Light emission profiles of a parallel plate dc micro discharge in different discharge modes

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Application Note

Introduction

Microplasmas have recently become in the focus of research due to their wide range of their possible applications. Complex micro discharge configurations are often used, even though many of their basic properties are not yet well understood. Due to their simple geometry parallel plate micro discharges are well suited to study and understand basic properties of micro discharges. To gain a better insight of the properties (especially studies of the formation and development of space charges are topics of our research) it is often important to combine both electrical and optical diagnostics. In micro plasmas many processes appear and change on small time scales. At the same time the light emission of the discharge can be very low depending on the discharge conditions. Therefore for optical recordings a sensitive and fast camera is required. The specifications of the iStar ICCD camera fulfill these requirements very well.

Experimental Setup

The parallel plate dc micro discharge consists of two stainless steel electrodes (electrode diameter 8 mm) which are mounted in a tight fitting Plexiglas tube. The distance between the two electrodes can be adjusted, however during the experiments presented here the gap was kept at d = mm. As feed gas argon was used. Details are given in [1].

A schematic sketch of the experiment is shown in figure 1.

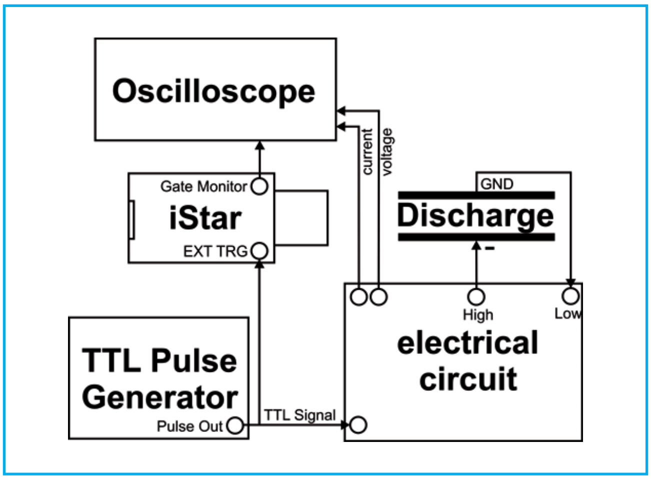

Fig 1. Schematics of the experimental setup.

The light emission profiles of the discharge are recorded with an Andor iStar ICCD camera (model DH734-18F-03). A TTL pulse is used to switch the working point of the micro discharge to different discharge modes (Townsend mode, normal glow, abnormal glow) and to trigger the iStar camera. The experiment and the camera are synchronized by the internal delay generator build inside the head of the ICCD camera.

Results

In this paragraph we will show and discuss some experimental results, which were obtained with the iStar camera.

Figure 2 shows a Volt-Ampere characteristic of the micro discharge. At selected points (a)-(d) we have recorded images of the light emission which are shown in figure 3.

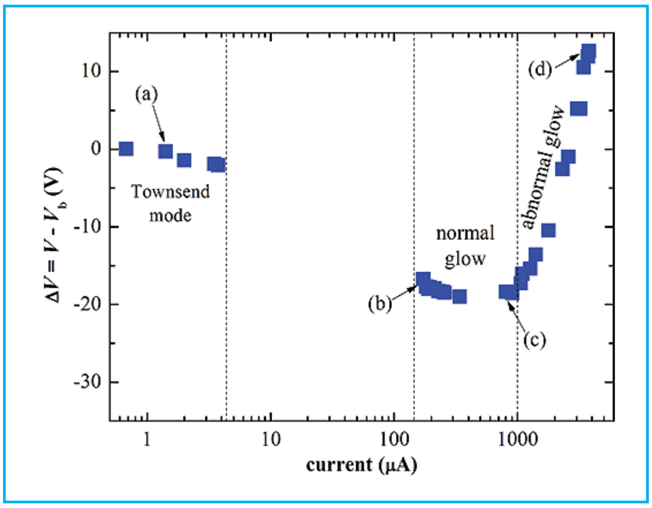

Fig 2. Volt-Ampere characteristic. Data points (a)-(d) correspond to the images shown in figure 3.

In the low current Townsend mode (a few microamperes discharge current) the maximum of the discharge intensity is located close to the anode (label a) and occupies the full electrode diameter. With increasing current the discharges switches to the normal glow. At the beginning of the normal glow the discharge is constricted and moves to the electrode edge (label 2).

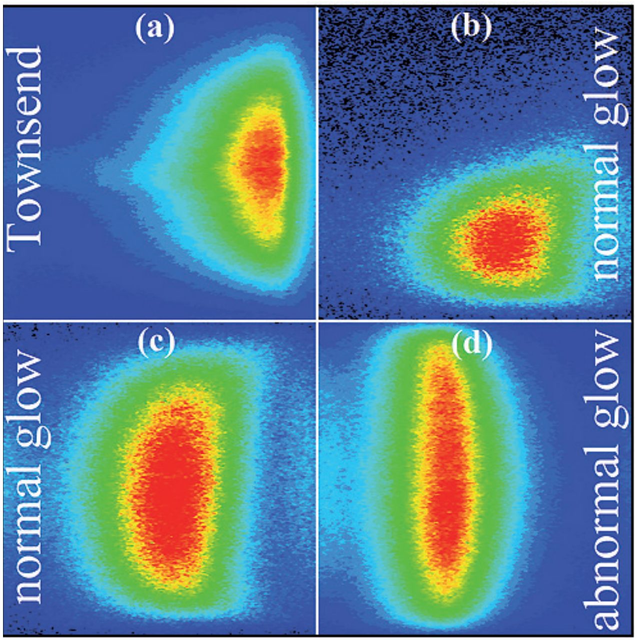

Fig 3. Light emission profiles of the parallel plate dc micro discharge in different discharge modes (a)-(d) recorded with the iStar DH734 ICCD camera. The powered electrode (cathode) and the grounded electrode (anode) are located on the left and right side of each image respectively. The images correspond to the conditions indicated in figure 2.

The peak of maximum emission moves away from the anode towards the cathode due to the buildup of space charge. With further increase of the current the discharge spreads in radial direction until the full electrode diameter is covered, which marks the ending point of the normal glow (label c). At high current values (discharge current >1000 microamperes) the discharge operates in the abnormal glow. The electrode diameter is fully covered and the peak of maximum intensity is shifted even further to the cathode (label d).

In our recent experiments we used the iStar ICCD camera to study the time development of the light distribution during fast discharge oscillations (self-pulsing) time averaged [2] and time resolved [1].

Conclusion

We have recorded the light emission profiles of a parallel plate dc micro discharge both time averaged and time resolved with an Andor iStar ICCD camera. The several acquisition modes and different triggering options as well as the integrated delay generator allows an easy control and synchronization with our experiment. The sensitive intensifier and the fast gating function of the camera enabled us to study the self-pulsing regime with a good time resolution, even under conditions with very low light emission.

Overall we are very satisfied with the handling and the performance of the iStar ICCD camera.

References

[1] T. Kuschel, B. Niermann, I. Stefanović, M. Böke, N. Škoro, D. Marić, Z. Lj. Petrović and J. Winter, 2011, *Plasma Sources Sci. Technol.* submitted (see also http://arxiv.org/abs/1104.5373)

[2] T. Kuschel, N. Škoro, D. Marić, I. Stefanović, G. Malović, J. Winter and Z. Lj. Petrović, 2011, *IEEE Trans. Plasma Sci.*, Spec. Issue on Images in Plasma Sci. accepted for publication (see also http://arxiv.org/abs/1104.5572)

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