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Diagnostics of low pressure microplasmas for surface modification

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The radical concentration in microdischarges in hollow sub-millimeter geometries was investigated. This type of plasmas allows the chemical modification of polymer surfaces with biocompatible functionalities like amino groups. Therefore, especially the concentrations of NH and NH_2 are of relevance. They can be generated from ammonia with admixtures of helium or argon, or from mixtures of nitrogen and hydrogen. A limitation is that the plasmas should have a gas temperature below the melting temperature of thermoplastic polymers.
We used two non-invasive diagnostic techniques, optical emission spectroscopy (OES) and laser induced fluorescence (LIF), to find gas mixtures and corresponding plasma conditions that produce NH- and NH_2- molecules in the gas phase.
The detection of NH or NH_2 with OES is rather difficult due to their low content in the plasma. One decomposition product of NH_3, atomic hydrogen, can be detected by OES. But this is not a proof for the generation of NH_2. Therefore we used LIF to detect these species in the ground state. With this method specific energy levels of NH- and NH_2-molecules can be excited and their fluorescence emission measured. From these data it is possible to get information about the main plasma processes in the gas phase for the production of NH_2.
Additionally, temperature data were measured in two ways; one is a temperature sensor attached on the outside of the plasma chamber and the other with temperature estimation from the N_2^+- line at 391.4 nm. By using plasma excitation in the kHz region, measurements show temperature values less than 100°C, while with MHz-excitation, the temperature rises up to 200°C.
Further experiments were carried out with a polymeric fibre. The quality of functionalization shows a high dependence on the power, the gas mixtures and their ratios.

Keywords
microplasmas
LIF
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