Polymer Design for High Performance Transparent Polyimides

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Introduction

Generally speaking in polymer design, the characteristics of heat-resistance and transparency exhibit a trade-off relation, which has strong relationship with electron density of main chain. We report the polymer design for the high performance transparent polyimides (PIs) with high Tg, low CTE, and low birefringence.

Experimental

Transparent PIs were prepared by polyaddition with a combination of various aromatic diamines and aliphatic tetracarboxylic dianhydrides and by following chemical imidization with pyridine-acetic anhydride. PIs were purified by reprecipitation with large amount of methanol and dried *in vacuo*. Films were obtained by solvent-casting method from NMP solution.

Results and Discussion

1) Design for heat resistance

We will discuss on the viewpoints of keeping high Tg and transparency with a selection of aliphatic dianhydrides, TCA (3-calboxymethyl 1,2,4-cycopentane tricalboxylic acid 1,4-, 2,3-dianhydride), BODA (bicyclo[2.2.2]octane 2,3,5,6-tetracalboxylic dianhydride), BTDA (cyclobutane-1,2,3,4-tetracalboxylic dianhydride) and aromatic dianhydride as a reference 6FDA (4,4'-(hexafluoroisopropylidene)diphthalic anhydride). Especially a series of PI with TCA moieties could provide transparent films with combination of wide range of aromatic diamines. Introducing unsymmetrical bicyclic structure like TCA contributes exhibiting transparency and increasing of Tg, as a superior example PI showing above 350^{0}C.

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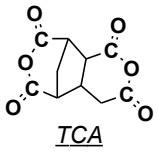
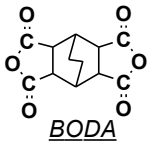

TCA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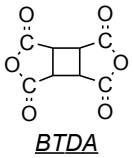
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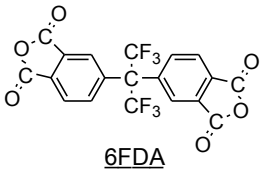
6FDA

2) Design for low coefficient of thermal expansion (CTE)

Some of necessary factors for low CTE of polymer design are introducing rigid structure and intermolecular interaction. We designed PIs with amide-linkage moieties satisfied above necessary. TCA PIs containing higher content of amide-linkage moieties showed lower CTE less than 30ppm/K with keeping good solubility as used solvents in PI preparation.

3) Design for low birefringence

We successfully obtained both low coefficient of stress-optical and photoelasticity by introducing fluorene moiety which can cancel birefringence perpendicular to main polymer chain. We will introduce some characteristics of this transparent film for optical application.