OR1304

Advances in characterization and control of plasma ion assisted deposition processes

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Plasma ion assisted deposition (PIAD) is a technique employed for the production of high-precision multilayer optical coatings. Typical applications are dielectric antireflective coatings, beam splitters or specific spectral filters in various optical components for ophthalmics, imaging or laser equipment. The key issue of PIAD is the densification of the growing films by precise momentum and energy input from a plasma ion beam. However, limits in repeatability and yield are observed, which are due to process drifts. It is intended to extend the operational range of PIAD by plasma characterization and related control schemes.
In this contribution we present results on the PIAD plasma sources APS (Bühler, hot cathode glow discharge) and eH3000 (KRi, end-Hall design) which are operated in argon, oxygen (except for APS) or mixtures thereof (both sources). Similarities and differences of the gridless sources concerning electron parameters and the ion energy distribution are discussed. In order to access plasma parameters during the deposition process we employ optical emission spectroscopy (OES) and active plasma resonance spectroscopy (APRS) as monitor diagnostics. The interpretation of diagnostics data is assisted by collisional radiative modelling. On the basis of radiance data obtained by OES and electron density measured by APRS novel schemes for plasma based control are introduced. The standard approach of keeping constant external parameters like voltages or currents is opposed by operating internal plasma properties. Deposition experiments of Al_2O_3, Ta_2O_5 and TiO_2 coatings allow for a comparison of conventional and novel control concepts. Here, we focus on layer properties such as refractive index, residual mechanical stress and refractive index inhomogeneity.
This work is funded by the German Federal Ministry of Education and Research under grants 13N13213 and 13N13214.

Keywords
optical coating
PIAD
APS
refractive index
mechanical layer stress