ST2-005

Absolute Determination of the Surface Areal Density of Functional Groups in Organic Thin Films

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There have been numerous studies on the quantification of organic thin films for various applications based on organic layers in which performance is determined by surface functional groups. To increase performance reliability in these applications, quantitative analysis of the functional group density for organic thin films is important. X-ray photoelectron spectroscopy (XPS), Fourier transformation infra-red (FT-IR), and time-of-flight secondary mass spectrometry (ToF-SIMS) analysis have been widely used to characterize the functional groups of an organic surface with molecular specificity. However, quantifying the amount of functional groups has been unsuccessful because of the difficulty in determining the relative sensitivity factors (RSF's). In this study, medium energy ion scattering (MEIS) spectroscopy was utilized to provide calibration factors (CFs) for calibration of XPS, FT-IR, and ToF-SIMS intensities to develop a methodology for absolute determination of the surface areal density of functional groups in organic and bio thin films. By using the MEIS, XPS, FT-IR, and ToF-SIMS techniques, we were able to analyze the organic thin film of a Ru dye compound ($C_{58}H_{86}O_8N_8S_2Ru$), which consists of one Ru atom and various stoichiometric functional groups. The complementary use of XPS, FT-IR, ToF-SIMS and MEIS techniques can be a new methodology for the absolute quantification of the surface density of functional groups in organic thin films for nanobio applications.