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GENERATION AND LOSS OF REACTIVE OXYGEN SPECIES IN LOW-TEMPERATURE ATMOSPHERIC-PRESSURE RF HE+O$_2$+H$_2$O PLASMA

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This study focuses on the generation and loss of reactive oxygen species (ROS) in low-temperature atmospheric-pressure rf (13.56MHz) He+O$_2$+H$_2$O plasmas, which are of interest for many biomedical applications. Pure He+O$_2$ plasmas are a good source of ozone, singlet oxygen and atomic oxygen, with densities of these species increasing as oxygen content increases$^1$. He+H$_2$O plasmas offer an interesting alternative to He+O$_2$ plasmas as a source of reactive oxygen species (ROS), and they produce significant amounts of hydrogen peroxide, hydroxyl radicals and hydroperoxyl radicals, which increase with increasing water content$^2$. Admixtures of O$_2$ and H$_2$O lead to richer cocktails of ROS that combine all these species.

By means of 1-dimensional fluid simulations (61 species, 878 reactions), the key ROS and their generation and loss mechanisms are identified as a function of the oxygen and water content in the feed gas. Identification of the main chemical pathways can guide the optimization of He+O$_2$+H$_2$O plasmas for the production of particular ROS.

For a given oxygen concentration, the presence of water in the feed gas decreases the net production of oxygen-derived ROS, while for a given water concentration, the presence of oxygen enhances the net production of water-derived ROS.

The optimum discharge conditions would depend on the actual application but the general trend is that a higher density of ROS is obtained at low water concentration and cocktails with higher oxidation potential at high water concentrations.

Although most ROS can be generated in a wide range of oxygen and water admixtures, the chemical pathways leading to their generation change significantly as a function of the feed gas composition. Therefore, care must be taken when selecting reduced chemical sets to study these plasmas.


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