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Sputter yields and plasma homogeneity in high-frequency low-pressure discharges

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High-frequency, low-pressure discharges are among the main tools for plasma processing of moderate to large surface areas for the electronics industry and materials science in general. They are also discussed for cleaning of metallic mirrors in fusion experiments [1]. For optimization and process control in these applications, it is essential to know the sputter rates and to achieve good plasma homogeneity for uniform treatment.

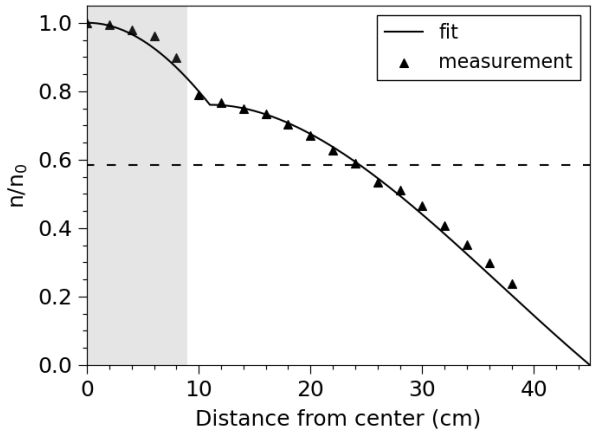

Fig.1: Fit of the theoretical diffusion profile to the measured one. The dashed line shows the line-averaged density and the shaded area marks the extent of the powered electrode. Argon plasma at 1 Pa and 30 W.

In this talk, a method is described for obtaining the relative sputter yields, which is applied to a 60 MHz large-volume capacitive discharge in argon with the powered electrode made of tungsten. The saturation current to a Langmuir probe provides the plasma density profile (Fig.1) and with the help of a microwave interferometer, the absolute densities are extracted. An analytical model with a step ionization profile provides first estimates for the electron temperature through fitting (Fig.1). Spatially resolved optical emission spectroscopy and a collisional-radiative model for argon [2] deliver benchmark values for the electron density and temperature, which are in a good agreement with the ones from the probe measurements. Voltage measurements give an estimate for the ion energy on the biased electrode and for the velocity of the sputtered atoms. These parameters in a combination with the intensity of the tungsten lines lead via a model to a value for the relative sputter yield. Very good agreement with known sputter yields is obtained [3].

At low pressures, inhomogeneous patterns in the plasma emission in front of the electrode are ob-served (Fig.2). Their formation is related to non-linear excitation of harmonic frequencies due to the plasma series resonance [4]. The behavior of the structures with the discharge parameters is investigated.

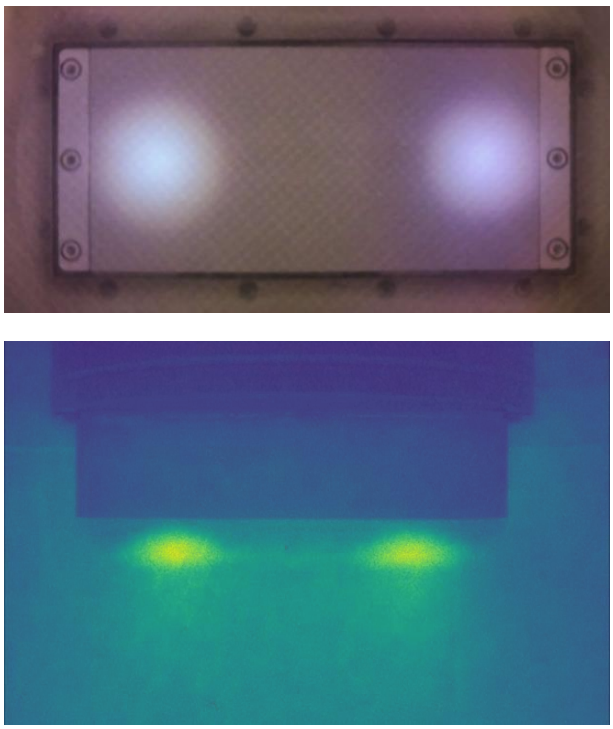

Fig.2: Photo of the inhomogeneity in the emission intensity from below (top) and from the side (bottom, false colors). Argon plasma at 0.3 Pa and 10 W.

References:
[1] L. Moser et al, *Nucl. Fusion* **55** (2015) 063020.
[2] S. Siepa et al, *J. Phys. D: Appl. Phys.* **47** (2014) 445201.
[3] Y. Yamamura, H. Tawara, *At. Data Nucl. Data Tables* **62** (1996) 149.
[4] D.-Q. Wen et al, *Plasma Sources Sci. Technol.* **26** (2016) 015007.