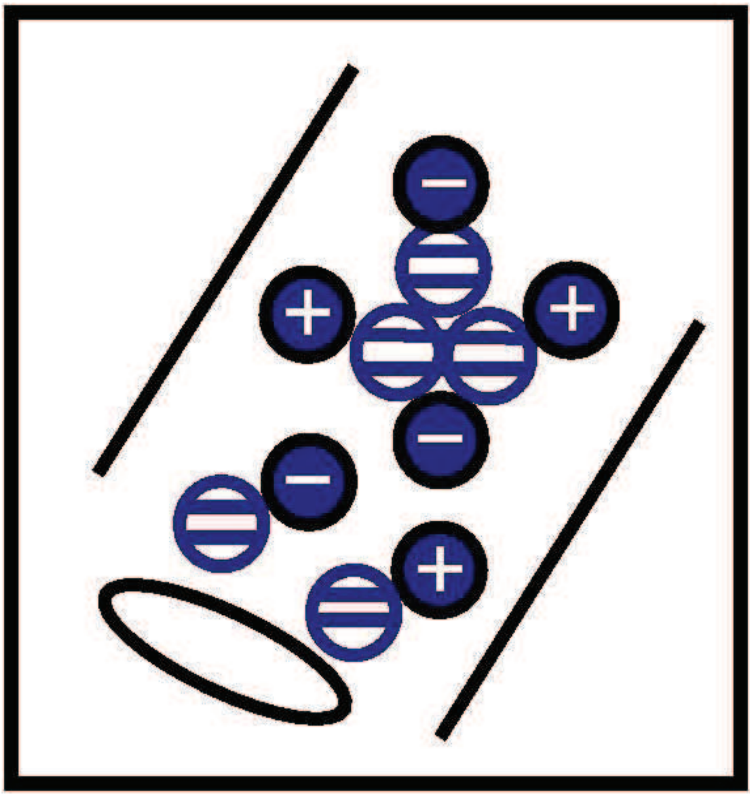

FLTPD XI

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List of topical lectures

Speaker	Affiliation	Title of the talk
Ana SOBOTA	Eindhoven University of Technology, The Netherlands	Cold atmospheric pressure plasma jets charge carried by plasma bullets
Abdollah SARANI	INP Greifswald, Germany	Investigation of discharge development in an atmospheric pressure single dielectric barrier discharge in N2/CO2 mixture by Cross-correlation spectroscopy
Torsten GERLING	INP Greifswald, Germany	Measurement of molecular argon ion density in an atmospheric pressure transient spark discharge by observation of ion acoustic waves
Uwe CZARNETZKI	Ruhr-University Bochum, Germany	Time resolved evolution of the EEDF in a ns-pulsed atmospheric pressure plasma jet in Helium
Arthur SALMON	Ecole Centrale Paris, France	Spatial characterization of N(4S) and N(2P) in the afterglow of a pulsed nitrogen discharge at atmospheric pressure using optical emission spectroscopy
Mario JANDA	Comenius University Bratislava, Slovakia	Imaging of self-pulsing nanosecond transient spark discharge
Xi-Ming ZHU	Ruhr University Bochum, Germany	Measurement of the radial density profile of Ar metastables by self-absorption method with an optical probe
Jean-Pierre VAN HELDEN	INP Greifswald, Germany	Mid-infrared laser absorption spectroscopy for the detection of transient species in plasmas
Augusto STANCAMPIANO	Università di Bologna Italy	Advanced investigation of the interaction between a plasma jet and a liquid surface: influence of electrical and fluid dynamic parameters
Sebastian NEMSCHOKMICHAL	INP Greifswald Germany	Laser-photodetachment of negative ions in He/O2 barrier discharges
Milan TICHY	Charles University in Prague, Czech Republic	Measurements of plasma potential in low-temperature magnetized plasma - comparison between Langmuir and ball-pen probe
Daniil MARINOV	CNRS, École polytechnique, France	Time-resolved quantum cascade laser diagnostics of pulsed plasmas with strong vibrational excitation.
Gilles CUNGE	CEA, CNRS, Université Grenoble Alpes France	Measuring IVDF through high-aspect holes in pulsed ICP plasmas
Jean-Paul BOOTH	CNRS, École polytechnique, France	Ultra broad-band high sensitivity absorption spectroscopy of inductively-coupled plasmas in Cl2/O2 mixtures
Dmytro RAFALSKYI	CNRS, École polytechnique, France	Electron density measurements in highly electronegative magnetized plasma using RF diagnostics
Emile CARBONE	Ruhr-Universität Bochum, Germany	Spatio-temporal dynamics of excited species and electrons in a pulsed argon microwave discharge

Imaging of self-pulsing nanosecond transient spark discharge

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1. Introduction

The transient spark (TS) is a periodic streamer-to-spark transition discharge with controlled spark phase operating at the repetition frequency *f* in the range of 1-10 kHz [1]. Due to the short spark current pulse duration (~10–100 ns), the TS generates highly reactive non-equilibrium plasma, suitable for example for the bio-decontamination of water [2].

The transfer of reactive species from the plasma to the liquid water is crucial for the efficiency of the bio-decontamination. We obtained good results when the contaminated water was electro-sprayed through the active zone of the TS discharge [2]. However, the bio-decontamination efficiency strongly depends also on *f*. Above ~3 kHz, the TS characteristics change (smaller and broader spark pulses) and its biocidal efficiency declines. We therefore performed extensive study of the TS dependence on *f*. However, we decided to discuss only one issue in this abstract – changes of the breakdown mechanism in the TS with increasing *f*.

2. Methodology

Besides electrical measurements, we performed time resolved emission spectroscopy and imaging of the TS using a fast iCCD camera (2 ns minimum gate width). Additionally, a streak camera like images were obtained using spatiotemporal reconstruction of the discharge emission detected by a photomultiplier tube with light collection system placed on a micrometric translation stage.

The positive polarity TS was generated in the ambient air between metal electrodes in point-to-plane configuration with distance $d = 4\text{-}7$ mm.

3. Results and Discussion

The TS is initiated by a primary streamer creating a relatively conductive plasma bridge between the electrodes. It enables partial discharging of the internal capacity C of the electric circuit, and a local gas heating inside the plasma channel. When the gas temperature T inside the plasma channel reaches ~1000 K, a very short (~10-100 ns) high current (>1 A) spark current pulse appears [3].

Since the appearance of the spark in the TS is governed by the increase of T to ~1000 K [3], the breakdown can be explained by the hydrodynamic expansion mechanism [4].

However, the increase of *f* influences the breakdown mechanism in the TS, since the significant shortening of the streamer-to-spark transition time (τ) was observed above ~3 kHz [3]. Above ~3 kHz, the breakdown in the TS is probably significantly influenced by the attachment control processes [5] initiating the so called secondary streamer.

The imaging of TS revealed the presence of the secondary steamer following the primary steamer. We observed the increase of the propagation velocity of both the primary and the secondary streamer with increasing *f*. Accelerating propagation of the secondary streamer crossing the entire gap could explain short streamer-to-spark transition times τ (~100 ns) at *f* above ~3 kHz. The secondary streamer was observed below 3 kHz as well, but it did not cross the whole gap and it probably disappeared long before the spark current pulse.

Acceleration of the primary and secondary streamers and shortening of τ with increasing *f* was attributed to the memory effect composed of pre-heating, pre-ionization, or gas composition changes induced by the previous TS pulses. Further research is required, including kinetic modeling, to verify this hypothesis and distinguish the respective contributors to the memory effect.

Acknowledgement

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