하이퍼브랜치 폴리우레탄-탄소나노튜브 나노복합체

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Hyperbranched Polyurethane-Carbon Nanotubes Nanocomposites

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1. Introduction

Carbon nanotubes(CNTs)-based materials have attracted great attention of researchers because of their thermal, electrical, mechanical and optical properties[1]. Among these properties, one of main problems of CNTs is their insolubility in many solvents due to the van der Waals interactions between CNTs. Several efforts have been made to make CNTs soluble in both organic and aqueous solution by functionalization[2]. Recently we have tried an application of hyperbranched polymer to dispersed polymer-CNT nanocomposites due to the high solubility and low viscosity of hyperbranched polymers[3]. The hyperbranched polymers have high capability to compatibilize with other polymers or additives. Further, a large number of functional groups of the hyperbranched polymer may help in better dispersion of CNTs into polymer matrix.

In this study, the caster-oil based polyurethane hyperbranched polymer is synthesize to prepare CNT nanocomposites with an enhanced dispersion of MWNTs, and the structural and thermal properties as well as dispersion of MWNTs for the nanocomposites are investigated.

2. Experimental

Vegetable oil-based hyperbranched polyurethanes containing different hard segments were synthesized in two steps process. First, the prepolymer was prepared from a reaction of MDI and poly(ε-caprolactone)diol(PCL-diol) under nitrogen atmosphere at 70°C for 3 h. After completion of prepolymer, the required amounts of castor oil and 1,4 butanedio(BD) were added. The modified multi-walled carbon nanotubes(MWNTs) by chemical treatment in acids were added. The reaction temperature then increased slowly up to 110°C and continued the reaction for 150 min under the same condition. After completion of reaction, the final product solution was poured on glass Petri-dish, and the solvent was evaporated at 60°C. The final samples containing different hard segments (HS) were prepared, and were named as HPU-36 (without MWNTs, HS36%), HPU-NT-30 (with MWNTs, HS30%), HPU-NT-36 (with MWNTs, HS36%), HPU-NT-40 (with MWNTs, HS40%).

3. Results and Discussion

The successful synthesis of hyperbranched polyurethane using caster oil and PCL with MDI was confirmed by FT-IR and NMR spectroscopic measurements. The chemical structure of the hyperbranched polyurethane synthesized in this study is shown in Figure 1. The effect of

hyperbranched PU on the dispersion of MWNTs in the nanocomposites was measured using a solubility test as shown in Figure 2. It can be clearly seen that the hyperbrached PU makes dispersion of MWNTs better compared to the nanocomposites with pure PU.

For the MWNTs nanocomposites including hyperbranched PU, TGA measurements were carried out to analyze the effect of presence of MWNTs on the thermal degradation of hyperbranched polurethanes. The pristine MWNT showed no weight loss below 600°C, whereas the neat polyurethane showed a large weight loss around 435°C. There was some significant effect in the nanocomposites including hyperbranched PU. The X-ray diffraction measurements for MWNT nanocomposites were performed. The two intense peaks at $2\Theta=21.20^{\circ}$ and 23.40° due to PCL crystals were shown in the samples, which indicated no significant change in crystal structure of PCL due to the addition of MWNTs, however, the presence of MWNTs affected the crystallinity of hyperbranched PU.

4. Conclusion

The hyperbranched polyurethane was successfully synthesized and the MWNTs nanocomposites including hyperbranched PU showed the enhanced dispersion of MWNTs. It was ascribed that the peculiar properties of the hyperbranched polymer helped in dispersion of MWNTs.

References

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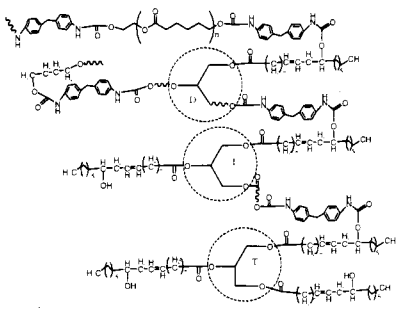

Figure 1. Chemical structure of hyperbranched polyurethane synthesized in this study.

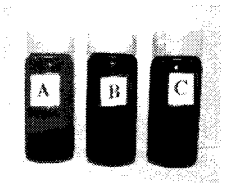

Figure 2. Solubility test results obtained in pristine MWCNT (A), PU/CNT nanocomposites without(B) and with(C) hyperbranched PU in DMF after 1 week.