Global Modeling of Low Temperature Atmospheric Pressure Plasmas Operated in Humid Air

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Low temperature atmospheric pressure plasmas (LTAPPs) have been recognized as a new paradigm in biomedical applications by virtue of their unique strengths of generating abundant reactive oxygen and nitrogen species, ultraviolet radiation, lots of ground state molecules such as peroxide and ozone at low gas temperature (~300 K) [1]. Plasma simulation and modeling have been widely adopted to investigate the phenomena and understand the underlying physics of LTAPPs [2]. Zero-dimensional global model (GM) is popular for simulation of LTAPPs because GM is able to take into account tens of species and hundreds of reactions, which are usually encountered in LTAPPs. In this regard, we have developed GM based on object-oriented method (GMoo), which is capable of easily taking into account the complex chemistry of LTAPPs. Contrary to general GMs which solve particle balance and power balance equations simultaneously to determine densities of species and electron temperature, GMoo solves the particle balance equation only. For this, a new algorithm for determination of electron temperature has been adopted [3].

GMoo is used for simulation of LTAPPs operated with H_2O_2 and H_2O which is popular method to enhance the production of abundant reactive species in plasma. The density of hydroxyl radical (OH) increases as H_2O_2 and H_2O concentration increases. However, further increases of H_2O_2 and H_2O concentrations cause a decrease of the OH density, which has also been observed through experimental investigations [4]. The decrease of the OH density at the higher concentration of H_2O_2 is due to the drastic increase of OH loss owing to H_2O_2. But the production rate of OH continues to increase, even as the OH density decreases at the higher concentration of H_2O_2.

References

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