COMPARISON BETWEEN HE/O_2 AND HE/H_2O ATMOSPHERIC PRESSURE COLD PLASMAS

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Atmospheric-pressure He/O_2 and He/H_2O plasmas have received growing attention in recent years, for they are easy to be kept cold and diffusive as well as capable of efficiently generating reactive radicals like O and OH. In this contribution we present the results of a comparative study of the chemistry of these two kinds of plasmas and their suitability for biomedical applications. An extensive literature review has been performed to create detailed up-to-date chemistry models of these He/O_2 and He/ H_2O discharges.

In this study the concentration of O_2 and H_2O are kept below 1% as this is the regime preferred in most practical scenarios. Higher concentration of O_2 (or H_2O) leads to unstable and hotter discharges with lower concentration of relevant reactive species.

The ionic composition of the pure helium discharge changes dramatically with just ppm level admixtures of O_2 or H_2O. This is due to the high energy of helium metastables and the dominant role of Penning processes at low impurity (O_2 or H_2O) concentration. As the impurity concentration increases, a further mode transition is observed. Further similarities between the two types of discharges include the fact that at low concentration electron energy is lost mainly through momentum transfer collisions whereas at high impurity concentration the loss is through inelastic collisions; a growing significance of electron attachment with increasing impurity concentration; and the transition into an electronegative discharge with decreasing electron density at impurity concentrations above a few hundred ppm.

Despite these similar general trends, several important differences are also observed. He/ H_2O plasmas are efficient for the generation of OH whereas He/ O_2 plasmas are efficient for generating O and O_3. The yield of O in a He/ H_2O plasma is typically more than 1 order of magnitude less than in an He/ O_2 plasma. However, due to the reduced amount of O_2 in He/ H_2O plasma, ozone concentration can be kept very low providing interesting opportunities from an application point of view.

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