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Comparison of four atmospheric pressure plasma jets applied for treatment of polypropylene

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Non-thermal atmospheric pressure plasma discharges are one of the most promising technologies for low-cost modification of adhesive properties of polymer surfaces. As working conditions of various types of discharges can differ by, for e.g., working gas, gas temperature and species' excitation path; the way how they affect polymer surfaces can also differ significantly. In this work, we compare effects of four different atmospheric pressure plasma jets on polypropylene (PP) slips.
The three industrial jets (PlasmaTreat rotating plasma jet, AFS plasma torch and SurfaceTreat gliding arc) utilize air as their working gas. The home-built RF plasma slit jet, developed by the Plasma technologies group of CEITEC, Masaryk University uses Ar. The gas chemistry was studied mainly using optical emission spectroscopy. While spectra of all discharges contained OH, N2 optical bands of different intensities, pronounced O and N atomic lines were observed only in the spectra of PlasmaTreat and SurfaceTreat jets. A distinct continuous emission observed in AFS plasma torch spectrum is assigned to NO2+ molecule whose formation was later confirmed by mass spectrometry measurements. In addition to the species identification, the rotational gas temperatures were determined by modelling the OH (A–X) 0-0 and N2 (C–B) 0-0(0-1) bands.
The chemistry of PP surfaces was assessed mainly by water contact angle and X-ray photoelectron spectroscopy (XPS). As revealed by XPS, both oxygen and nitrogen containing functional groups can be attached onto the surface when air plasma is used. Ar plasma promotes only attachment of oxygen containing functional groups. Tensile strength measurements suggest that the presence of nitrogen containing groups might be beneficial for a stronger bond between PP and the epoxy adhesive (DP190, M3). Surface morphology was observed using a combination of scanning electron and atomic force microscopy. Smoother PP surfaces were obtained after treatment with higher gas temperatures.

Keywords
atmospheric pressure plasma jet
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polypropylene