Validation of a plasma chemistry model for an atmospheric pressure plasma jet in helium/water gas mixture

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Cold atmospheric pressure plasmas (APPs) are known sources of reactive oxygen, nitrogen and hydrogen species, and therefore offer a great potential to be used for biomedical applications, where these species play an important role. However, in order for APPs to achieve widespread usage in therapeutics, controlled production of the species of interest is essential. At atmospheric pressure, diagnostics on these reactive species are challenging, due to short particle lifetimes and significant spatial inhomogeneity, especially in the plasma effluent region, which is usually where the interaction with biological samples takes place. Additionally, impurities in the plasma source coming from ambient air can significantly change the plasma chemistry. Plasma simulations can help to further understand the chemical kinetics in the plasmas, however, their validation against experiments is important.

In this work, we investigate a radio-frequency (RF) atmospheric pressure plasma jet (APPJ) operating in Helium (He). By introducing different levels of humidity (H_2O), we can significantly change the production of several reactive species such as atomic hydrogen (H), atomic oxygen (O) and hydroxyl radicals (OH). A 0-dimensional chemical kinetics model is used to investigate the plasma chemistry. For the validation of the proposed reaction mechanism, we also carry out experimental investigations using picosecond Two-photon Absorption Laser-Induced Fluorescence and ultra-violet Broad-Band Absorption Spectroscopy to quantify H, O and OH in the plasma. With a combination of experiments and simulations, we investigate the formation of these species, and the influence of feed gas impurities.