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Miscibility of phenolphthalein poly(ether ether ketone) with poly(hydroxy ether of bisphenol A) and polysulfone

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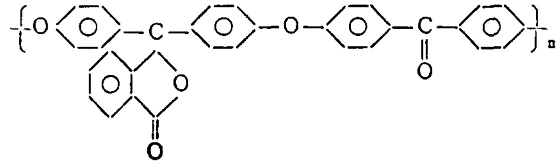
SUMMARY

A novel poly(ether ether ketone) (PEK-C) from phenolphthalein was found to be miscible with poly(hydroxy ether of bisphenol A) (phenoxy) as shown by the existence of a single glass transition temperature (Tg) in each blend. A FTi.r. study revealed that a hydrogen-bonding interaction occurs between these two polymeric components and its strength is weaker than that in pure phenoxy. PEK-C was judged to be miscible with polysulfone based on the existence of a single composition-dependent glass transition temperature.

INTRODUCTION

Phenolphthalein poly(ether ether ketone) (PEK-C) with structural formula



and Tg = 228°C is a novel amorphous high performance thermoplastic developed by this laboratory (1). Recently, our attention has been devoted to blends of it with other thermoplastics. In this brief report, we present the miscibility of PEK-C with poly(hydroxy ether of bisphenol A) (phenoxy) and polysulfone (PSF).

EXPERIMENTAL

PEK-C ($\bar{M}n$=12,000) was supplied by Xuzhou Chemical Factory; phenoxy ($\bar{M}w$=43,000) and PSF ($\bar{M}w$ = 59,000, $\bar{M}w/\bar{M}n$ = 1.81) were commercial products.

Blends were prepared by solution casting from chloroform. Solvent was allowed to evaporate slowly at room temperature. The blends were then dried in a vacuum oven at room temperature for 2 weeks and at 100°C for 48 hours.

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Glass transition temperature (Tg) of various samples was measured with a Perkin-Elmer DSC-2C differential scanning calorimeter at a heating rate 20 °C/min. The initial onset of the change of slope in the heat capacity plot from the second scan was taken as Tg.

A Perkin-Elmer 580B FTi.r. spectrometer was used to record absorption spectra at room temperature. A minimum of 30 scans at a resolution of 3 cm^{-1} were signal averaged. Sufficiently thin films were required to be within the absorption range where the Beer-Lambert law is obeyed (2).

RESULTS AND DISCUSSION

All the PEK-C/phenoxy blends were transparent. Each blend showed a single composition-dependent Tg indicating its single-phase nature. Thus, PEK-C is miscible with phenoxy over the entire composition range. The Tg data for the blends as shown in Fig. 1. can be described by the use of Gordon-Taylor equation (3)

$$Tg = (w_1Tg_1 + kw_2Tg_2)/(w_1 + kw_2)$$

Here, Tg is the glass transition temperature of the blend, whereas Tg_1 and Tg_2 are the glass transition temperatures of the component 1 and

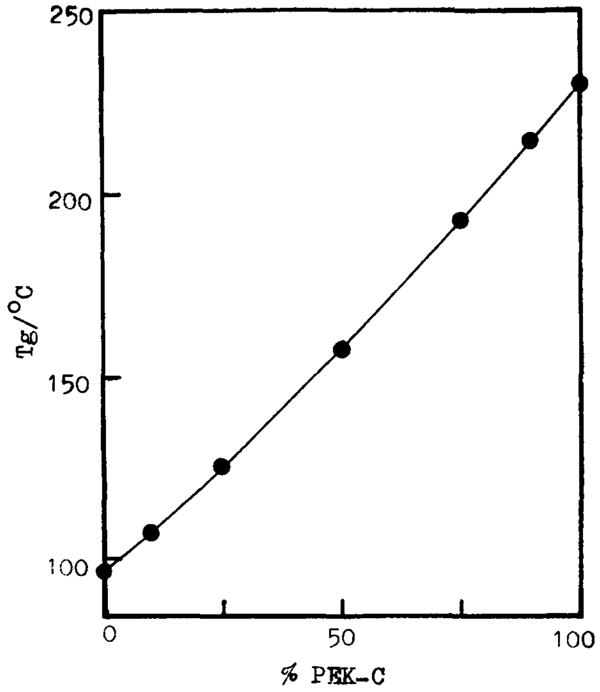

Figure 1. Tg of PEK-C/phenoxy blends.

component 2, respectively, w is the weight fraction, and k is a constant. It has been suggested (4) that the value k relates to the strength of interaction between the components in the blend. However, no theoretical basis for such a relationship has suggested. The curve in Fig. 1 is drawn using the Gordon-Taylor equation with a k value of 0.87.

Phenoxy is miscible with many polyesters and polyethers (5-10). Coleman and co-workers (9,10) have shown that there are hydrogen-bonding interactions involving the phenoxy hydroxyl groups and either the carbonyl or the ether oxygen moieties of the other polymers. Fig. 2 shows infra-red spectra in the 3000 to 3800 cm^{-1} region of pure phenoxy (denoted A) and PEK-C/phenoxy blends containing 10, 25 and 50 weight percent PEK-C, all recorded at room temperature. As shown by Coleman and Moskala, the spectrum in this region of pure phenoxy may be considered to be composed of two component: a broad band centred at 3400 cm^{-1} attributed to hydrogen bonded hydroxyl groups (self-associated) and a relatively narrow band at 3570 cm^{-1} assigned to free (non-associated) hydroxyl groups. Upon mixing with PEK-C, the broad hydrogen bonded hydroxyl band of the phenoxy is observed to shift to higher frequencies as a function of increasing PEK-C concentration indicating that the hydrogen-bonding interaction between hydroxyl groups of phenoxy and PEK-C is presented and its strength is weaker than that in pure phenoxy. Hence, given that the PEK-C/phenoxy blend system is miscible, this must imply that the resulting balance between the enthalpy and entropy of mixing leads to an overall decrease in the free energy of the system.

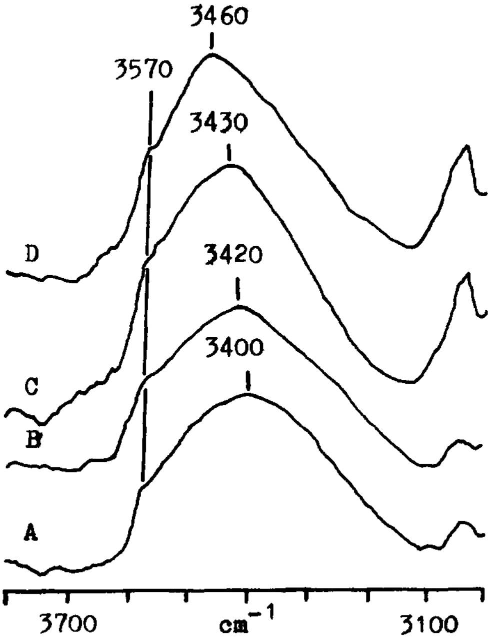

Figure 2. FTi.r. spectra of the region from 3800 to 3000 cm^{-1} recorded at room temperature of PEK-C/phenoxy blends containing: (A)0,(B)10, (C)25 and (D)50 weight percent PEK-C.

PEK-C/PSF blends were also transparent and each blend showed only one composition-dependent Tg as shown in Fig. 3. These suggested that PEK-C is miscible with PSF. The curve in Fig. 3 is drawn by using the Gordon-Taylor equation with a k value of 0.54. The miscibility between PEK-C and PSF may be due to the similarity in structure of the two polymers.

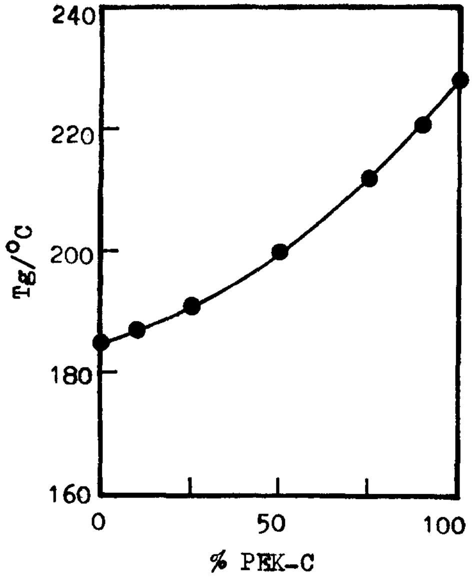

Figure 3. Tg of PEK-C/PSF blends.

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