DC microplasma arrays on silicon wafers

R. Dussart[1], R. Michaud[1], S. Iseni[1], O. Aubry[1], A. Stolz[1], S. Dzikowski[2],

V. Schulz-von der Gathen[2], L.J. Overzet[3], L. Pitchford[4]

[1] *GREMI, CNRS-University of Orleans, France*

[2] *Experimental Physics II, Ruhr-Universität Bochum, Germany*

[3] *PSAL, University of Texas at Dallas, Richardson, TX, USA*

[4] *LAPLACE, CNRS – University Toulouse III, France*

Introduced in the mid 90's, DC Micro Hollow Cathode Discharges (MHCD) have the remarkable property of operating at atmospheric pressure in a normal glow (non equilibrium) regime provided the cathode area is not fully utilized [1], [2]. MHCD on silicon platforms were first studied by J. G. Eden's group [3]. Silicon processing initially developed for microelectronic devices offers many opportunities to design new, original and efficient devices to produce high density microplasmas.

At GREMI lab, original microreactors were fabricated in a clean room facility using different process steps such as lithography, deposition, oxidation, etching… The device consists of two electrodes separated by a dielectric layer. The thermal silicon oxide layer separating the two electrodes is 8 µm thick and is etched to form microcavities having a diameter of typically 100 µm. Arrays of up to 1064 microplasmas using an etched silicon cathode could be completely ignited in different gases such as argon, helium or nitrogen [4].

Even if complete arrays could be successfully ignited, the device operation was unstable and produced many current spikes that significantly damaged the microcavities and led to device failure. The mechanisms responsible for this unstable operation and short lifetime were investigated [5]. In this paper, we will discuss the involved mechanisms and the different ways to enhance the stability and lifetime of the microdischarges. A 2D fluid model developed at LAPLACE was used to simulate a single microplasma in helium. Finally, a very stable operation of the microdischarge array was obtained. The ignition dynamics of the array was also studied versus pressure.

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