Reactive Oxygen Species Production in Atmospheric-pressure Low-temperature $He+O_2+H_2O$ Plasmas

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Low-temperature atmospheric pressure plasmas have received growing interest in recent years, due to their increasing popularity in technological and biological applications. There are many advantages to using these plasmas, for example, they are relatively cheap to run as they do not require expensive vacuum equipment, they are portable, they can be run at near room temperature and they can create complex reactive chemistries inside and outside the discharge region.

In previous studies it has been shown that atmospheric-pressure non-thermal RF discharges with admixtures of O_2 and/or H_2O become electronegative and display intricate dynamics[1,2]. Both of these precursors are also good sources of reactive oxygen species (ROS)[1-4]. The actual composition of the plasma, however, varies depending on which ROS source is used. A question that arises is whether the two ROS sources can be combined to create new and potentially more effective ROS cocktails. In this study, we therefore analyse the variation of the ROS cocktail composition as the concentration of O_2 and H_2O is varied in a $He+O_2+H_2O$ plasma. The goal of this study is to identify not only the final composition of the plasma but also the key chemical pathways, so that this information can be used to optimize sources for different applications.

From this study it has been established that combining oxygen and water leads to the generation of new cocktails of ROS. Mixing water and oxygen, however, introduces added complexity to the chemistry of the discharge and it has been seen that the chemical pathways that lead to the generation and loss of ROS change depending on the feed gas composition.

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

References:

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