PO1090

The role of oxygen impurities in 3D surface amination by atmospheric plasma treatment under defined gas atmospheres

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Adapted surfaces with chemical functionalities play an important role in biomedical applications like the coupling of biomolecules [1] as well as for gluing or metallization of electronic devices [2]. To improve the wettability of these mostly 3-dimensional substrates, e.g. microtiter plates or moulded interconnect devices (MID), commercial plasma systems working at atmospheric pressure are available. Due to the miniaturization of these components, long term stability requirements and the need for special chemical groups only cost and time efficient low pressure plasmas or wet-chemical processes are able to fulfil these properties.
In this work the surface treatment by an atmospheric-pressure AC corona discharge stabilized by a dielectric barrier under defined gas atmospheres has been investigated to functionalize different substrates of varying geometries. A set-up for continuous treatment of 3-dimensional polymer substrates is presented, which allows a complete surface amination under defined gas atmosphere. As process gases synthetic air, nitrogen and nitrogen/hydrogen mixtures were used. Optical emission spectroscopy (OES) was used for monitoring the discharge. A correlation between the OES measurements and the surface functionalization for different process parameters e.g. substrate shape, process speed, power and gas mixture was carried out. The oxygen content in the gas was measured using a lambda probe and the area density of primary amino groups depending on the geometry of the substrates was determined by chemical derivatization and subsequent attenuated total reflection Fourier transform infrared spectroscopy (CD-ATR-FTIR) [3]. More than 10 NH_2 groups per nm^2 could be detected for nitrogen/hydrogen mixtures and oxygen content below 50 ppm. It was demonstrated, that OES could be a promising tool for plasma process control achieving defined number of functional groups.

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Keywords
atmospheric-pressure plasma
surface functionalization
optical emission spectroscopy
chemical derivatization