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Glass Transition Temperature – Molecular Weight Relation of a Poly(Amide-Imide)

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Summary

Several fractions of a poly(amide-imide), prepared from 3,4-dicarboxy-4'-chloroformyl biphenyl anhydride and 4,4'-methylene dianiline, were studied in order to determine the Tg^{∞} and K values of Fox-Flory relationship.

Introduction

Specially at lower molecular weight, the glass transition temperature depends strongly on the molecular weight due to the free volume around to chain ends. So, FOX and FLORY (1) deduced the expression

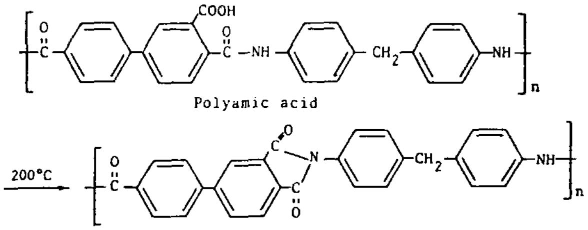
$$Tg = Tg^{\infty} - KM^{-1}$$

where Tg^{∞} is the glass transition temperature of an infinite molecular weight polymer, Tg the glass transition temperature at molecular weight M and K a constant.

In this work we describe the molecular weight effect on the glass transition temperature of a poly(amide-imide)(PAI) synthetized in N,N-dimethyl acetamide solution at low temperature from 3,4-dicarboxy-4'-chloroformylbiphenyl anhydride and 4,4'-methylenedianiline.

Results and Discussion

The PAI was synthetized in solution according to TAGLE and DIAZ (2).



The polyamic acid was fractionated with m-cresol/cyclohexane as solvent/precipitant pair. The viscosimetric measurements were obtained from the fractions of the polyamic acid. The glass transition temperature were obtained from PAI films of the fractions. With the viscosimetric measurements, the molecular weights were calculated applying the Mark - Houwink relationship, using values of a and K, 0,8 and $1,84 \cdot 10^{-4}$, respectively (3).

Table I gives the values of $[\eta]$, Tg and $\bar{M}_V$ for the different fractions of the PAI. Figure 1 shows the dependence of Tg on the reciprocal of molecular weight. A linear relationship was obtained between Tg and $\bar{M}_V{}^{-1}$, with Tg^{∞} and K 446°C and $8,25 \cdot 10^{-5}$, respectively.

TABLE I

Data of M_V, $[\eta]$ and Tg for the different polymer fractions.

Fractions	$[\eta]^a$	$M_V \cdot 10^{-3}$	$Tg(°C)^b$
I	0.32	11.15	375
II	0.30	10.29	366
III	0.29	9.86	361
IV	0.28	9.44	354
V	0.25	8.19	348

a: dl g^{-1}, DMAc at 25°C
b: DSC-1B, 16°C/min, N_2.

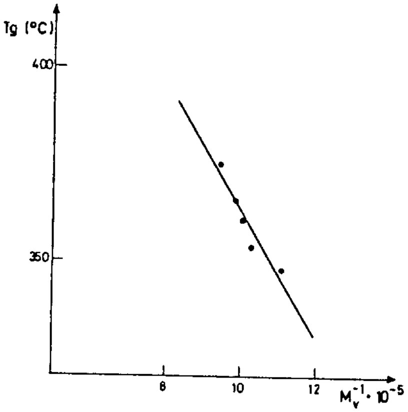


Fig. 1. Plot of Tg versus $M_V{}^{-1}$ for the fractions of the PAI.

The results is a high value of Tg^{∞} and is in good agreement with the Tg values for other PAI, derived from the same monomer (2) and from trimellitic chloride anhydride (4), both with aromatic diamines. PAI with aliphatic diamines present lower values as a consequence of the flexibility of the aliphatic groups in the main chain (5). Aromatic rings of the biphenyl and diamine group have an important influence in the glass transition temperature.

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References

(1) FOX, T.J. and FLORY, P.J., J. Appl. Phys., 21, 581 (1950)
(2) TAGLE, L.H. and DIAZ, F.R., Polymer, 23, 1057 (1982)
(3) WALLACH, M.L., J. Polym. Sci., A-1, 5, 653 (1967)
(4) FRIGERIO, P.F., TAGLE, L.H. and DIAZ, F.R., Polymer, 22, 1571 (1981)
(5) TAGLE, L.H., NEIRA, J.F., DIAZ, F.R. and RAMIREZ, R.S., J. Polym. Sci., Polym. Chem. Ed., 13, 2827 (1975)

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