermal processability, indicating that the chemical structure of dopant is extremely important to show processability. DBSA is the best dopant to produce a processable PANI, possibly not only because bulkiness of DBSA can reduce inter- or intramolecular interactions of PANI molecules but because DBSA molecules act as a plasticizer.

TABLE 1. Synthesis condition and the properties of PANI and the polymer blend

PANI	Dopant / Aniline	APS / Aniline	Conductivity of PANI (S/cm)	Thermal processability of PANI	Specific volume resistivity of blend (Ω-cm)
A	DBSA (0.4)	0.75	0.02	processable	1000
B	p-TSA (0.4)	0.75	0.7	no flow	Insulating
C	AQSA (0.4)	0.75	0.8	no flow	Insulating
D	DBSA (0.4)	1.0	0.6	no flow	Insulating
E	DBSA (0.4) p-TSA(0.2)	0.75	0.4	processable	1000
F	DBSA (0.4) p-TSA(0.2)	0.85	0.5	no flow	Insulating

However, it was observed that the oxidant concentration was also important to control processability. PANI (D, F) synthesized with higher concentration of the oxidant lost its processability even though only DBSA was used as the dopant. When mixture of DBSA and p-TSA was used as the dopant, PANI (F) lost its processsbilty even at lower concentration. It is believed that higher oxidant concentration leads to higher molecular weight of PANI, which limits molecular motion of PANI.

PANI with thermal processability could be easily blended with various polymers to give electrical conductivity, where a threshold content of PANI was about 15 weight percent in the blend. However, PANI without thermal processability did never produce electrically conducting blends even at very high content (50 weight percent) of PANI. It can be, therefore, concluded that thermal processability of PANI is a key factor to give conductivity to the blend. Figure 1 shows the change of the specific resistivity of PVC/PANI and PP/PANI as a function of PANI content. Specific resistivity of the blends decreased steeply until 20 weight percent of PANI. PANI synthesized in this study could be also blended with other thermoplastic polymers such as ABS, PS, PMMA, HIPS, LDPE, or HDPE, producing electrically conducting blends, whose specific resistivities were in the range of 10^2 to 10^{10} Ω-cm and low enough to be applied for antistatic applications.

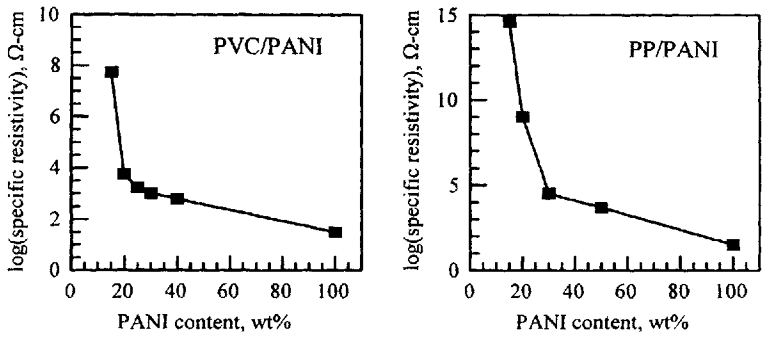

FIGURE 1. Specific volume resistivity of the blends.

CONCLUSIONS

Thermally processable PANI was synthesized using APS as an oxidant and DBSA or mixture of DBSA and p-TSA as a dopant. Thermal blending of the PANI with thermoplastic polymers resulted in thermoplastic blends with high electrical conductivity.

Acknowledgment
Authors with to acknowledge that this work was supported by Korea Research Foundation (Project number : 99-041-E00555E5205).

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