THEORETICAL STUDY ON SPATIO - TEMPORAL DYNAMIC BEHAVIOR OF MICROHOLLOW CATHODE DISCHARGE*

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Microhollow cathode discharge (MHCD) is a kind of high pressure, non-equilibrium glow discharges with relative low operating voltage(several hundreds volts).It has advantages of stable discharge under high gas pressure even atmosphere and generating high-energy electron.Potential applications for the devices using MHCD technology include light source, plasma cathode, analytical spectroscopy, material processing, sterilization, microplasma jet, and microplasma propulsion[1].

The two-dimensional fluid model of MHCD in argon consists of the continuity equations for electron and ion and Poisson's equation for electric field coupled with gas temperature equation. The model considers the drift-diffusion approximation for the particle flux of electron and ion and accounts for the mean electron energy dependence of the ionization rate. In the numerical study, the thickness of cathode, anode and dielectric are 100 μm , 100 μm and 250 μm respectively and the hole diameter is 100 μm. The discharge occurs in argon with the pressure 100 Torr. The computation results show the spatio-temporal dynamic behavior of potential profile, electron density, ion density, electron temperature and gas temperature distribution. The potential contour shows that the axial electric field is dominant at the discharge initialization and then the radial electric field becomes very important as the forming of the cathode sheath. The highest electron density is at the hole center on the order of 10^{20} m^{-3}, electron temperature of several to tens of eV and gas temperature of 400~600 K. The peak electron/ion density occurs near the region of the cathode and the dielectric as well as near the anode at the discharge initialization, then localizes along the centerline of the hollow near the cathode. The gas heating due to ion power deposition is dominant. Most of the model predictions are in agreement with experimental data for MHCD under the similar conditions.

1. J. P. Boeuf, L. C. Pitchford and K. H. Schoenbach, "Predicted properties of microhollow cathode discharges in x enon", Appl. Phys. Lett, 86, 071501, 2005, pp. 1-3.

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