Real-Time Particle Detection for Enhanced Coating Deposition Processes

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Coatings and the associated vacuum deposition processes will play an increasingly significant role in upcoming technological trends, particularly in the fields of photonics, optics, and Industry 4.0. However, the demands for these applications are imposing increasingly stringent requirements in terms of defect size and particle inclusions within functional layers. This is primarily attributed to the ongoing reduction in the size of device structures. Particles ranging in size from a few hundred nanometers to a few microns have proven to be a major challenge during various deposition processes. These minuscule particles often lead to component failures, resulting in unacceptably high rejection rates. Therefore, the development of deposition technologies capable of monitoring and significantly reducing the incorporation of particles into coatings is essential to access and succeed in these emerging markets.

As part of a multi-partner research project, we are focusing on the development of methods for the detection and real-time monitoring of particles generated in physical vapor deposition (PVD) processes, with particular emphasis on electron beam deposition and sputtering systems. Our research objectives include understanding the different sources of particle generation, whether related to the process, mechanical movements or the cleanliness of the deposition reactor during a production campaign. It also involves determining their size distribution and tracking their velocity in the vacuum environment with spatial and temporal resolution. In addition, we aim to contribute to the development of applicable strategies for eliminating particle sources during the vacuum deposition process, thereby increasing production yields.

To achieve these goals, we are engaged in the research and development of an in situ particle detector solution based on the fundamental principles of visible light beam scattering by particles. The chosen method will be compared with other possible particle detection methods suitable for high vacuum environment. First results on particle detection during different phases of a deposition batch will be presented. In addition, a first insight into the development of a data analysis algorithm that could enable informed decisions to be made for the maintenance of parts to be changed will be discussed.

Fig. 1: 532 nm laser sheet illumination for particle detection in air