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Proceedings

International Workshop on Plasmas with Liquids IWPL 2010

March 22–24, 2010

Hotel Okudogo

Matsuyama, Ehime, Japan

Operated by

Orange Plasma Project, Ehime University

The DC-excited Atmospheric Pressure Glow Discharge with Liquid Electrode

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DC-excited atmospheric pressure glow discharges in a metal pin-liquid electrode system are investigated in air, N_2, He, Ar, N_2O and CO_2. Self-organization is observed in the case of liquid anode. The observed patterns depend on the current and the conductivity of the liquid. In the different gases the acidification of the liquid is studied as well as the influence of the filling gas on the optical emission. The rotational population distribution of OH(A-X) is investigated in the context of the determination of the gas temperature.

1. Introduction

Like other atmospheric pressure non-equilibrium discharges such as corona discharges and dielectric barrier discharges, atmospheric pressure glow discharges (APGDs) have been extensively studied in recent years in view to overcome the need for expensive low pressure systems as well as for new applications [1-3]. Additionally using a liquid electrode efficient strong generation of UV radiation and active radicals can be obtained.

In this contribution the DC-excited APGD with liquid electrode is investigated in different gases such as air, N_2, He, Ar, N_2O and CO_2.

2. Results

Self-organization of the anode layer occurs when the liquid electrode is anode. In the case of air the anode spot structure evolves from a constricted homogeneous spot to a pattern consisting of small distinct spots with increasing current in the range 5 to 30 mA. The coexisting spots group together and form stripe patterns or rings [4].

In nitrogen containing gases (air, N_2 and N_2O) as well as in CO_2 the acidity of the liquid increases after plasma treatment, which is caused by the formation of HNO_2, HNO_3 and H_2CO_3 [5]. In Ar the pH remains constant after treatment.

As is already known, the rotational temperature obtained from OH(A-X) does not always provide a good estimate of the gas temperature in the case of liquid plasmas [1, 6]. The measured rotational temperature of OH(A-X) is higher than the rotational temperature obtained from N_2(C-B) and is significantly lower in atomic gases than in molecular gases. In all gases a deviation from a Boltzmann rotational population distribution of OH(A) is observed due to the formation process of OH(A). This non-Boltzmann behavior is more pronounced in the case of He. The measurements suggest that vibrational energy transfer could explain the non-Boltzmann distribution of OH(A). The importance of recombination processes in the production of excited species will be discussed [7].

3. Conclusion

Self-organization is observed when the liquid electrode is anode. When the discharge gas contains nitrogen or CO_2, acidification of the liquid occurs. Deviation from a Boltzmann rotational population distribution is observed in all gases due to the formation process of OH(A) and deviating temperatures are found compared to other molecular bands.

Acknowledgments

This work is acknowledged by the funding of the Interuniversity Attraction Poles Program of the Belgian Science Policy (project 'PSI'-P6/08).

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