Dependence of anode glow on surrounding geometry in a parallel plate glow discharge plasma

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An intense anode glow is observed in a parallel plate glow discharge plasma (cathode to anode surface area ratio ≈ 90; cathode: grounded) that strongly depends on the surrounding geometry. The electrode system was placed inside a grounded vacuum vessel. The experiments were performed in three configurations: (a) when the discharge is allowed between the electrodes by covering them with a glass tube and mica discs at the ends, the anode glow appears only at low currents. (b) When a deliberate leak is introduced using smaller diameter mica discs that allow plasma to escape from the ends to reach the cathodic vacuum chamber, the anode glow is still formed at low currents, but a negative differential resistance (NDR) along with hysteresis appear in the *I-V* characteristics. (c) However, when the discharge is exposed to the whole chamber, the anode glow is present at high discharge currents also, although the NDR and hysteresis disappear.

1. Introduction

Anode glow may appear at low discharge currents to maintain the discharge [1,2] by formation of a potential double layer which accelerates the electrons near the anode, energizing them to energies above the ionization energy of the gas, which causes additional ionization near the anode. The present paper correlates the dynamics of anode glow with the system geometry at various discharge currents.

2. Experimental setup

The experimental setup consists of a cylindrical stainless steel chamber (inner diameter 150 mm and height 355 mm) in which two planar electrodes (grounded cathode (dia. = 76 mm) and anode (dia. = 8 mm)) were placed at a separation of 35 mm. A glass tube of inner diameter, 90 mm along with mica discs at the two ends, were used to cover the electrode system to isolate the plasma from the grounded chamber walls. The external circuit was completed through a variable DC power supply (1kV, 1A) and a variable ballast resistor. The argon gas pressure (p) was varied from 200 to 800 mTorr. The experiments were carried out in three different configurations: (a) the plasma discharge was completely isolated from the chamber walls; (b) a small gap was permitted between the glass tube and the electrodes (at both ends); (c) both glass tube and mica discs were removed and the discharge was left fully uncovered.

3. Results and discussion

Discharge characteristics (plot of discharge voltage (V) versus discharge current (I)) were observed at different gas pressures for all three configurations. In configurations (a) and (b), the anode glow appears at low currents ($\leq$ 2 mA) and its size and intensity are found to be linked to the slope of the *I-V* characteristics. More interestingly, an NDR with hysteresis is observed in the *I-V* characteristics in configuration (b). However, in configuration (c), the anode glow is present throughout, at all currents. Also, the size of the glow is larger and more intense than for configurations (a) and (b). Figure (1) shows the plasma snap shot for covered (Fig. 1a) and uncovered (Fig.1b) conditions.

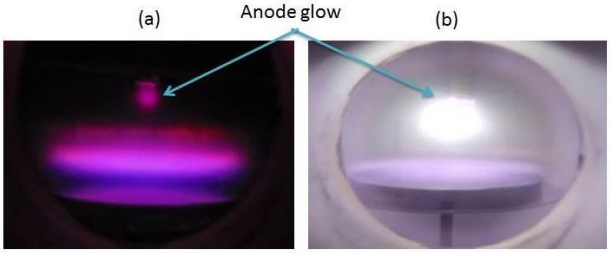

Fig. 1. Plasma snap shot at p = 400 mTorr for covered (Fig. a) and un-covered (Fig. b) (at I_d = 0.55 mA and 30 mA respectively).

The minimum discharge voltage required to sustain the discharge at 400 mTorr in configurations (a) and (b) is $V \approx 225$ V, which is greater than that for configuration (c), for which, $V \approx 180$ V. The detailed experimental results will be presented in the conference.

4. References

[1] K. G. Emeleus, Int. J. Electronics, **52** (1982) 407.

[2] B. Song, N. D. Angelo, R. L. Merlino, J. Phys. D Appl. Phys., **24** (1991) 1789.