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Polyurethane treatment by air dielectric barrier discharge at atmospheric pressure

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Polymeric materials are increasingly replacing the traditional engineering materials like steel and aluminum in fabrication of space and aircrafts, automobiles, civil construction as well as in biomedical applications due to their superior properties like better corrosion resistance, high strength to weight ratio, relatively low cost and easy recycling. However, polymers are intrinsically hydrophobic, low surface energy materials, and thus do not adhere well to other materials. Surface treatment of polymers by discharge plasmas is of great and increasing industrial application because it can uniformly modify the surface of treated samples without changing the material bulk properties and is environmentally friendly. The plasma acting mechanisms are complex, but the main outcomes of plasma-surface interaction are surface cleaning, activation, cross-linking, and etching or in many cases combination of these effects. The plasma processes that can be conducted under ambient pressure and temperature conditions have attracted special attention because of their easy implementation in industrial processing. Present work deals with surface modification of commercial polyurethane (PU) polymer by an air dielectric barrier discharge (DBD) at atmospheric pressure. The DBD treatment was performed in a parallel plate reactor driven by a 60Hz power supply. The DBD plasmas were generated in air and also in atmosphere of N_2 and Ar gases. Material characterization was carried out by contact angle measurements, atomic force microscopy (AFM) and X-ray photoelectron spectroscopy (XPS). The surface energy of the polymer surface was calculated from contact angle data using Fowkes method. The plasma-induced chemical modifications are associated with incorporation of polar oxygen and nitrogen containing groups on the polymer surface. Due to the surface structural and morphological changes the DBD-treated polymers became more hydrophilic resulting in enhanced adhesion properties. Aging behavior of the treated samples was followed for 14 days and it revealed that all polymer surfaces were prone to hydrophobic recovery although they did not completely recover their original wetting properties.

Keywords
Atmospheric plasma
Dielectric barrier discharge
Polymer modification