SCALING OF NORMAL GLOW DISCHARGE TOWARDS 1μm: MICROPLASMA DISCHARGES IN HIGH PRESSURE GASES

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Atmospheric pressure micro-plasmas are uniquely characterized by their very high energy densities and also by their small discharge sizes. These properties allow for unique applications such as chemical reactors and light sources [1]. We have investigated the operational characteristics of microplasmas at higher energy densities and smaller sizes by operating micro-plasma configurations at high pressure conditions. We have been able to operate a stable non-thermal discharge at pressures up to 270 psi in high pressure Nitrogen & Helium. We studied the discharge and analyzed its variation with changes in current & pressure. The discharge was analyzed by microscopic visualization and data from the images has been processed to measure the current density & estimate particle density. By increasing the pressure beyond 200 psi and by minimizing the discharge current required for sustaining the plasma, we have been able to achieve discharge sizes of less than 10 μm in Nitrogen (see Fig.1) and as small as 20 μm in Helium. Optical emission spectroscopic studies were used to measure gas temperature and vibrational temperature using the N_2 2^{nd} positive system [2]. The temperature and current density measurements are used to estimate normalized current densities. Results obtained after introducing the corrected pressure based on the gas temperature are close to the expected values of 400-500 μA /cm^2*$Torr^2$ for low pressure normal glow discharges in N_2 [3]. The research presents further validation of the general operational characteristics of micro-plasmas being pressure scaled versions of normal glow discharges [4]. Attained energy densities are ten to twenty times higher than in atmospheric pressure micro-plasmas. Discharge sizes are also significantly smaller, decreasing with increasing pressure, but the scaling is not 'pd' due to the increase in gas temperature with pressure.

Figure1: N_2 discharge size variation with increasing pressure

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4. D. Staack, B. Farouk, A. Gutsol *et al.*, *Plasma Sources Science & Technology,* vol. 17.2, 2008.