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Atmospheric pressure plasma treatment of polyurethane foams with oxygen containing feed mixtures

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Atmospheric pressure non-equilibrium plasmas attract growing interest in surface processing of materials, since the absence of vacuum equipments allows the reduction of processes and reactors costs, the employment of easy-to-handle apparatuses and the easier integration into continuous production lines. Dielectric barrier discharges (DBDs) are particularly suitable in this applicative field as for instance for the treatment of non-conductive materials (e.g., plastics, textiles, etc.) and of high specific area 3D porous substrates. Due to their operating conditions, DBDs allow the ignition of the discharge also inside small cavities and, therefore, assure the uniform treatment of the entire structure of porous substrates.This contribution focuses on the treatment of polyurethane (PU) foams by atmospheric pressure DBDs fed by He and O_2 mixtures, in order to functionalize the 3D foam porous structure with oxygen containing groups. Plasma treatments were carried out using a home-built atmospheric DBD reactor with parallel plate electrode configuration; commercial PU foams (pore density of 45 pores per inch, porosity of about 97%), were used as substrates. The surface chemical and morphological characterization of the PU foams was carried out with small spot X-ray Photoelectron Spectroscopy (XPS) and Field Emission Scanning Electron Microscopy. The treatments resulted in an efficient functionalization of the PU with oxygen containing chemical groups, including carboxylic moieties. The XPS characterization showed that uniform treatments were achieved, since appreciable composition differences were not detected also throughout the foam thickness.Treated PU foams were able to adsorb heavy metal ions from water. The adsorption capacity was evaluated for cadmium and lead by measuring, with Anodic Stripping Voltammetry, their concentration before and after the immersion of the foams in aqueous solution. The ageing of treated PU in water was studied with Nuclear Magnetic Resonance spectroscopy and High Resolution Mass Spectrometry. These investigations allowed us to obtain interesting details on the PU treatment with oxygen containing DBD and information on the chemical composition of the fragments released in water by the treated PU foam.

Keywords
DBDs, plasma treatment, PU, heavy metal adsorption