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Comparative analysis of properties of helium and argon atmospheric pressure plasma jets

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This paper presents the results of studies of the structure, electrical, optical properties and temperature of the atmospheric pressure plasma jet in noble gases, such as helium and argon. The length and shape of the plasma jet at different gas flow rates and values of high voltage on the discharge electrodes were compared. Dynamic and static current-voltage characteristics on the basis of the oscillograms were also analyzed. Discharge spectra were obtained by optical emission spectroscopy method and compared for *He* and *Ar* gases. Temperature of treating surface (cupper plate) measured by thermocouple at different values of gas flow rate.

1. Experiment

Atmospheric pressure plasma jet on the basis of dielectric barrier discharge is a universal source of low temperature plasma [1,2]. In our experiments cold plasma was generated in the noble gas flow through a quartz tube. Two parallel cylindrical foils (electrodes) were attached to the quartz tube with length 80 mm, diameter 9 mm, an inner diameter of 7 mm. The distance between two electrodes was 15 mm. High voltage sinusoidal signal with a frequency f = 30 kHz was used. To register the current and the discharge voltage a high voltage probe (Tektronix P6015) and digital oscilloscope (Le Croy Wave Jet 354A) were used. The current is detected by low-voltage Le Croy probe and measuring resistor with resistance of 100 Ohms. The optical characteristics were measured by optical emission spectrometer Solar Systems.

2. Results

Series of experiments were performed to determine the optimal gas flow and to identify the optimal conditions for obtaining the longest plasma jet length. With increasing gas flow rate the plasma jet length is increased up to a certain value and then the value is decreased (Figure 1). The reason for such behaviour is transition of gas flow from laminar to turbulent regime at high gas velocities in the quartz tube [3]. The plasma jet length was also studied as a function of the applied voltage on the electrodes. To determine the surface temperature in contact with the plasma jet the copper plate and a thermocouple was used. The results showed a decrease in the treated copper plate temperature at higher gas flow. It is also revealed that the surface temperature in the contact with argon plasma much exceeds the temperature than in the case of helium. The emission spectrum was investigated for argon and helium at different discharge voltage and a fixed frequency and gas flow. In the both case results of optical emission spectroscopy of the plasma jet under atmospheric pressure indicates the presence of active chemical component and radicals as atomic oxygen, ozone, nitrous oxide and hydroxyl.

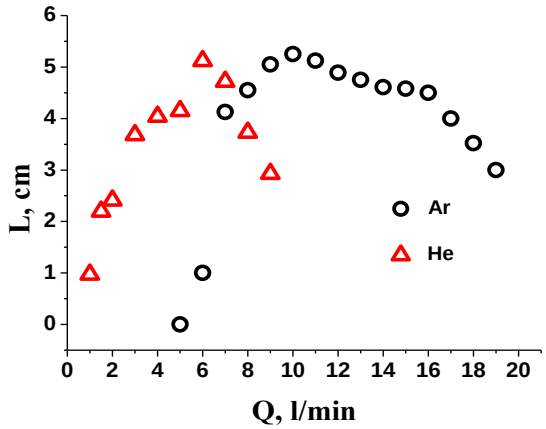

Figure 1. The dependence of plasma jet length on gas flow rate

3. References

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