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Interactions Between Small Arrays of Atmospheric Pressure Micro-Plasma Jets: Gas Dynamic, Radiation and Electrostatic Interactions[1]

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Atmospheric pressure plasma jets are widely used devices for biomedical applications. A typical plasma jet consists of a tube through which noble gas or its mixture with a molecular gas flows. The noble gas creates a channel into the ambient air which is eventually dispersed by interdiffusion with the air. Plasma plumes are formed by the propagation of ionization waves (IWs) through the tubes and then through the noble gas phase channel. The IW typically propagates until the mole fraction of the ambient air in the channel increases above a critical values which requires a larger E/N to propagate the IW. By grouping several jets together to form an array of jets, one can in principle increase the area treated by the plume. If the jets are sufficiently far apart, the IWs and resulting plasma plumes are independent. As the spacing between the jets decreases, the plasma jets begin to mutually interact. In this talk, we discuss results from a computational investigation of small arrays of He/O_2 micro-plasma jets propagating into ambient air. The model used in this work, *nonPDPSIM*, is a plasma hydrodynamics model in which continuity, momentum and energy equations are solved for charged and neutral species with solution of Poisson's equation for the electric potential. Navier-Stokes equations are solved for the gas dynamics and radiation transport is addressed using a propagator method. We found that as the spacing between the jets decreases, the He channels from the individual jets tend to merge. The IWs from each channel also merge into regions having the highest He mole fraction and so lowest E/N to sustain the IW. The proximity of the IWs enable other forms of interaction. If the IWs are of the same polarity, electrostatic forces can warp the paths of the IWs. If in sufficient proximity, the photoionization from one IW can influence its neighbors. The synchronization of the voltage pulses of adjacent IWs can also influence its neighbors. With synchronized pulses, adjacent IWs can simultaneously travel along their common single stream or their separate helium channels. If the voltages pulses are not synchronized, adjacent IWs may be extinguished or enhanced, depending on the timing and polarity of its neighbors.

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