Characterisation of Silicon based micro discharge plasma arrays in Direct Current (DC) at atmospheric pressure

M. Kulsreshath[1], L. Schwaerele[1], P. Lefaucheux[1], T. Tillocher[1], J. Ladroue[1], O. Aubry[1], P. Ranson[1], L. Overzet[2], R. Dussart[1]

1 University of Orléans, GREMI, 45067 Orléans, France
2 University of Texas at Dallas, Richardson, Texas, 75080-3021, USA
(* For oral presentation)

Abstract:

The ignition of micro plasma in silicon (Si) based MHCD arrays at atmospheric pressure is point of interest due to many potential applications in different fields like bio-medical field, photonics/display technologies and sensors etc., but on the other hand it is also a challenge to ignite the many hole arrays at atmospheric pressure. G. Eden's team from the University of Illinois (Urbana) was the first to use clean room techniques to realize the arrays of micro discharges made in silicon.[1] In this case the typical dimensions of the cavities were 50x50 µm². He used a silicon nitride layer and polyimide to form the dielectric separating the two electrodes. The cathode shape is made by silicon wet etching and having the inverted pyramidal cavities. The anode was made in nickel. The same team was able to ignite up to 250,000 micro-discharges all together in AC.[2]

In this paper we present DC driven micro discharges based on silicon platform with arrays of 1024 holes of different diameters: 50 µm, 100 µm, and 150 µm. In these micro discharges, we have used mainly two kinds of cavities, viz. isotropic and anisotropic; and for the experiment, we have used inert gases like Helium (He), Argon (Ar), Nitrogen (N_2) at pressure varying from 100 to 1000 Torr. Our micro discharge reactors are fabricated with different configurations, for example: there exist single hole devices containing a single hole cavity whose diameter can vary from 25 to 150 µm and many hole devices containing arrays of holes varying from 50 to 150 µm. Among the many hole arrays we have some arrays containing the acronym for GREMI with 150 µm diameter hole array, CNRS with 100 µm diameter hole array and ANR with 50 µm diameter hole array.

We will present breakdown voltage experiments for different pressures, hole diameters and cavity depths and for different geometries. Then, by plotting a Paschen-like curve, we will conclude on what matters between hole diameter or interelectrode distance in the P x d factor. Different VI curves have been obtained depending on the geometry we designed during the Silicon etching step. Finally, lifetime experiments will be presented for different geometries and for different injected currents.

References:

1. J G Eden, S-J Park, N P Ostrom, S T McCain, C J Wagner, B A Vojak, J Chen, C Liu, P von Allmen, F Zenhausern, D J Sadler, C Jensen, D L Wilcox and J J Ewing, « Microplasma devices fabricated in silicon, ceramic, and metal/polymer structures: arrays, emitters and photodetectors » J. Phys. D: Appl. Phys. 36 (2003) 2869–2877

2. J. Chen, S. J. Park, Z. Fan, J. G. Eden, « Development and characterization of micromachined hollow cathode plasma display devices », Journal of Microelectromechanical Systems, 11 (5) 536, 2002