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Atmospheric plasma DC source in the micro scale elaborated by micro-nanotechnologies

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Plasma micro reactors are in their whole elaborated in clean room by MEMS fabrication techniques. They are usually made on silicon platform and constituted by SiO_2 dielectric grown by thermal oxidation and nickel coated by PVD process. Electrical and optical characterizations are the main diagnostics used to determine the properties of the discharge and the robustness of the device. SEM images are also made before and after plasma operation. These DC microdischarges can operate continuously during more than 24 hours in stable regime from 100 Torr up to the atmospheric pressure. In these conditions, a high density of reactive species is produced and can be used for gas, liquid or surface treatment.

Micro hollow cathode discharges (MHCD) operating in DC were first introduced in the mid-90s [1]. Due to their dimensions and their large surface to volume ratio, the produced micro plasma remains cold and can operate at atmospheric pressure in a stable and normal discharge regime as long as the cathode area is not limited [2]. These properties have opened a large number of possible application like destruction of volatile organic compounds, surface analysis of treatment and even UV and VUV radiation sources [3].

Silicon processing, developed for microelectronic devices, offers many opportunities to design new, original and efficient devices to produce high-density microplasmas. We present here a Si-based microstructure realized by MEMS fabrication techniques to create from one to more than a thousand microdischarges on a 2x2 cm chip. These plasmas can be ignited in different gases such as helium or argon from 100 Torr up to the atmospheric pressure [4].

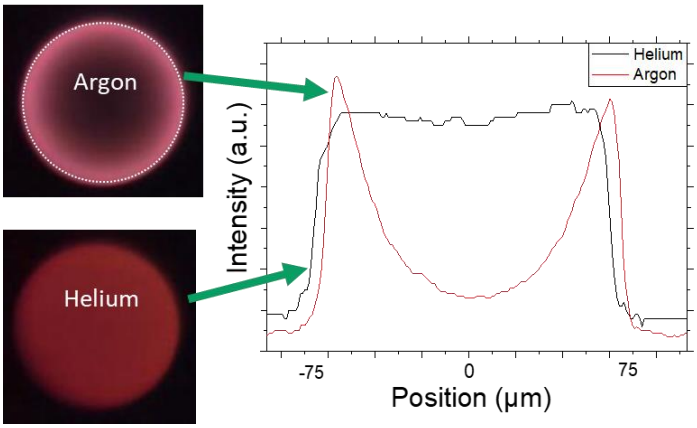

Fig. 1: Images of a micro discharge in single hole configuration operated in argon and helium at atmospheric pressure with a maximum current of 0,8mA. (Micro reactor configuration : single hole, diameter 150 µm, depth 55 µm)

The electrical and optical properties of a discharge in a single hole configuration was investigated and compared to simulations using a fluid model. The results show that the microdischarge seems to have the same behaviour as a classic glow discharge and, depending on the geometry and the parameters, the characteristics of the plasma can be tuned. For example, the position of the discharge for the same electrical parameters in argon and helium is shown in Fig. 1. In argon, the discharge is located in a ring-shape near the edge of the hole while, in helium, the discharge is more homogenous over the cathode surface area. Finally, as introduced by Eden et al. [5], a study using the semi-conductor properties of silicon to elaborate photodetector was investigated.

References

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