

NOTE

A Further Study of Interpenetrating Polymer Networks of Poly(2,6-Dimethyl-1,4-Phenylene Oxide) and Polybutadiene: Effect of Higher Molecular Weight Crosslinker

INTRODUCTION

We showed previously¹ that a single intermediate glass transition temperature (obtained from differential scanning calorimetry) was found for the full IPNs formed from poly(2,6-dimethyl-1,4-phenylene oxide) (PPO) crosslinked with ethylene diamine (ED) and polybutadiene (PB) crosslinked with ethylene glycol dimethacrylate (EDGM) over the whole composition range. These apparently single phase full IPNs exhibit a maximum tensile stress to break around 10% by weight PB and a maximum in elongation to break at 80% by weight PB. To investigate the change in IPN properties when ED is replaced by a considerably higher molecular weight crosslinker for the PPO, we have synthesized the corresponding full IPNs of PB (still crosslinked with EDGM) and PPO now crosslinked with a polyoxyalkylenediamine of number average molecular weight, $M_n = 600$. The resulting IPNs, having the same molecular weight between crosslinks of both networks as those of Ref. 1, exhibit microphase separation over a considerable composition range as seen by the optical opaqueness of the samples and the presence of two glass transition temperatures (T_g).

EXPERIMENTAL

The high molecular weight diamines, Jeffamine ED-600, was supplied by Texaco Chemical Co. It is an $M_n = 600$ polyoxyalkylenediamine [i.e., oxirane, methyl-polymer with oxirane, bis(2-aminopropyl ether)] and was dried at room temperature under a vacuum of about 2 mm Hg for 16 h prior to using. The purification of the other materials and the procedure for the synthesis of the IPNs was the same as that employed in Ref. 1. From the employed stoichiometry the number average molecular weights between two crosslinks of the PPO network and PB network were the same as those of our previous study,¹ 3000 and 4000, respectively.

MEASUREMENTS

Ultimate Properties. The tensile strength (TS) and elongation at break were measured at room temperature on an Instron Table Model 1130 universal tester (ASTMDI708) with crosshead speed of 2 in./min.

Differential Scanning Calorimetry (DSC). The glass transition temperatures were determined on a DSC V4.0B DuPont 2100 differential scanning calorimeter with a scanning rate of 20°C/min from -120 to 250°C.

RESULTS AND DISCUSSION

The measured mechanical and thermal properties of the IPNs are listed in Table I. Like the IPNs of our previous study,¹ our new PPO/PB IPNs exhibit also not only a maximum in the tensile strength to break (around 10% PB) but also a maximum in the elongation to break (around 80% PB). We speculate that the 10% by weight PB composition may reflect a maximum extent of catenation of the two networks.²⁻⁴ Thermal analysis showed that both the 10% by weight of PB composition and 80% by weight of PB composition exhibit a single glass transition temperature, in between the T_g values of pure crosslinked PB and PPO. On the contrary, the 20, 40, and 60% by weight of PB compositions have two inward shifted glass transition temperatures and exhibit microphase separation. This is due perhaps to a variety of factors, such as differences in enthalpy of mixing due to the longer crosslinks or perhaps less favorable for miscibility elastic free energy

TABLE I
Results of Measurements of the Full IPNs

Sample	Composition (wt % PPO-PB)	Appearance ^a (color, transparency)	Tensile strength (psi)	Elongation at break (%)	T_g (°C)
Crosslinked PPO	100-0	PY, TP	6725	8.8	187
FIPN 10	90-10	PY, OP	7580	11.1	178
FIPN 20	80-20	PY, OP	4607	9.4	-78, 169
FIPN 40	60-40	PY, OP	1184	15.8	-85, 175
FIPN 60	40-60	PY, OP	56	13.7	-76, 186
FIPN 80	20-80	PY, TU	12.1	327	-78
Crosslinked PB	0-100	Colorless, IP	39.3	29.8	-85

^a PY = pale yellow, TP = transparent, TU = translucent, OP = opaque.

contributions⁵ to the free energy of mixing, to mention but two. It was expected that the crosslinked PPO and 10% by weight PB composition IPNs exhibit a lower glass transition temperature than those of the corresponding polymers crosslinked with ethylenediamine because of the local flexibility of the aliphatic ether group and the longer chain length of Jeffamine ED-600.

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YAO-HE HUA
HARRY L. FRISCH

Department of Chemistry
State University of New York
Albany, New York 12222

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