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Spatially resolved Langmuir probe measurements of a magnetically enhanced hollow cathode arc plasmaBurkhard Zimmermann¹, Fred Fietzke¹, Wolfhard Möller²¹Fraunhofer Institute FEP, Dresden, Germany ²Institute of Ion Beam Physics and Materials Research, FZD, Dresden, Germany

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Hollow cathode arc discharges are efficient plasma sources and applied e.g. for substrate pretreatment or in plasma-activated deposition processes. In order to generate large volume homogeneous plasmas to guarantee uniformity of plasma activation and coating properties, in the presented configuration a ring-shaped anode is positioned coaxially around the hollow cathode tube. A magnetic field is applied, which is axial within the cathode tube and spreads out in the deposition chamber.

In order to characterize the hollow cathode plasma, spatially resolved Langmuir probe measurements have been carried out. The charge carrier density maximum is on the cathode tube axis with values up to 10^{12} cm^{-3} . With increasing distance from the plasma source, the density slowly decreases and shows a flat lateral profile. The electron temperature is spatially independent and reaches 2-3 electron volts. Increasing the discharge current or the chamber pressure leads to higher plasma densities, but hardly affects the average electron energy. Drastic reduction of the gas flow through the hollow cathode tube results in higher electron temperatures at low chamber pressures, while at higher pressures in excess of 0.5 Pa, gas flow reduction increases the plasma density about one order of magnitude. The magnetic field supports the low gas flow mode and leads to higher plasma densities, too. The electron energy distribution function is found to have a Maxwell-like shape.

In the presentation, the dependency of the plasma properties on the varied parameters will be discussed and conclusions on the hollow cathode arc discharge mechanisms will be drawn. The probe measurements are furthermore related to optical emission measurements performed in the vicinity of the hollow cathode orifice.

Keywords

Hollow cathode arc discharge
Langmuir probe measurements
Optical emission spectroscopy