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Plasma polymerization of 3-aminopropyltrietoxysilane (APTES) by an open-air atmospheric arc plasma jet

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Non-equilibrium atmospheric plasma jets are extensively used for many in-line industrial treatments related to cleaning, surface activation or coating. In this work, an open-air arc plasma jet has been used to polymerize 3-aminopropyelthrietoxysilane (APTES) on various substrates from air/APTES mixtures. Nitrogen containing silicon oxide coatings have many interesting applications ranging from cell culture or protein adhesion to bonding, and the challenge of plasma deposition is to control the retention of functional groups to satisfy the desired application.
The pulsed arc plasma jet used in this work and generated from compressed air has been characterized by different diagnostics elsewhere [1]. Briefly, the rotational and vibrational temperatures are respectively around 1000K and 3000K, while the emission spectra is dominated by the NO_2 continuum chemiluminescence. APTES polymerization has been reported at atmospheric pressure in He DBD [2], N_2 plasma jet [3,4] or post-discharge of Ar-O_2 (1-2%) or Ar-N_2 (8%) microwave plasma [5,6], but not in hot air discharges. Therefore, in a hot and oxidative environment, one would not except to have any retention of amine groups which are sensitive to temperature and oxidation.
The results show that the 500 nm thick plasma polymerized APTES coatings deposited by arc plasma jet are characterized by a relatively high content of nitrogen (2%-8%) as compared to the monomer (7%). Both XPS and ATR-FTIR analysis indicated the presence of amine groups as well as amides and/or oximes. The important role of hydrodynamic and heat transfer was also studied and modeled.
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