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Investigation of Plasma Effects in Ultra High Molecular Weight Polyethylene (UHMWPE) Cords

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Ultra-high-molecular-weight polyethylene (UHMWPE) has been widely used because of its high chemical stability, high impact strength, flexibility and low cost. Its field of applications includes use in composites, packing for microelectronic components and biomaterials, usually requiring its surface modification for improved wetting and/or adhesion with other polymeric materials. Atmospheric pressure plasma treatment is promising for this purpose due to its environmental compatibility, high treatment effects without affecting the textural characteristics of the bulk material, its applicability to a variety of shapes, and easy up-scaling and construction of in-line production processes.
An atmospheric pressure dielectric barrier discharge (DBD) plasma is used to study surface modification effect on UHMWPE cords, operated at a frequency of ca. 40 kHz in He, He/O2, O2 and N2 gases. The cords were continuously treated by the plasma with an exposure time of 5-20 s. The plasma is diagnosed by optical emission spectroscopy, while the treated UHMWPE cords are characterized using Fourier transform infrared spectroscopy, core and valence-band X-ray photoelectron spectroscopy (XPS), and atomic force microscopy. Core XPS results indicate the formation of carboxylic (COOH, COOR), carbonyl (C=O), ether (C-O-C) epoxide (cyclic ether), acetal (O-C-O) and hydroxylic (OH) groups at the surface after the treatment, but can not quantitatively distinguish between epoxide and hydroxilic groups. Valence-band XPS spectra are more sensitive to the differences in the surface functionality than core region spectra, being a useful tool for the estimation of the epoxide and hydroxylic group concentrations at the surface. The surface modification mechanism will be extensively discussed in terms of the plasma conditions, referring the application for adhesion improvement.