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Current – voltage characteristic of Argon plasma jet

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Abstract: *We have simply constructed a plasma jet that can work in the frequency range (10-40) kHz and within the range of (0-10) kV of applied. High voltage probes are used in order to obtain current and voltage waveforms. In this paper, we will show V_{RMS}-I_{MRS} plasma jet characteristics for the working frequency of 30 kHz. Current and voltage measurements were made both for the increase and decrease of the applied voltage in order to see if there is a hysteresis effect.*

I. Introduction

The scientific community who studies the plasma state has recently paid much attention to the expansion of atmospheric pressure plasma sources having the gas temperatures close to the room temperature and to use these plasmas for technologies applied up to now only under low-pressure conditions. The benefit in this object is dictated by a potential economic interest from numerous non-thermal plasma technologies: plasma aid chemical vapor deposition, etching, polymerization, protective coating deposition, toxic and harmful gas decomposition, sterilization and decontamination, electromagnetic wave shielding, polymer surface modifications, and so on. These new technologies can be now applied on the materials which can not be treated at low-pressure or can not favor the temperature much higher than the room temperature. Such plasmas are laid in non-thermal plasmas category which were defined as having the gas temperature lower than combustion temperature ($T_{gas} < T_{combustion} = 2300$ K) [1]. A comparatively recent review paper presents the generation mechanisms, the guise of the plasma states and physical. Characteristics of some atmospheric pressure discharges, which can have a non-thermal character and could be cold [2].

Starting from these considerations, different kind of atmospheric pressure non-thermal plasmas were generated, the most important being: plasma needle, plasma pencil, dielectric barrier discharge and plasma jet. Plasma needle was developed by Stoffels and was characterized having in view the electrical and optical characteristics [3], the action on bacterial cells [4] and in vivo treatments of biological tissues [5].

II. Experimental Setup

1. plasma jet

Plasma jet consists of a hollow stainless steel pipe 100 mm long with inner diameter 1mm and outer diameter 2.7mm inserted inside a Teflon pipe as shown in figure (1). The stainless steel connected to the high voltage power supply. As put between Teflon pipe and stainless steel pipe filled with Teflon tape. Under certain conditions an argon plasma jet can be extracted from the downstream tube end since there is no discharge inside the plastic tube. All configuration the high voltage power supply generates high voltage of sinusoidal shape of 9.6kV peak to peak and frequency of 30kHz.

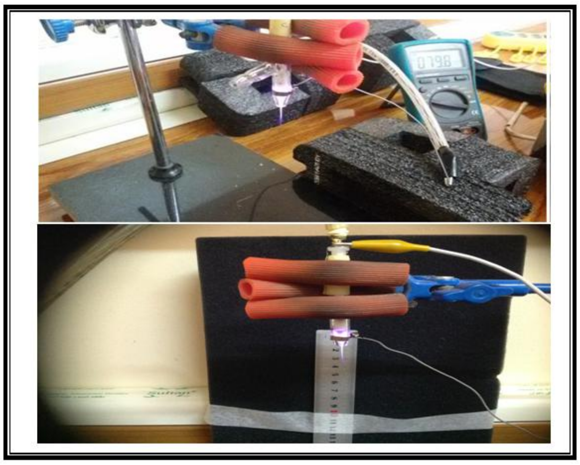

Fig (1) plasma jet at working

2. Plasma jet system:

Plasma system includes four main parts:

1. The source of alternating high voltages.
2. Plasma jet.
3. Argon gas.
4. Flow meter.

Figure (2) shows the schematic diagram of plasma jet the system. Which consists from high voltage source, Argon gas and gas flow meter.

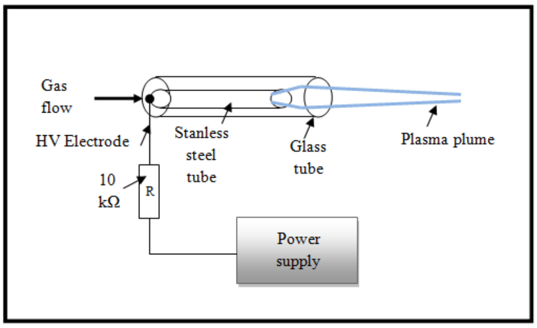

Fig (2) Schematic of the experimental setup

III. Results And Discussion

In Figure (3)) shows the relation between the flow current as a function of the applied voltage for different flow rate for argon gas (1, 2, 3) l/min. The general behaviour for (I-V) curves was found similar to all gas flow rates.

The value of current will be very small about many of (mA). The small increasing of current recorded with the increasing of the applied voltage to a certain value of voltage that called (breakdown voltage), this value depends on the gas flow rate, The breakdown voltage decreasing with the increasing of gas flow rate. At the breaking down voltage, the needle begin produce the plasma jet, the intensity of the plasma jet will be different for different gas flow rate. Also found that the value of current will be increasing at the breakdown voltage to a point that change its position by charging the gas flow rate.

Also noted that a positive relationship between the frequency of the system and current discharge.
At a certain voltage, we noticed that the current increasing by increasing the gas flow rate, so, the increasing in gas flow rate lead to increase the number of molecules that passing through the tube and that will be ionized to cause increasing in the flow current value by the needle.

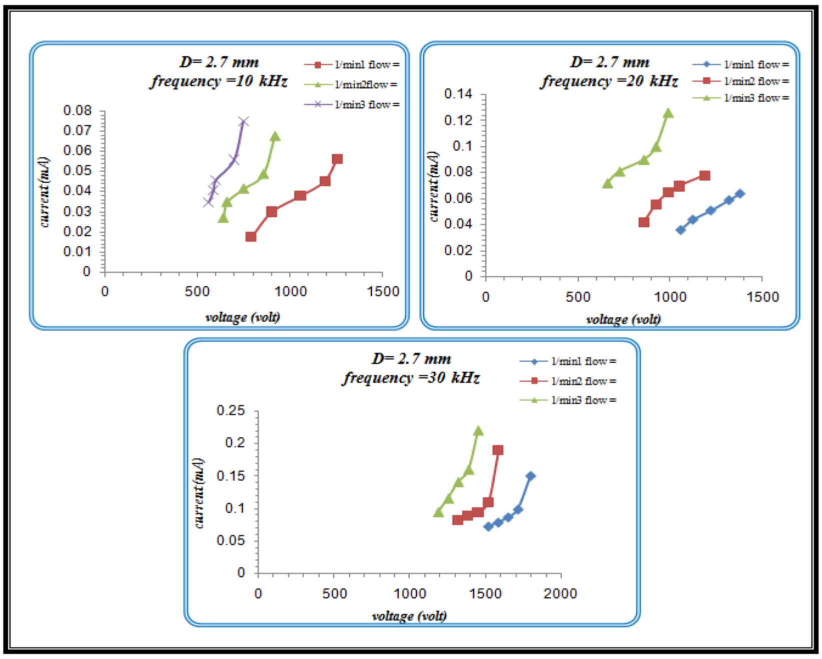

Figure (3): The current as a function of voltage using different gas flow rates for a fixed frequency, (a) 10kHz, (b) 20kHz, (c) 30kHz

IV. Conclusion

The present work concluded the following: We have constructed a plasma jet which can operate in a range of frequencies (10-40) kHz. In this paper, we have shown results for the frequency of 30 kHz and several gas flows of the feeding gas (Argon). High-voltage probes were used in order to record the current and voltage waveforms. The ignited plasma behaves like a nonlinear load introduced into the electrical circuit. With the increase of the Argon flow, the ignition voltages reduce for the same current range. The power in

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