MODELING OF MICRO-DIELECTRIC BARRIER DISCHARGES

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Arrays of micro-plasmas having dimensions of tens to hundreds of microns are finding use as sources of radicals and charged particles in addition to their conventional use as photon sources. In one variant of these devices, the electrodes are fully or partially covered by dielectrics, and so they operate as dielectric barrier discharges (micro-DBDs). As such, the devices must be pulsed or driven with high frequency (HF) waveforms. When operating at atmospheric pressure in air, the plasma formation and decay times can be as short as tens of ns, and so the plasma may need to be re-ignited with each discharge pulse. In this situation, the physical structure of the micro-DBD and the electron emitting properties are important to its operation.

In this presentation, we will discuss the properties of micro-DBDs sustained in atmospheric pressure N_2 and air using results from a 2-d plasma simulation. The micro-DBDs are sandwich structures with openings of tens-of-microns excited with HF voltage waveforms. The model includes solution of Poisson's equation, transport of charged and neutral species, radiation transport, electron photo-emission from surfaces, and beam transport of secondary electrons. We found that, depending on the details of the voltage waveform and surrounding structures, the plasma can be expelled from the micro-DBD cavity during one part of the HF cycle, thereby requiring the plasma to be reformed later in the cycle. This expulsion is partly facilitated by the Debye length being larger (in some cases) than the DBD cavity. Long lived neutral species in the plasma can facilitate restart by production of secondary electrons from surfaces. For example, UV photon emission from long lived states continuously provides seed secondary electrons at surfaces until the potential is favorable to generate the plasma.

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