Discharge dynamics of a micro-structured atmospheric pressure plasma channel

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We report on phase and space resolved optical emission spectroscopic combined with electrical measurements on a micro-structured plasma channel device (µ-channel) operated close to atmospheric pressure. This device haa confining structures in the range of several 10 µm and is made up of one linear discharge channel. It consists of a 50 µm wide channel of triangular cross-section etched into a silicon wafer and Ni electrodes coated onto the edges of the channel as electrodes (Fig. 1). This type of device is typically operated in rare gas at frequencies in the range of several kHz. Apart from an electrical characterisation investigations on the influence of excitation frequency on the development of pulse bursts are presented.

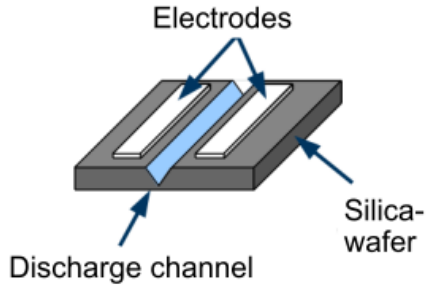

Fig. 1: Sketch of a micro-structured atmospheric pressure plasma channel

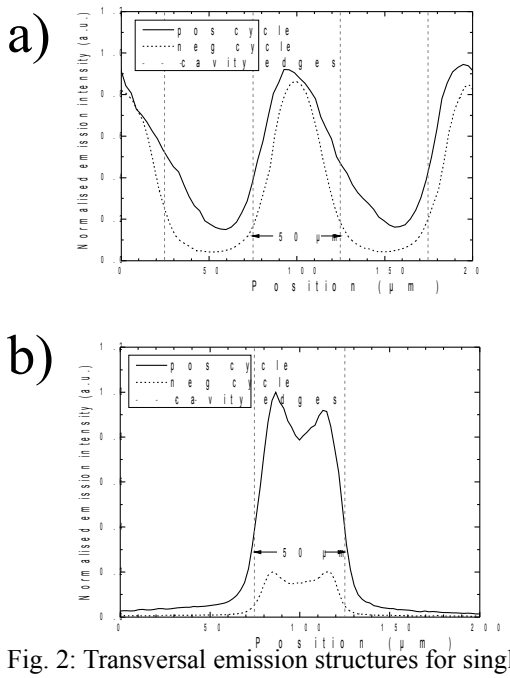

Fig. 2: Transversal emission structures for single pyramidal discharge (a) and µ-channel (b)

Emission features propagating across the discharge channel are observed. Discharge dynamics are compared to those observed for micro-structured atmospheric pressure plasma arrays with discharge cavities of inverted pyramidal shape and comparable cross-section. The velocity of these features is for the µ-channel about 500 m/s and by this about one order of magnitude smaller than for the micro discharge arrays [1].

Analysis of the emission distribution emphasises the assumption that the discharge behaves as a Townsend-mode discharge with an overlap of two spatially discriminated emissions evoked by electrons accelerated in the fields between the silicon base and the equipotential coplanar nickel electrodes. For the small pyramidal micro discharges of 50 µm edge length these features are overlapping to form one single emission structure due to field distortions (Fig. 2a). For the µ-channel with equal width and depth of the channel two clearly discernible structures appear (Fig. 2b).

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[1] J. Waskoenig, D.O'Connell, V. Schulz-von der Gathen, J. Winter, S.J. Park and J.G. Eden, Appl. Phys. Lett. 92, (2008) 101503