

Evaluation of Molecular Orientation on Biopolyimide Film Using Polarized ATR/FT-IR

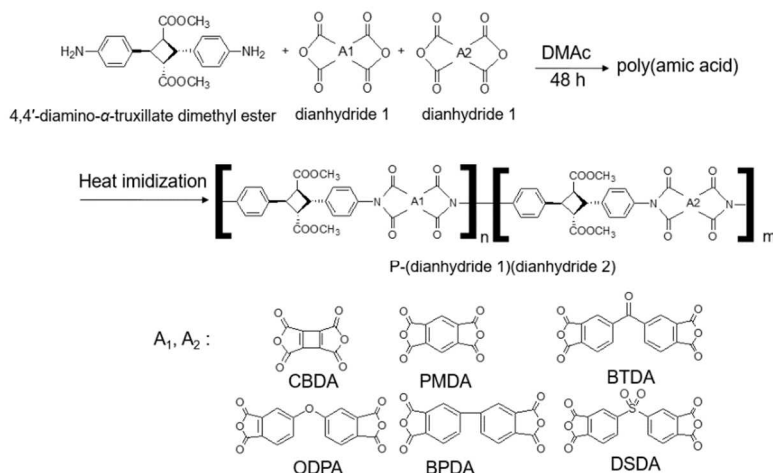
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Introduction

We have prepared bio-based polyimides (BPI) with high thermal and mechanical performances by a polymerization of photodimers of microbial 4-aminocinnamic acid with dianhydrides [1, 2]. The thermomechanical properties such as coefficient of linear thermal expansion are significantly affected by the orientation of BPI films [3]. Here the orientation of the BPI film is analyzed by ATR-FTIR spectroscopy [4], providing the orientation information of polyimide chain by monitoring the IR absorption of C-N bond which is representative of polyimide chains. Birefringence of the BPI films is quantitatively analyzed by polarized microscopy.



Scheme 1. Synthetic Route and Chemical Structures of BPI Copolymers Derived from 4,4'-Diamino- α -truxillate with Two Dianhydrides

Results and Discussion

BPI were prepared by a polymerization of aromatic diamine, 4,4'-diaminotruxillate dimethyl, with stoichiometric amounts of dianhydride monomers: CBDA, PMDA, BTDA, ODPA, BPDA, and DSDA (Scheme 1) [1]. Based on ATR/FT-IR spectra of PI films (Nicolet AVATAR320 IR spectrometer), the orientation coefficient was calculated from degree of absorption around 1363 cm⁻¹ (ν (C-N) axial stretching). The birefringence was estimated by in-plane and out-of-plane refractive indices, which were measured using a prism-coupler (Metricon, Model PC-2000) at a wavelength of 1310 nm. Both techniques revealed that the BPI composed of dianhydrides, CBDA, PMDA or BPDA exhibited the high degree of chain orientation, due to steric geometric conformation of dianhydrides. We will discuss orientation-properties relationships of BPI films.

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References:

- [1] Suvannasara, P., et al. *Macromolecules*, 47(5), 1586-1593 (2014).
- [2] Shin, H., Kaneko, T. et al. *Ind. Eng. Chem. Res.* 55(32), 8761-8766 (2016).
- [3] Park, S.C., Liang, Y., and Lee, H.S. *Macromolecules*, 37(15), 5607-5614 (2004).
- [4] Flournoy, P.A. Schaffers, W.J. *Spectrochimica Acta*, 22(1), 5-13 (1966)

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