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Chemical Characterization of the Ageing of Nitrogen-rich Plasma Polymer Films under Various Ambient Conditions

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A well-documented characteristic of plasma modified surfaces and plasma-polymerized coatings is the time dependent evolution of their surface characteristics following post-treatment exposure to ambient air, a phenomenon commonly referred too as “ageing”. This effect, which often translates to a decrease in the changes induced by the surface treatment over time, is considered detrimental for many applications. While the phenomenon has been described in details many times, an improved understanding of the parameters influencing its kinetics and extent would be helpful in circumventing negative effects.
In this contribution, we investigate the effects of various ambient conditions on the ageing of nitrogen rich plasma polymers films (L-PPE:N). L-PPE:N films prepared by low-pressure capacitively-coupled radio-frequency plasma using a 1:1 mixture of ethylene and ammonia and aged for 62 days in four different ambient conditions of varying atmosphere and temperature: i) at room temperature (RT) in air; ii) at RT in N_2; iii) at -20°C in air and; iv) at -20°C in N_2. The films were analysed by X-ray photoelectron spectroscopy (XPS) “in-situ” immediately after deposition and subsequently, by XPS and time-of-flight secondary ion mass spectrometry (ToF-SIMS) at various intervals over the duration of the experiment. The ageing of primary amines, NH_2, was followed by chemical derivatization with 4-trifluoromethyl benzaldehyde accompanied by XPS quantification (CD-XPS). The results demonstrate that both a storage in N_2 atmosphere or in a cold environment slow down the ageing of PPE:N films. Storage at -20°C, independently of ambient atmosphere, slowed down ageing to levels undetectable by the XPS and CD-XPS.

Keywords
plasma polymers
ageing
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