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XPS investigation of the mechanisms responsible for activation of the surface of ultrahigh molecular weight polyethylene with a medium pressure dielectric barrier discharge

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Although non-thermal plasma treatment of hydrophobic polymers with the aim to enhance their surface wettability is a common procedure, the mechanisms behind those changes in surface properties are still under debate. In an effort to elucidate these mechanisms, the aim of this study is to try to make a distinction between plasma-induced reactions occurring during plasma exposure and those taking place post-plasma, when the sample is exposed to ambient air. To achieve said goal, an experimental plasma set-up (medium pressure DBD) was designed that can be directly connected to an X-ray photoelectron spectrometer (XPS), thereby avoiding exposure of the samples to ambient air. Basic characterization of the plasma treated polymer was carried out by water contact angle goniometry (WCA) to pinpoint the saturation region of the plasma treatment (in ambient air). Subsequently, different treatment times were selected and samples were investigated in detail, using XPS, to identify and quantify the differences in functional group incorporation for samples that were exposed to air and those that were not. Results show that the oxygen/nitrogen incorporation was significantly altered by post-plasma exposure. To aid in the characterization of the plasma phase, optical emission spectroscopy (OES) was also employed to identify the active species and their relative concentrations inside the plasma reactor that governed the changes in surface properties. Based on these results, a preliminary model was made explaining the different reaction pathways.

Keywords
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