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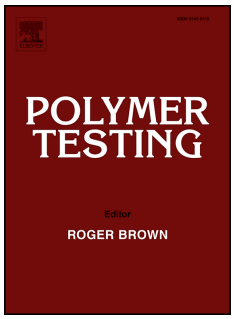

Synthesis and characterization of high-barrier polyimide containing rigid planar moieties and amide groups

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Synthesis and characterization of high-barrier polyimide containing rigid planar moieties and amide groups

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Abstract

A high-performance polyimide was prepared by the dipolymerization of 4,4'-diaminobenzanilide (DABA) and pyromellitic dianhydride (PMDA). Due to the introduction of rigid planar moieties and amide groups, the polyimide shows outstanding properties, such as high glass transition temperatures (435 °C), excellent thermal stability ($T_{d5\%}$, 542 °C, coefficient of thermal expansion, -3.2 ppm K^{-1}), and superior mechanical properties. Most importantly, the polyimide exhibits excellent barrier properties, with oxygen transmission rate (OTR) and water vapor transmission rate (WVTR) low to 7.9 cm^3 $(m^2\ day)^{-1}$ and 5.1 g $(m^2\ day)^{-1}$, respectively. Wide angle X-ray diffractograms (WAXD), positron annihilation lifetime spectroscopy (PALS) and molecular dynamics simulations reveal that the excellent barrier properties are mainly attributed to the high crystallinity, high extent of in-plane crystalline orientation, and low free volume, which are resulted from the rigid planar structure and strong interchain hydrogen bonding. The high-barrier and thermally stable polyimide has an attractive potential application prospect in the fields of micro-electronics encapsulation and high grade packaging industry.

Keywords: functional polyimide; rigid planar moieties; free volume; barrier properties; thermal properties