

Electrical and Physical Evaluation of Processable Conductive PANI/PI Blends

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1. INTRODUCTION

Polyaniline (PANI) has emerged as one of the most promising conducting polymers of the many types of conducting polymers in that it is soluble and therefore processable in the conducting form, and it is both environmentally and thermally stable^{1,2)} together with high conductivity when it is doped by functionalized protonic acids like camphorsulfonic acid (CSA) and dodecylbenzenesulfonic acid (DBSA)³⁾. In the conducting emeraldine salt form which use functionalized protonic acids, PANI can easily be miscible with general polymer and solubility together with conductivity can be increased with proper combination of dopant and solvent. Thus, conducting polyblends can be made by co-dissolving the conducting PANI complex and a suitable matrix polymers in a common solvent and processing the conducting blend directly from solution. In this research, we report our observation of electrical properties and physical properties of polyaniline/polyimide blend films by using N-methyl-2-pyrrolidone as a co-solvent of PANI-complex and polyamic acid (PAA).

2. EXPERIMENTAL

Polyaniline powder was prepared by conventional chemical method⁴⁾. PANI-complex solution was obtained by mixing emeraldine base powder with DBSA, CSA and dissolving it in NMP with proper molar ratio ($H^+/PhN = 0.5$)⁵⁾. Polyamic acid was synthesized with ODA and PMDA in NMP. Then, these blend solution was prepared by blending PANI-complex solution with PAA solution with proper weight ratio. And the films were prepared by solvent casting at 50°C under vacuum. These PANI-complex/PAA films were converted to polyimide state by thermal imidization process. Electrical conductivity measurement, wide angle X-ray diffraction patterns, FT-IR, Thermal Gravimetric Analysis (TGA), UV-vis absorption spectra, Dielectric properties, x-ray photoelectron spectroscopy (XPS) were performed.

3. RESULTS AND DISCUSSIONS

The effect of PANI content on the electrical conductivity of the blend films is plotted in Figure 1. The percolation threshold of the PANI-CSA/PAA and PANI-DBSA/PAA are 20 wt % and 5 wt%, respectively. It indicates that the dopant of the PANI in the blends leads to the difference in percolation threshold conductivity.

The WAXD patterns of the blends are illustrated in Figure 2. ring around $2\theta = 19.5^\circ$. In PANI-CSA/PAA, the peaks are shown at $2\theta = 14.4, 25.2^\circ$. PANI-DBSA/PAA shows sharp scattering peak at $2\theta = 2.5^\circ$ together with amorphous scattering at 19° . Thus, it is concluded that chain structure of the blends is dependent on dopant in the PANI.

UV-vis spectra of PANI-DBSA/PAA and PANI-CSA/PAA are shown in Figure 3-A and B. Both samples show three distinctive absorption peaks at about 650 and over 860 nm, which are attributed to the exciton band of quinoid ring and localized polaron band, respectively, together with shoulder like peak at around 440 nm. When the PANI-dopants are blended with PAA with proper ratios, two spectra are slightly different without changing the tendency. Compared with the spectra of PANI-DBSA/PAA, the polaronic band of above 860 nm of PANI-CSA/PAA reveals at higher wave number indicative of higher conjugation length. So we can conclude that the dopants affect the chain structure and blend behavior in the PANI-dopant/PAA system.

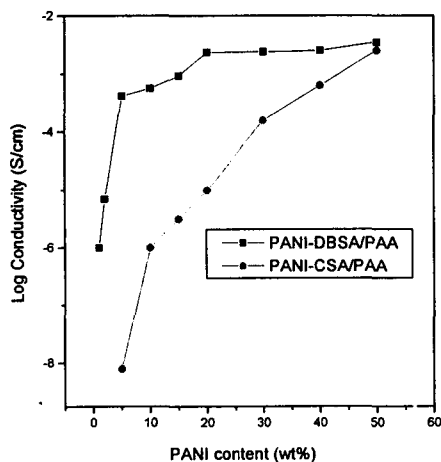


Figure 1. Log (conductivity) versus PANI content.

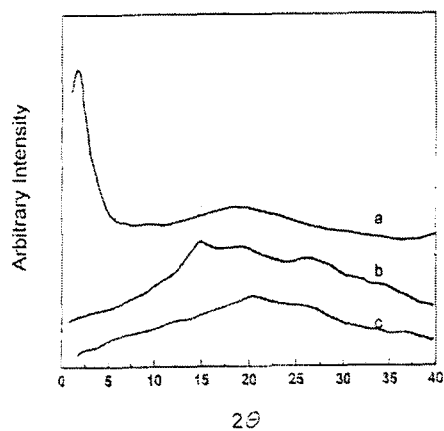


Figure 2. WAXD patterns of (a) PANI-DBSA/PAA, (b) PANI-CSA/PAA, (c) PAA

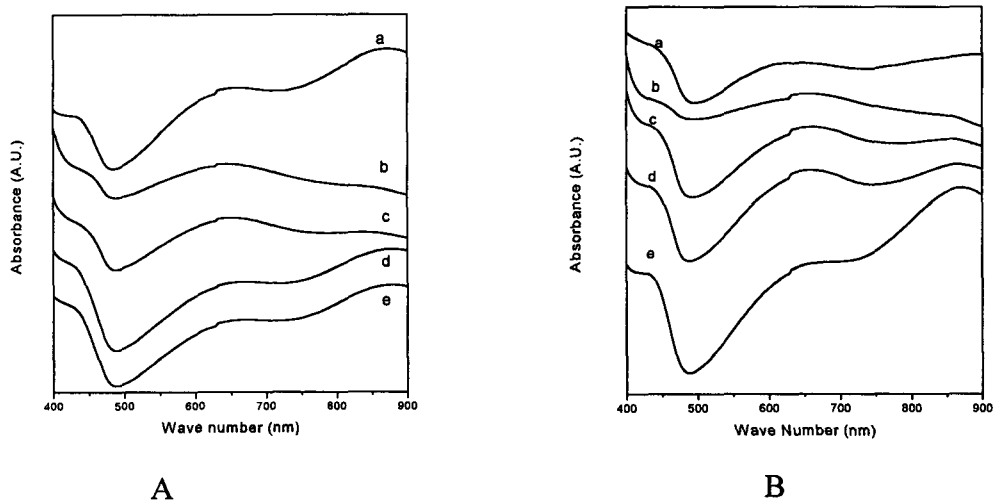


Figure 3. UV-vis spectra of A ; DBSA-doped blend, B ; CSA-doped blend - (a) PANI-dopant, (b) PANI-dopant/PAA (2 wt %), (c) the same blends (5 wt %), (d) 20 wt %, (e) 50 wt %.

4. CONCLUSIONS

It was shown that polyaniline/polyamic acid blend films could be prepared with DBSA-doped · CSA-doped polyaniline solution and polyamic acid solution by solvent casting using NMP as a co-solvent. The percolation threshold of the DBSA-doped blends was lower than CSA-doped blends. The structures of the blends were different with varying the dopants. The compatibility of the DBSA-doped blends were lower than CSA-doped blends verified from TGA and Dielectric.

5. REFERENCES

1. W. W. Focke, G. E. Wnek, and Y. Wei, *J. Phys. Chem.* 94 (1990) 7716
2. A. G. MacDiarmid, J. C. Chiang, M. Halpern, W. S. Huang, S. L. Mu, N. L. D. Somasiri, W. Wu, and S. I. Yaniger, *Mol. Cryst, Liq. Cryst*, 121 (1985) 173
3. A. G. MacDiarmid, A. J. Epstein, *Synth. Met.*, 65 (1994) 103
4. Y. Wei, G. W. Jang, K. F. Hsueh, E. M. Scherr, A. G. MacDiarmid, and A. J. Epstein, *Polymer*, 33 (1992) 314
5. Y. Cao, J. Qiu, and P. Smith, *Synth. Met.*, 69 (1995) 187