A novel approach for low pressure wire anode glow discharge

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Introduction

Non-thermal treatment of surfaces by an electron beam is a widely used technology in the fields of medical tools sterilization, curing lacquers, polymers modification, seeds disinfection and water treatment. Usually, the electron sources provide a planar or a coaxial beam, so a complex combination of several sources is necessary when the desired application requires an all side treatment. For example, in the case of seeds disinfection two planar sources are combined in order to irradiate the entire seed coat. However, even in this particular case it is not ensured that all sides have been treated homogenously due to grain rotation.

In order to overcome this challenge Fraunhofer FEP has developed a new kind of plasma cold cathode electron source, in which electrons are propagated in the radial direction towards the inner treatment area. Therefore, rotationally symmetric surfaces can be irradiated with the same dose.

Basic principle

To provide an ion source for secondary electron emission at the cathode, a wire anode glow discharge is realized inside a shielded plasma chamber. The specific geometry, which is based on McClure [1], makes it possible to sustain plasma at very low pressures, which is necessary for the very high acceleration voltage. 20 equidistant wires, which are acting as anode potential, are radially installed in the plasma chamber. Electrons are trapped in the electrostatic field generated by the wire anodes, so their average lifetime is considerably enhanced [2], and consequently, the ion production is also increased. The ions are extracted from the plasma towards the cathode (120 keV) in which secondary electrons are emitted. The beam electrons propagate through the plasma with almost no interaction, then being transmitted through the extraction window (a 15µm Ti-foil) to the treatment area at normal atmosphere.

In this contribution, the first investigations on the novel wire glow discharge plasma chamber will be presented.

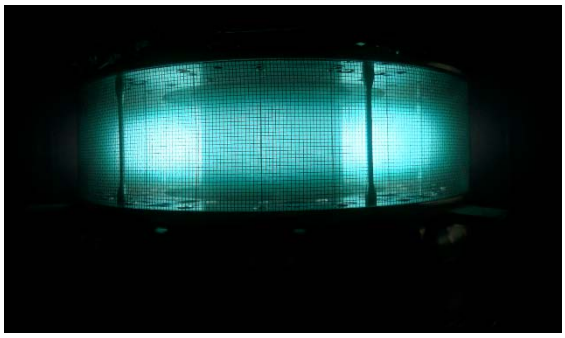

Fig. 1: Wire glow discharge.

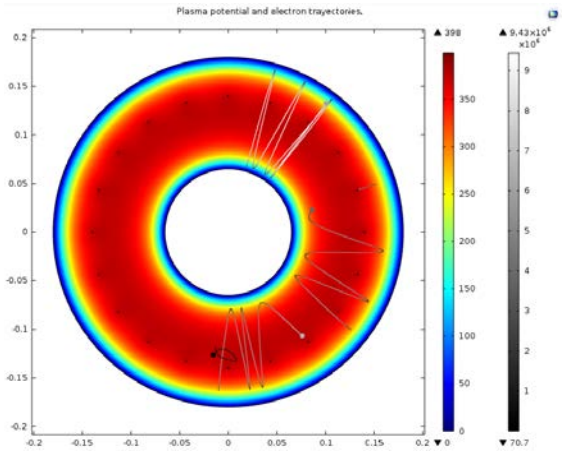

Fig. 2: Simulation of electron trajectories inside the plasma chamber simulated with the software COMSOL Multiphysics. Rainbow colours represent the potential (V) and the greyscale show the particle velocity (m/s).

References

[1] McClure, Low-pressure glow discharge. *Applied physics letters* volume 2, number 12, 1963.

[2] Makarov, Why does a low-pressure wire-discharge exist self-sustained? *Europhys. Lett, 74(3), 2006*