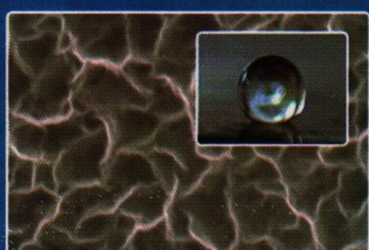
16th International Conference on Plasma Physics and Applications

16th CONFERENCE
June 20-25, 2013
Magurele - Bucharest
ROMANIA
PLASMA PHYSICS & APPLICATIONS



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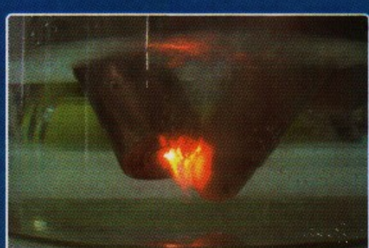

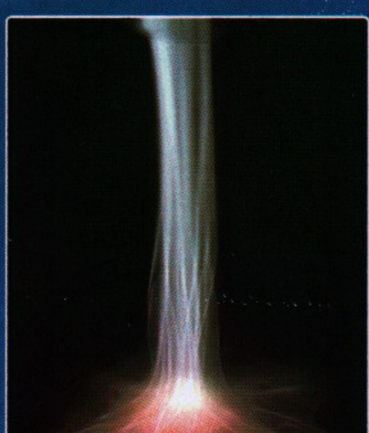

Edited by: B. Mitu, G. Dinescu

Time-resolved electrical and optical study of transient spark

M. Janda, V. Martišovitš, K. Hensel, L. Dvonč, Z. Machala

Division of Environmental Physics, Faculty of Mathematics, Physics and Informatics, Comenius University, Mlynská dolina, 84248, Bratislava, Slovakia
janda@fmph.uniba.sk

1. Introduction

Transient spark (TS) is a streamer-to-spark transition type discharge initiated by a streamer followed by the gas breakdown and a short (~10ns) spark current pulse (~ 1 A) [1]. Despite using DC high voltage (HV) power, TS has a repetitively pulsed character: and the streamer-to-spark transition repeats in the kHz frequency range. TS generates highly reactive non-equilibrium plasma suitable for bio-medical applications [2].

2. Methodology

In order to study the TS properties, we employed an iCCD (ANDOR Istar) camera with 2-ns gate coupled to a spectrometer, as well as a photomultiplier tube (Hamamatsu H955) with 2.2-ns rise time and appropriate narrow-band optical filters.

Experiments were carried out at room temperature in atmospheric pressure air. A dc high-voltage (HV) power supply connected via a series resistor (6.56–9.84 MΩ) was used to generate a positive TS discharge in point-to-plane configuration. The distance between the stainless steel electrodes was ~5 mm. The discharge voltage was measured by an HV probe Tektronix P6015A, and the current was measured on a 1 Ω resistor shunt. All electric signals were recorded by a 200 MHz oscilloscope Tektronix TDS2024.

Experimental results were used to validate a kinetic model of TS based on ZDPlasKin package [3]. The goal was to mimic evolution of the reduced electric field strength *E/N* during all TS phases so that the calculated electron densities agree with experiment.

3. Results

Time resolved emission spectra of the N_2 2nd positive system were used to estimate time evolution of the gas temperature T during the streamer-to-spark transition [4]. The value of T at the beginning of the streamer $T_{streamer}$ was used to estimate the pre-heating effect of the increasing f. Next, the emission of H_α line was used to calculate the electron density n_e during the spark phase of TS (from Stark broadening). Finally, the imaging of TS was used to observe the frequency influence on the propagation of the streamer, and the evolution of the plasma channel diameter.

The plasma diameter, and current and voltage waveforms were used to estimate the plasma resistance R_p during all phases of TS. From R_p we calculated n_e. These data were used to validate our kinetic model of TS. We obtained reasonable profile of *E/N*, consistent with the literature and capable to reproduce the time evolution of n_e during all phases of TS.

Acknowledgements: Effort sponsored by the Slovak Research and Development Agency APVV SK-RO-0024-12, and Slovak grant agency VEGA 1/0668/11.

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Keywords: *transient spark, electrical and optical diagnostic, kinetic model*