Chinese Chemical Letters Vol. 16, No. 12, pp 1597-1599, 2005 1597
http://www.imm.ac.cn/journal/ccl.html

Synthesis and Characterization of a Hydrophilic/Hydrophobic IPN Composed of Poly(vinyl alcohol) and Polystyrene

Yi Zhen TAN, Man Cai XU*, Hai Tao LI

College of Chemistry and Chemical Engineering, Hunan Normal University, Changsha 410081

Abstract: A hydrophilic/hydrophobic interpenetrating polymer network (IPN) of poly (vinyl alcohol) / polystyrene was prepared by conversion of the IPN of poly (vinyl acetate)/polystyrene. The hydrophilic/ hydrophobic IPN was characterized by FT-IR and DSC, and the swelling ratios of the IPN in different solvents were measured.

Keywords: Hydrophilic/hydrophobic interpenetrating polymer network, poly(vinyl alcohol), polystyrene.

Interpenetrating polymer networks (IPNs) are a part of the broad class of polymer blends. Today there are many papers, patents and applications of IPNs. However, it is difficult to synthesize hydrophilic/hydrophobic IPNs directly. The intense repulsive interaction between the incompatible network components resulted phase separation in synthetic process. Few hydrophilic/hydrophobic IPNs have been reported [1,2]. In our work, poly(vinyl alcohol) / polystyrene hydrophilic/hydrophobic IPN was prepared by a novel method. Its primary characterization was reported in this paper.

The IPN was prepared by sequential-IPN method. Firstly, gel-type poly(vinyl acetate-co-triallyl isocyanurate) (shorted as PVAc) beads were synthesized using free-radical suspension polymerization technique, and the mass ratio of vinyl acetate to triallyl isocyanurate was 98:2. Secondly, the PVAc beads were swollen in the monomer mixture of styrene, divinylbenzene and BPO overnight, and then the monomer mixture was polymerized by free-radical suspension polymerization technique to obtain the PVAc/PS IPN. The mass ratio of styrene to divinylbenzene was 99:1, and that of the first network to the second one was 41:59.

The PVAc/PS IPN beads were alcoholysised in sodium hydroxide (3% wt) methanol solution at 40°C for 14 h with stirring. After filtrating and washing with hot water and acetone, the PVA/PS IPN beads were obtained, and the mass ratio of PVA to PS in the IPN

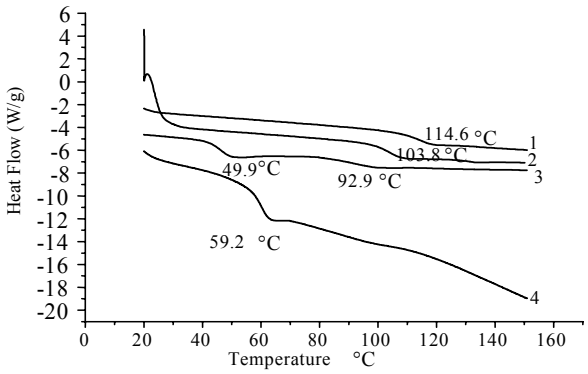
* E-mail: xu_mc@yahoo.com.cn

was 29:71. The hydroxyl value of the PVA/PS IPN was 5.86 mmol/g, determined according to the reference[3].

FT-IR spectrum of PVAc, PVA, PS, PVAc/PS IPN and PVA/PS IPN were obtained on Nicolet Nexus 670. The FT-IR spectrum of PVAc/PS showed the presence of the strong absorption of ester group at 1793 cm^{-1}. This peak nearly disappeared and the strong absorption of hydroxyl group was presented at 3383 cm^{-1} when PVA/PS IPN was alcoholyzed from PVAc/PS IPN.

The differential scanning calorimetry (DSC) of PVA, PS, PVAc/PS IPN and PVA/PS IPN was measured. DSC analysis of PVAc/PS IPN showed two glass transition temperature at 49.9°C and 92.9°C. It implies that the phase separation in the PVAc/PS IPN existed. But DSC analysis of PVA/PS IPN showed only one T_g , which was higher than the T_g of PVA (59.2°C) and PS (103.8°C) (shown in **Figure 1**). This result might be caused by the unusual hydrogen bonding[4] between the hydroxyl groups (in PVA network) and the benzene rings (in PS network). The hydrogen bonding diminished phase separation.

Figure 1 DSC traces of PVA, PS, PVA-PS IPN, PVAc-PS IPN



1: PVA/PS IPN 2:PS 3: PVAc/PS IPN 4: PVA

The swelling ratio of PVA/PS IPN in different solvents is represented by the amount of solvents needed for swelling per gram of PVA/PS IPN beads. The swelling ratio was measured as follows: PVA/PS IPN beads swelled in different solvents for 24 h and weighing the mass of the beads before and after swelling. The results are showed in **Table 1**.

The results in **Table 1** showed that PVA/PS IPN beads have higher swelling ratio in solvents containing benzene ring and hydrogen-bonding donator and/or acceptor, such as aniline, N, N-dimethylaniline, *m*-cresol and phenol, and this may be caused by two factors. One factor is that the π-π stacking interaction between benzene rings of the solvents and those of PS network increased the swelling ratio; and the other factor is that hydrogen bonding between the hydrogen-bonding donators (*i.e.* hydrogen atoms of the phenolic

hydroxyl groups) or acceptors (*i.e.* nitrogen atoms of aniline and N, N-dimethylaniline) of these solvents and the hydroxyl groups of PVA network. The cooperative interactions of π-π stacking interaction and hydrogen bonding make the solvents penetrating into the PVA/PS IPN beads relatively easily. This IPN can be expected to find its use in adsorptive separation of organic compounds. Further investigations are in progress.

Table1 The swelling ratios of PVA/PS IPN beads in different solvents, T=45°C

Solvent	Swelling ratio		
	g/g	mmol/g	mL/g
cyclohexane	0	0	0
toluene	0.39	4.23	0.45
aniline	0.52	5.56	0.51
N,N-dimethylaniline	0.51	4.21	0.53
water	0.06	3.33	0.06
cyclohexanol	0	0	0
phenol	1.95	20.72	1.84
m-cresol	1.23	11.39	1.19

Acknowledgment

This work is supported by the National Natural Science Foundation of China (No.20474015) and the Scientific Research Fund of Hunan Provincial Education Department (No.04A029).

References

1. J. H. Lee, S. C. Kim, *Macromolecules*, **1986,** *19*, 644.
2. A. K. Bajpai, J. Bajpai, S. Shula, *Reactive Functional Polymer*, **2002**, *43*, 4341.
3. C. P. Wu, C. H. Zhou, F. X. Li, *Experiments of Polymer Chemistry*, Anhui Science and Technology Press, Hefei, **1989**, 271.
4. I. Rozas, I. Alkorta, J. Elguero, *J. Phys. Chem. A,* **1997**, *101,* 9457.

Received 11 March, 2005