Investigation of imine formation on PE surfaces treated in ambient-pressure nitrogen/hydrogen DBD afterglow

Zohreh Khosravi\textsuperscript{1}, Claus-Peter Klages\textsuperscript{2}

\textsuperscript{1}Institut für Oberflächentechnik, TU-BS, Braunschweig, Germany \textsuperscript{2}Fraunhofer-Institut für Schicht- und Oberflächentechnik (IST), Braunschweig, Germany

zohreh.khosravi@ist.fraunhofer.de

This article reports in situ FTIR-ATR investigations during treatment of PE ultrathin films in the afterglows of dielectric barrier discharges (DBDs) operating at atmospheric pressure in mixtures of nitrogen and hydrogen, as well as during subsequent gas-phase derivatization and H/D isotope exchange reactions. 4-trifluoromethyl-benzaldehyde (TFBA) derivatization showed considerable amounts of 4-CF\textsubscript{3}-C\textsubscript{6}H\textsubscript{4}- moieties being bonded to the surface while no primary amines could be detected by H/D exchange experiments. The suggested presence of imines as major products of the plasma-chemical surface reaction was investigated by derivatization of PE foils using vapors of strongly nucleophilic 2-mercaptoethanol and 4-(trifluoromethyl)-phenylhydrazine (TFMPH), respectively. XPS spectroscopy was subsequently applied in order to quantify the amount of sulfur and fluorine, respectively, introduced to the surface due to the presence of electrophilic moieties generated by the plasma treatment. Ex situ reduction and acid-catalyzed hydrolysis experiments were performed on plasma-modified PE in order to corroborate the formation of imino groups on the surfaces by revealing the typical signatures of reaction products. Optical emission spectroscopy was performed on N\textsubscript{2} + x H\textsubscript{2} discharge afterglows in order to gain some insight into the nature of gas phase species responsible for the introduction of nitrogen into polymer surfaces.

Keywords
Plasma treatment
In situ FTIR-ATR
Nucleophilic derivatization
Optical emission spectroscopy
XPS