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Interpretation of optical emission in a strongly inhomogeneous PIAD environment

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Plasma ion assisted deposition (PIAD) is adopted for the production of high quality optical coatings. A system well established on the market is the Advanced Plasma Source (APS), which combines a hot cathode DC glow discharge, typically operated in argon, with an aux. magnetic field. The rather small plasma source volume (0.7 l) is placed in a large coating chamber (103 l, Syrus 1100, Leybold Optics) held at high vacuum (20 mPa). A population of energetic ions (~100eV) is generated by a drop of the plasma potential connected to the plasma expansion. The key issue of PIAD is the optimization of APS operation conditions in order to meet the tight specification for the film properties. Spatially resolved optical spectroscopy and Langmuir probe (LP) diagnostics have been applied for the determination of the profiles of electron density ne, electron temperature Te and neutral density n0 in the expansion region (plasma plume). Previous results on argon/helium mixtures [1] indicate the need for substantial refinement of the analysis scheme. The plasma plume of the APS is strongly inhomogeneous where ne varies by a factor >102, and Te decreases by a factor >5, while the neutral parameters, in particular near the source are barely known. A simplification of the problem arises from the fact, that for the existing conditions and proven by the LP data the electron energy distribution function (EEDF) can be described in the framework of the non-local approximation (NLA). The impact of the NLA and the profile of the plasma potential on the optical emission is investigated theoretically. For a quantitative analysis a collisional radiative model for argon [2] is applied. Based on the results, the feasibility of the usage of optical emission recording for monitoring of the plasma process is discussed. Funded by the German Federal Ministry of Education and Research (BMBF, Fkz. 13N10462).

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