

PO3060

Pressure-dependent study of water-plasma interactionJakob Barz¹, Jan Hennigs², Hendrik Schikora¹, Michael Haupt¹, Christian Oehr¹¹Fraunhofer IGB, Stuttgart, Germany ²Otto-von-Guericke-University Magdeburg, Magdeburg, Germany

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The treatment of water by plasma is a topic both of interest for the removal of contaminations from water and, more recently, for the production of plasma activated water (PAW) which is investigated for potential applications in agriculture. When plasma is brought into contact with water, reactive species are produced from the plasma gas, from water vapor and by chemical reactions. In addition, hydroxyl radicals are formed by (V)UV radiation. As further species, solvated electrons are under discussion.

When oxygen plasma treated water is chemically analyzed, comparably stable molecules such as hydrogen peroxide and ozone can be found in high amounts. In case that air plasmas are used, in addition, nitrite and nitrate can be found. The reactions leading to the formation (and destruction) of these molecules are numerous even in pure deionized water (see e.g. Y. Sakiyama, D. B. Graves, H.-W. Chang T. Shimizu, G. E. Morfill, Plasma Chemistry Model of Surface Micro-discharge in Humid Air and Dynamics of Reactive Neutral Species, J. Phys. D: Appl. Phys. 45 425201). Many of the ongoing reactions are pressure dependent. Therefore, a pressure dependent study was carried out.

For this purpose, a reactor was designed allowing to generate plasmas in the pressure range between some millibar up to atmospheric pressure. During the pressure variation, the plasma characteristics change from a glow discharge via a multi-filamentary discharge to dielectric barrier discharge. The power was supplied by a Redline pulsed-kHz generator and kept constant during the experiments. The concentrations of nitrite, nitrate, hydrogen peroxide and ozone were determined. It was found that compounds like ozone, being produced from three-body reactions, appear at lower concentrations when the pressure is decreased. The formation of the other species depends on several other parameters as well which will be discussed in the paper.

Keywords

water plasma

PAW

reactive species

pressure dependence