CHARACTERIZATION OF AN ATMOSPHERIC PRESSURE NONEQUILIBRIUM SURFACE BARRIER DISCHARGE MICROPLASMA WITH LIQUID ELECTRODE

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As part of a project on plasma chemistry in microreactor chips, we have studied the generation of an atmospheric pressure, surface barrier discharge microplasma in a silica micro capillary (i.d. 0.25 mm × 25 mm) by flowing argon and nitrogen mixtures with varying flow rates of 0.1 – 4 sccm. The device consists of a twisted metallic wire (i.d. 0.1 mm) and tap water as electrodes. The electrodes are separated by the capillary wall which forms a dielectric layer with thickness of 0.05 mm. A surface discharge was formed on the inner surface of the capillary when a sinusoidal high voltage (100 Hz – 10 kHz, 0.7–2 kV) was applied. Time-resolved electrical and optical characteristics of the microplasma were investigated. Power densities were calculated from corresponding Lissajous figures (figure 1(a)). It was found that a high power density (175 W/cm^3) and a uniform atmospheric pressure plasma can be obtained in the capillary. Discharge current profiles evolved from two spikes into a continuous regime when the frequency was increased from 100 Hz to several kHz. Emission spectra of OH and N_2 molecular species were collected by a fiber-coupled miniature emission spectrometer with 0.7 nm spectral resolution (figure 1(b)). In order to calculate rotational and vibrational temperatures, simulated spectra were compared with experimental molecular spectra. Analysis of OH(A) and the second positive system of nitrogen indicates a rotational temperature of 300 – 400 K and a vibrational temperature of 2000 K. The influence of voltage, frequency and gas flow rate through the capillary on electrical and optical properties of the nonthermal, high power density uniform discharge will be discussed.

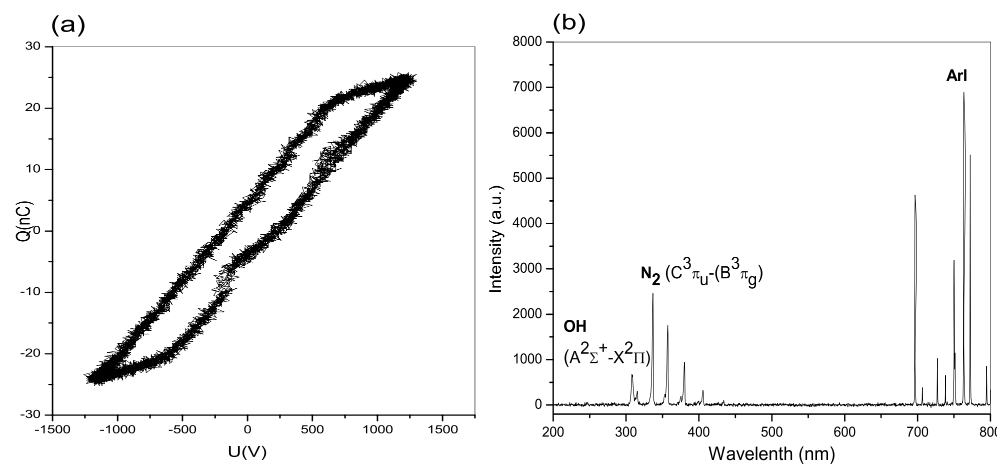

Figure 1. Measured Lissajous figure in Ar+1% N_2 with f = 2 sccm, u_{appl} = 2 kV (peak-to-peak) and υ = 5kHz (a) and corresponding emission spectrum (b).