SIMULATION STUDIES OF MICROMETER SCALE DIELECTRIC BARRIER DISCHARGES FOR MICROTHRUSTER APPLICATIONS*

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The recently designed Microplasma thruster[1] employs the use of direct-current (DC) microdischarge to cause heating of argon gas during the expansion process through a nozzle. This helps in enhancing the cold gas thrust. However, one of the deficiencies of direct-current microdischarges is the need for exposed electrodes that incur ion bombardment with large thermal fluxes and consequently subject to wear. A different approach is to use an alternating current (AC) with electrodes covered by a suitable dielectric to prevent electrode erosion. The discharge will then be similar to a micrometer scale Dielectric Barrier Discharge (micro-DBD). It is thus important to investigate the power densities that are attained by this system and assess its effectiveness in gas heating. Classical large-scale (mm gap) Dielectric Barrier Discharges (DBD) is used in excimer lamps, ozone generation and in materials processing[2] and are not subject to any significant gas heating. In this study we compare the gas heating effects in a micro-DBD and a classical large-scale DBD over a range of frequencies.

A detailed first-principles computational model is used to provide time-accurate solutions of multi-species, multi-temperature, self consistent plasma governing equations for the discharge physics. We use a finite rate argon chemistry which has been validated through simulations on micro hollow cathode discharges[3]. The paper will present details of important discharge parameters, power densities and gas temperature in a micro DBD and a millimeter scale classic DBD.

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2. U. Kogelschatz, B. Eliasson, W. Egli, “From ozone generators to flat television screens: history and future potential of dielectric-barrier discharges”, Journal of Pure Appl. Chem.,Vol 71,No. 10,pp. 1819-1828, 1999

3. T. Deconinck, L. L. Raja, ``Modeling of Mode Transition Behavior in Argon Microhollow Cathode Discharges", Plasma Processes and Polymers, Vol. 6, No. 5, Apr 2009.

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