Investigation of optical emission in the plume of the Advanced Plasma Source in argon-oxygen mixtures

J. Harhausen, J. Wauer, D. Loffhagen, R. Foest

Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany

Plasma ion assisted deposition employing the Advanced Plasma Source (APS) is an important tool for the production of high precision optical interference coatings. Present efforts focus on radiance monitoring of the plasma plume of an APS by optical emission spectroscopy (OES) to provide the basis for an advanced plasma control. In this contribution the electron density, plasma potential and electron energy distribution function in Ar/O_2 mixtures are determined using a Langmuir probe. Moreover, results of the optical emission of various argon 2p – 1s transitions and of oxygen atoms at 777 and 844 nm are presented. The measured radiance is compared to results of collisional radiative modelling.

In various optical applications like imaging, metrology or laser technology, interference coatings are required to provide specific spectral properties e.g. for lenses, mirrors or beam splitters. Plasma ion assisted deposition (PIAD) is commonly used to produce such optical coatings [1]. The knowledge of plasma properties promotes the control of the deposition process regarding accuracy and reproducibility.

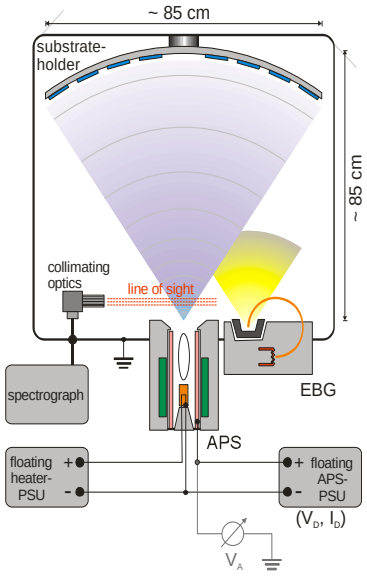

Fig. 1: Scheme of the box coater equipped with plasma source (APS) and diagnostics (OES).

An industrial PIAD box coater using an APS plasma source serves as experimental environment and is equipped with additional diagnostics (Fig. 1). OES provides data on the spectral radiance, and a movable Langmuir probe allows the determination of the plasma potential and electron energy distribution function (EEDF) at different heights above the APS [2].

Figure 2 shows typical results for an EEDF in an argon/oxygen gas mixture as a function of the total energy E_{tot} demonstrating the non-local character of the EEDF.

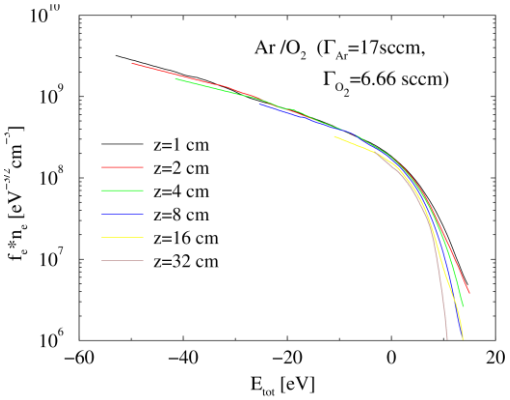

Fig 2: Measured EEDF in the plume of an argon oxygen plasma as a function of the total energy at various heights *z* above the APS.

In addition, the optical emission of various argon 2p – 1s lines and atomic oxygen lines (777 nm and 844 nm) near the plasma source was measured and the radiance was calculated. The measurements are related to results of a collisional radiative model of the plasma plume providing further possibilities to analyse the plasma properties and ultimately to control the plasma process at an elevated level.

Acknowledgment

This work was financially supported by BMBF under grant 13N13214.

References

[1] O. Stenzel et al., Appl. Opt. 56 (2017), C193.

[2] J. Harhausen et al., Plasma Sources Sci. Technol. **21** (2012) 035012.