

## Workshop »Coatings for Optics and Optical Components«

### Advanced Sputtering Technologies for High-Precision Multilayer Depositions of Sensor and Optical Films

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High precision coatings for optical and sensing applications gain more and more importance in the last decades. Thermal and e-beam evaporation are well-established technologies for optical thin film coatings in the anti-reflective (AR) and high-reflective (HR) optical interference filtering since decades. More sophisticated application like precise Bragg reflector coatings for EUVL, and large area high throughput deposition of AR and HR coatings are addressed by high efficient magnetron sputtering systems, where ion beam deposition techniques are applied in the field of high laser induced damage threshold applications, respectively.

The basic principles of these process technologies will be presented and pros and cons are discussed. Especially, the energy distribution of the sputtered species, ranging from milli-electron-Volts up to several ten eV's, act as crucial distinguishing parameter amongst all these different coating methods, and defines their typical film growth properties and capabilities. The review shows that none of them is outstanding in the field of thin film coating for precision optics, but using and optimising the advantages of each technology justify the special application fields, and even open new capabilities. So, it's up to the application and its requirements as well as economic considerations which technology fits best for the desired aims.

The magnetron sputtering, as a well-established vacuum coating technology, in combination with defined controlled substrate motion gives excellent performance for high precision coating of multilayers in the nanometer and sub-nanometer range, even on large optical substrates of up to 1.5 m diameter. The tool setup and some processing results for high precision magnetron sputter applications for soft x-ray application and extreme ultra violet lithography (EUVL) will be shown.

The author focus' on ion beam technologies since this is a special expertise of the company and carries the best abilities for high precision coatings with best film qualities. Since ion beam sputter deposition (IBSD) creates highest film densities, close to bulk properties, it's best choice for high photonic fluency, low defect laser mirrors and precise multilayer deposition. A more specific, but still attractive application field is in the defined under-stoichiometric deposition of compound materials, e. g. Vanadium Oxide as temperature sensitive film for bolometric applications in autonomous driving. The high demand for precision is achieved by in-situ process control methods using transmission and reflection monitoring at spectroscopic wavelengths respectively, combined with an inhouse developed control software.

Even the traditional e-beam evaporation technologies find new application in glancing angle deposition (GLAD) for plasmonic and optics devices, furthermore catalytic, surface dominated functionality in energy conversion systems, when it is combined with precise substrate motion control and in-situ diagnostics.