FTIR SPECTROSCOPY OF GASEOUS PRODUCTS OF ATMOSPHERIC PRESSURE COPLANAR BARRIER DISCHARGE FOR PLASMA ASSISTED GRAPHENE OXIDE REDUCTION

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Dielectric barrier discharges are atmospheric pressure plasma sources, which are used in applications as in surface treatment, thin film deposition, plasma medicine, plasma agriculture etc. These applications often rely on the joint action of emitted UV radiation and the active and reactive species. Therefore, it is crucial to measure the chemical composition of the discharge in order to understand the effect of the plasma on the treated materials.

In this work, a coplanar barrier discharge operated in ambient air and in $N_2/H_2/O_2$ mixtures was used to study the plasma initialized reduction of graphene oxide samples, prepared in the form of dried aerogel and vacuum sprayed thin sheets. The FTIR spectroscopy was used (i) to study the chemical composition of the gas products of the pure plasma source and (ii) to identify and measure the gaseous products of graphene oxide reduction. The rovibrational spectra of important molecules were simulated using the molecular line data taken from the Hitran database. The molecule densities were then obtained from the fit.

While ozone and nitrogen oxides (N_2O, NO, NO_2 and N_2O_5) were the stable products of the discharge in N_2/O_2 mixtures, HNO_2, HNO_3 and CO_2 were also present in the gas coming from the discharge in ambient air.

Water, CO and CO_2 were identified as the stable gaseous products of graphene oxide reduction for both sample forms. The graphene oxide sheets provided more reproducible molecule densities compared to aerogel samples. The ratio of CO to CO_2 density ranged from 0.7–1.4 depending on the gas mixture. The higher density ratio was observed in pure nitrogen and in nitrogen-hydrogen mixture, the lower ratio was observed in mixtures with oxygen. The reaction kinetics was mostly too fast to be captured by FTIR; a slower time development was observed in oxygen mixtures.

The FTIR diagnostics provided complementary information to other diagnostic methods which may be used for the optimization of the plasma-assisted reduction of graphene oxide in order to prepare reduced graphene oxide material of adjusted electrical and chemical properties.

This research has been supported by the project LM2023039 funded by the Ministry of Education, Youth and Sports of the Czech Republic.