ONE-DIMENSIONAL RADIAL MODEL OF COLD ATMOSPHERIC PLASMA JET

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Recent development of atmospheric plasma sources capable of creating plasmas at or near room temperature has led to an increased interest in this technology from the medical community. Atmospheric plasmas have been routinely used for surface treatment and sterilization, however, the low temperature demonstrated by these new sources makes this technology attractive for applications dealing with living tissue. Plasmas have been found to effectively dispose of living cells and to reduce the migration speed of living cells[1]. This technology could thus be applicable in areas such as wound healing.

In this paper, we analyze the temporal evolution of the plasma column using a numerical approach. We consider an axial cut of the jet and assume that for $t<0$, the region of interest consists only of the Helium working gas and the atmospheric gases, N_2 and O_2. At $t=0$, small electron population is introduced in the Helium beam. This electron population approximates the photo-ionization process occurring ahead of the stream head and has diameter corresponding the streamer head size. Ionization rates are then computed by considering chemical rate equations. Chemical equilibrium is also used to compute the production rates of radical species. Temporal evolution of the plasma column is computed from the continuity and momentum equations. Electrostatic forces acting on charged particles are obtained from the Poisson equation. Using the code, we compute the radial distribution of the reacting species at several times and compare with the measurements in Ref. 2.

1. A. Shashurin, M. Keidar, S. Bronnikov, R. A. Jurjus, and M. A. Stepp, “Living tissue under treatment of cold plasma atmospheric jet,” Applied Physics Letters, Vol. 93, No. 181501, 2008
2. A. Shashurin, M. N. Shneider, A. Dogariu, R. B. Miles and M. Keidar, “Temporal behavior of cold atmospheric plasma jet”, Applied Physics Letters, Vol. 94, No. 231504, 2009