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Determining the effect of substrate cleaning on the solution stability of plasma polymer films

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Plasma polymerization modifies surfaces via the deposition of a thin film possessing specific functional groups. The organic monomer is introduced into the low pressure chamber as a vapour, fragmented via radio frequency and deposited onto all surfaces in contact with the plasma. Commonly used monomers such as octadiene, allylamine and acrylic acid enable the deposition of hydrocarbon, amine and carboxylic acid terminated surfaces respectively. Surface cleaning prior to the deposition of thin films is frequently carried out to improve film adhesion. The use of plasma polymer films in biomedical applications has increased the demand for coatings suitable for use in physiological conditions. Significant changes in film properties in aqueous conditions have serious implications on the incorporation of these films in biomedical technologies and devices.

In this study, silicon wafer substrates were cleaned by several different methods prior to the deposition of plasma polymerized thin films to investigate the influence of substrate cleaning on film stability in aqueous solutions. The substrates were used untreated or cleaned by liquid sonication, UV/ozone cleaning or air plasma. X-ray photoelectron spectroscopy (XPS) and contact angle measurements were undertaken to determine the effect of the cleaning method on surface chemistry and wettability. After cleaning, the substrates were coated by plasma polymerized octadiene, acrylic acid or allylamine thin films. The surface chemistries and film thicknesses of the plasma polymerised films were determined by XPS and variable angle spectroscopy ellipsometry respectively. The plasma polymerised films were immersed in both Milli-Q water and phosphate buffered saline for time periods of 1, 24 and 168 hours. Films were again analysed via XPS and ellipsometry to determine the influence of substrate cleaning, immersion solution and immersion duration on film stability. Substrate cleaning was shown to have an influence on film stability with visible pitting on some films, even after only 1 hour of immersion. Substrate cleaning is an important step prior to the deposition of thin films and can be used to extend the solution stability of plasma polymerised films, which has important implications for a variety of biomedical applications.

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