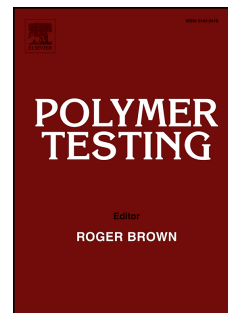


Accepted Manuscript

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PII: S0142-9418(17)30152-6

DOI: [10.1016/j.polymertesting.2017.05.007](https://doi.org/10.1016/j.polymertesting.2017.05.007)

Reference: POTE 5013

To appear in: *Polymer Testing*

Received Date: 8 February 2017

Revised Date: 29 April 2017

Accepted Date: 9 May 2017

Please cite this article as: J.-J. Liu, J.-H. Tan, Y. Zeng, Y.-W. Liu, K.-J. Zeng, Y.-J. Liu, R.-M. Wu, H. Chen, Synthesis and characterization of high-barrier polyimide containing rigid planar moieties and amide groups, *Polymer Testing* (2017), doi: 10.1016/j.polymertesting.2017.05.007.

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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 cm³ (m² day)⁻¹ and 5.1 g (m² 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

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