Non-destructive In-Depth Chemical Characterization of Air Exposed Plasma Polymers by Energy Resolved XPS

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Plasma polymers can be deposited on a wide range of substrates in order to introduce a desired surface chemistry intended for a wide range of applications. For many of these, only the chemistry of the outermost surface layer is relevant and therefore, many works have favoured the use of surface-specific techniques such as X-ray photoelectron spectroscopy (XPS) or time of flight secondary ion mass spectrometry (ToF-SIMS), which have various sampling depth under the surface. Recently, a technique enabling XPS depth resolution by the modulation of the photoelectron attenuation length for non-destructive chemical depth profiling, known as energy-resolved XPS (ERXPS), has emerged. In the best case, the minimum attainable 95 % information depth value is about 22 % of its value under standard Al Ka XPS conditions, thus permitting a better surface sensitivity than angle resolved XPS (ARXPS). ERXPS has also many other positive points that are thoroughly discussed.

In this study, plasma polymers containing oxygen and nitrogen based surface chemistries were prepared from allylalcohol, allylamine and acrylic acid. Established selective chemical derivatisation procedures with trifluoroacetic anhydride (TFAA) and 4-trifluoromethyl benzaldehyde (TFBA), are used to determine alcohols and amines, respectively. All samples were analysed by energy resolved XPS (ERXPS). By analysing the high resolution spectra we demonstrate that slightly aged plasma polymers prepared from allylalcohol and allylamine present a homogeneous in-depth chemistry in the range of XPS information depth (≈10 nm) while this was clearly not the case for their acrylic acid counterparts. Furthermore, it is shown that standard derivatisation reactions result in homogeneous changes of the chemistry in the above-mentioned information depth.

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