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个人介绍 Personal Profile

安藤 慎治教授于1989年在东京工业大学（Tokyo Tech）获得高分子科学与工程工学博士学位。从1989年到1995年，他曾在日本电信电话株式会社（NTT）担任研究员，后于1995年到东京工业大学有机高分子材料系担任副教授。1998至1999年，他在英国杜伦大学做访问学者。自2006年以来，担任东京工业大学化学科学与工程系教授。在2016至2018年间，任东京工业大学副校长。主要研究方向包括利用光谱学方法对含氟聚合物和聚酰亚胺的三维结构进行解析，对聚合物的电子结构和物理性质进行量子化学计算，对含氟聚合物和聚酰亚胺的光学、热学和介电性能等功能化应用研究。

Shinji Ando received Dr. Eng. degree in polymer science and engineering from Tokyo Institute of Technology (Tokyo Tech) in 1989. He was a research scientist at Nippon Telegraph and Telephone (NTT) Corp. from 1989 to 1995, and he transferred to the Department of Organic and Polymeric Materials at Tokyo Tech as an associate professor in 1995. He stayed at Univ. of Durham, UK as a visiting scientist from 1998 to 1999. He has been a full professor of the Department of Chemical Science and Engineering, Tokyo Tech since 2006, and he was a vice president of Tokyo Tech from 2016 to 2018. His research interests include the three-dimensional structural analysis using spectroscopic methods and functionalization of optical, thermal, and dielectric properties of fluoropolymers and polyimides including quantum chemical calculation of their electronic structures and physical properties.

5G/6G应用聚酰亚胺介电性能的各向异性极化分析和湿度相关性
Anisotropic Polarization Analysis and Humidity Dependence of Dielectric Properties of Polyimides for 5G/6G Wireless Applications

Abstract: Polyimides (PIs) are expected to be used as low-dielectric insulators for 5G/6G wireless communications. In our study, dielectric constants (D_k) and dissipation factors (D_f) of 15 types of PIs were measured in the transverse electric (TE_{011}) mode at 10 GHz, and the relationships among the dipolar orientational (P_d) and electronic (Pe) polarizations, as well as D_k and D_f, were quantitatively investigated.[1] The total polarization per unit volume, namely P_t ($\propto D_k$), shows a positive linear correlation with P_e, which indicates that P_t is mainly dominated by the Pe calculated from average (n_{av}) or in-plane refractive index (nTE). Besides, we have newly found that the Df of PIs is anisotropic and linearly proportional to P_d in the in-plane direction ($P_{d(TE)}$), which points out that they are closely related to the in-plane component of dipole moment (μTE) and their relaxation motions at 10 GHz. Furthermore, the D_k and D_f of all PIs increased linearly with respect to the relative humidity (RH) of the environment, and their slopes (h_{Dk} and h_{Df}), i.e., the RH sensitivities of D_k and D_f showed a proportional relationship with each other. In particular, perfluorinated PI[2] and highly fluorinated PIs exhibited extremely low h_{Dk} and h_{Df} values owing to their hydrophobicity. Intriguingly, commercial PIs derived from sBPDA dianhydride also showed low h_{Dk} and h_{Df} due to their dense molecular packing[3] which prevents permeation of water. Most recently, the D_k and D_f of 11 types of PIs were systematically measured between 25 and 330 GHz using Fabry-Pérot resonators.[4] As the frequency increased, all the PIs exhibited a continuous decrease in Dk and a consistent increase in D_f. Notably, no distinct peaks were observed over the entire frequency range, and the PIs containing $-CF_3$ groups in the diamine moieties exhibited a rapid increase in D_f with frequency over 50 GHz.

Keywords: Polyimides, Dielectric constant, Dissipation factor, Anisotropic property, Polarization analysis, Humidity dependence,

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