Workshop »Coatings for Optics and Optical Components«

In-situ Metrology and Data Analysis for Optical Deposition Processes

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The fabrication of complex optical coatings requires an incremental level of precision and stability in the deposition process, which is increasingly dependent on reliable process monitoring and control technologies. In particular, in-situ metrology is essential for the production of optical coatings as it has the potential to make process drifts and fluctuations visible and controllable in real time. This presentation will provide an introduction to the field of in-situ monitoring and control approaches for the production of high quality optical coatings. One focus will be on thickness monitoring and end point detection strategies that are crucial for the successful production of optical coatings, especially for complex thin film designs. In industrial production, these thickness monitors are often highly integrated into flexible manufacturing concepts that combine tailored computational manufacturing tools with monitor-specific online re-calculation and design re-optimization modules. These techniques provide real-time information on film thickness, refractive index, and optical constants essential for online optimization of the deposition process. This enables adaptive manufacturing with high precision and flexibility, increased economic efficiency and shortest product development times. This talk will also cover new approaches to improve the stability and reproducibility of even highly stable deposition processes. For example, online plasma diagnostics or in-situ thickness uniformity monitoring can be used to balance fluctuations within a single deposition run or to compensate for long-term process drifts to improve overall process robustness. In addition, in-situ metrology was researched that allows for the direct determination of microparticle contamination or film stress of growing layers on optics. As an outlook, plans are presented to use aggregated process and sensor data in combination with data analysis techniques such as multivariate analysis and machine learning algorithms to extract meaningful information from the large amount of data obtained from in-situ metrology measurements. These techniques have the potential to allow the identification of hidden correlations between deposition process parameters and film properties, which can be used to optimize the deposition process, improve the quality of the deposited films, and to enable benefits from combined in-situ metrology, e.g. for anomaly detection, predictive maintenance or predictive cleaning concepts.