Topic number

Research on Active Species Production Mechanism of an Atmospheric He-Water Plasma Jet

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Abstract: The active species (OH, O and H_2O_2) in plasma play important role in bacterial killing and wound healing. Low gas temperature of plasma is another requirement while treating heat labile tissue. A DBD structured He-H_2O plasma jet can effectively produce OH and H_2O_2 with low gas temperature. In this paper, optical emission lines in plasma jet are measured, gas temperature, vibrational temperature, electron density and electron temperature are deduced from these lines. In conjunction with 2D neutral gas and 1D fluid model simulation, the production and loss mechanism of OH (A-X) is electron collisional dissociation and OH+OH→H_2O_2 reaction. Meanwhile, H_2O_2 production in saline solution indicates that the highest energy efficiency of H_2O_2 production is achieved with He/H_2O plasma jet in bullet mode when water vapor concentration is 1200ppm.

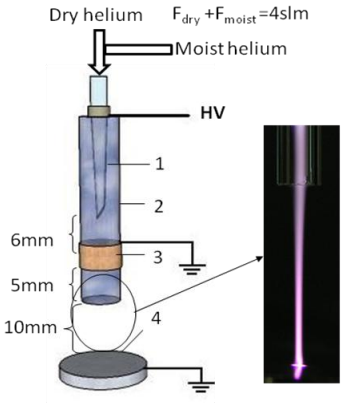
1. Introduction

Atmospheric plasma has attracted lots of attention due to its wide applications in bio-medicine, material, environment and chemical engineering.[1] With the development of plasma medicine, liquid-containing plasma can not only realize blood and tissue coagulation, necrotic tissue removal and kidney stone elimination [2] based on its physical effect, but also achieve low temperature treatment on many diseases, such as: wound healing, chronic and acute injury, cancer and tumour [3] due to its excellent chemical function.

Low temperature and abundant chemically reactive species are two main requirements for plasmas treating heat labile materials (live tissue, organic materials etc). A DBD structured He/H_2O plasma jet can effectively produce OH and H_2O_2 with low gas temperature. At present, some possible reactions to produce OH(A) and H_2O_2 are concluded, however, the main mechanism to produce OH(A)/ H_2O_2 and the influence of plasma working mode and water vapour concentration on their generation are still not clear. It is generally regarded that the accurate measurements of electron density and electron temperature play key role on the analysis of reactive species production mechanism. In this paper, the main generation and loss mechanisms of OH(A) and H_2O_2 will be found out by both experimental measurements of time-spatial distribution of OH(A) emission intensity, electron density and electron temperature and neutral gas/plasma fluid simulation at different working modes and water vapor concentrations.

2. Experimental setup

The schematic diagram of the experimental apparatus is shown in 0. The powered electrode is a capillary needle with inner and outer diameter of 0.8mm and 1.2 mm, where as a copper ring electrode and a stainless steel plate electrode are connected to the ground. The frequency of the applied voltage is 20 kHz. The outer and inner diameters of the glass tube are 2mm and 1.3 mm respectively. The axial distances between different electrodes are shown in 0. The working gas is a helium and water vapor mixture which is realized by mixing two channels of helium flow, one being a dry helium (99.996%) and the other being helium flowing through a water bubbling system. The total gas flow rate is 4slm, and the water vapor concentration is controlled by adjusting the ratio of the dry (F_{dry}) and moist helium (F_{moist}) flow rates. The optical emission spectra are measured at the plasma contact point on the surface of stainless steel plate.



1-needle electrode, 2-glass tube
3-copper electrode, 4-stainless steel

FIG.1 SCHEMATIC EXPERIMENTAL SETUP

3. References

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