6th International Workshop on Microplasmas (IWM 2011)

Characterization of the Capillary Plasma Electrode (CPE) discharge

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Numerous approaches have been pursued to create stable atmospheric pressure discharges by extending the lifetime of the diffuse phase of the discharge to hundreds of microseconds. Extensive research has found that the stability of the diffuse mode is dependant on the frequency (in the kilohertz range), gas type, power of the excitation, and geometrical confinement. Some of the most promising results have come from this later approach based on the recognition that arc formation in high-pressure plasmas can be avoided and stable high-pressure plasmas can be generated and maintained when the plasmas are spatially constricted to dimensions of tens to hundreds of microns. The Capillary Plasma Electrode (CPE) discharge is able to produce stable atmospheric pressure nonequilibrium plasmas. The CPE discharge is essentially a barrier-electrode discharge with perforated dielectrics. Discharges from this configuration, aside from exhibiting a diffuse mode of operation, also exhibit a distinct mode namely, "the capillary jet." As the frequency of the source is increased above a few kilohertz, one first observes the diffuse mode, but a certain frequency is then reached at which the capillaries "turn on" and bright plasma jets are observed to emerge from the capillaries. The distinction between the diffuse and capillary modes is dramatic. The capillary jets seem to overlap so that the discharge appears uniform when the electrode contains an array of capillaries. Past observation seem to indicate that the threshold frequency for the capillary jets formation is strongly dependent on the *L/D* ratio of the capillaries, where D is the diameter of a capillary and L its length. However, the operating principles and basic properties of this behavior are not well understood. This current work explores these modes of operation of the CPE discharge by characterizing the electrical and optical emission properties of this discharge from initially examining a multi-capillary discharge and a subsequent single capillary discharge reactor.

Acknowledgment: This research was funded by the Electro-Energetic Physics Program of the United States Air Force Office of Scientific Research (AFOSR) under grant number FA9550-08-1-0332.