Underwater plasma jet based on the pin-hole configuration

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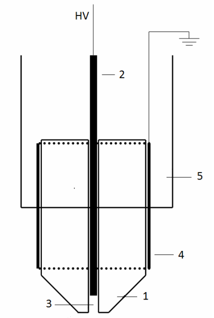
1. Introduction

Electrical discharges in liquids have been subject of many studies during the last years mainly focused on the formation of a conductive channel in the discharge gap filled with liquid, its diagnostic and various potential applications in various fields. The creation of electric discharges in liquids is very complex and it is not fully understood, because they are operating under extreme conditions. There are various possible configurations for the discharge ignition. The pin-hole systems where the discharge is created inside a small orifice connecting two chambers filled by any conductive solution (each chamber contains one of the electrodes) is one of them and was widely studied by our research group recently [1, 2]. Based on the experience with this system, a new plasma jet based on the pin-hole configuration was developed very recently. Plasma can be created by wide range of power supplies from DC over AC, high frequency up to RF in continuous as well as pulsed regimes. This contribution shows the first results of discharge operation monitored by current-voltage characteristics with simultaneous ultra fast filming.

2. Experimental set up

The set up scheme and its photo are given in Fig. 1.



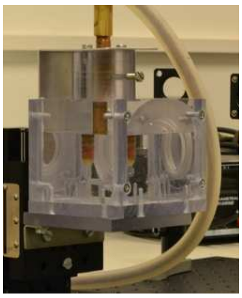


Fig. 1. Schematic drawing of the plasma jet (left) and reactor with installed plasma jet (right). 1 – ceramic body, 2 – inner tungsten wire electrode (diameter of 0.6 mm), 3 – space with increased current density, 4 – outer copper electrode, 5 – silicon insulation.

The current-voltage characteristics were recorded using oscilloscope equipped by HV probe Tektronix P6015A, current was monitored by voltage drop at shunt resistor of 5.13 Ω in case of DC supplying or by Rogowski coil in case of audio frequency created discharge. The discharge was filmed by ultra fast camera Photron FASTCAM SA-X2 that was used for both light emission and shadowgraphy. The discharge time evolution was thus visualized in detail and it was possible also relate this with the current-voltage characteristics.

3. Results

An example of the current-voltage time evolution during the DC discharge operation in positive polarity (inner electrode is positive) is shown in the Fig. 2. The irregular strong very short high current peaks are well visible and they are accomplished with significant decrease of the discharge voltage due to limited charge capacitance of the used power supply. Based on the fast film record, the spark character of the discharge at the same moment was observed.

In the case of negative polarity, the same effect was recorded but the current peaks were smaller. No sparking was observed is discharge was supplied by audio frequency high voltage. Besides the fast camera and current voltage measurement, the space but not time resolved optical emission spectroscopy was used for the discharge characterization.

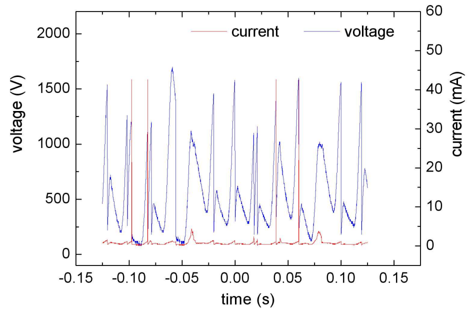


Fig. 2. Current and voltage wave forms of the plasma jet in NaCl solution (500 µS/cm) in the positive polarity of the inner electrode.

References

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