Plasma Diagnostics of Non-thermal Atmospheric - Pressure Plasma Jet for Biomedical Application

MOHAMMED Kalaf[1], Murtdha A. Siyah[1]

[1] *Ministry of Science and Technology*

In recent years, non-thermal atmospheric pressure plasma has attracted wide attention in health care for the "processing" of medical tools and living tissues due to its many advantages, such as non-destructive surgery, controlled, high-exactness removal of diseased sections, high efficiency, simple systems, easy operation, non-toxic residue, and low cost. In this work, the construction and characterization of an Atmospheric Pressure Microwave Induced (APMI) Plasma Jet, that had been generated using microwave up to 2.4GHz for argon (Ar) and helium (He) gases and operated at low-temperature plasma below 40 ºC for exceptional standardization protocol of this plasma source that meets medical requirements. The plasma column has been characterized as a function of the Ar and He flow rate. The influence of the higher gas flow rate lead to increase of the plasma column length and reduction of the plasma jet temperature. The optical Emission Spectroscopy (OES) method was employed to detect the active species inside the plasma column and determine plasma parameters such as electron temperature (T_e), electron density (n_e), plasma frequency (f_p), Debye length (λ_{D}), and Debye (N_{D}) number of the Ar and He plasma jet. The plasma parameters, of the electronic excitation temperature and density of electrons were determined by Boltzmann's plot method and Stark broadening effect equation respectively. The inactivation efficiency of the APMI plasma jet is evaluated against Gram-positive pathogenic bacteria (Staphylococcus aureus) and Gram- negative (*E. coli*) with different time exposure. These samples were exposed to a plasma column at different exposure times (5, 10, and 15 min) with an argon flow rate of 15 slm and helium gas flow rate of 4 slm , the distance between the plasma column nozzle and sample (bacteria) was 3 cm. The results presented that the plasma column temperature was lower than 40 ºC, which will not cause damage to living tissues. The inactivation efficiency is directly extended with increased exposure time and treatment with helium plasma jets showed a higher efficiency in bacterial inhibition than argon plasma jets. The result of the emission line spectrum showed the presence of reactive oxygen and nitrogen species between lines 300 nm and 700 nm which formed from ambient air. These species are the main key in the bacteria inactivation process. We confirmed that the inactivation mechanism was unaffected by UV irradiation while the charged particles played a minor role in the inactivation process.

Presenting Author Email Address: *mohammedkhkh@yahoo.com*