Conformal surface functionalization of additively manufactured components

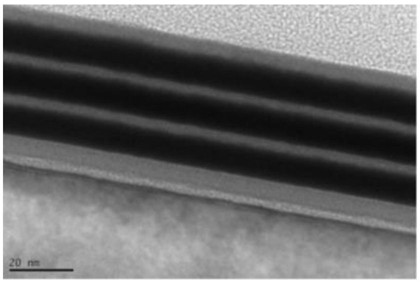
Supervisor: Prof. Dr. Detlev Ristau, Leibniz Universität Hannover, IQO; LZH

Co-Supervisor: Dr. Henrik Ehlers, Laser Zentrum Hannover e.V. (LZH)

Projekt ID: 13

Motivation: Additive manufacturing processes enable the realization of components with complex geometries using new material combinations. In addition to the fulfilment of structural-mechanical tasks, these components will have to offer additional functional properties to an increasing extent in the future. Often the surface quality, which is closely linked to the respective additive manufacturing process, limits their possible applications. Limitations can result directly from the (micro) structure, but also from the chemical and physical properties of the material combinations used. If surface functionalization or modification becomes necessary, classical functionalization processes often reach their limits. The process challenges lie in the complex component geometries with external and often internal surfaces as well as the specific surface properties already mentioned. This applies in particular to the field of additive manufacturing of (micro) optical components with its high precision requirements for complex functionalization (e.g. spectrally broadband antireflective effect with high angle of incidence tolerance).

Objective of the PhD project: The project is aimed at the development of a novel ALD (Atomic Layer Deposition) process, which enables a tailored surface functionalization of additively manufactured components. The goal is a flexible process that allows to cover the different techniques and materials used in generative manufacturing. The highly conformal coatings must be able to functionalize (accessible) inner surfaces by ALD precursor penetration into complex geometries. Here metals, oxides or nitrides are to be applied in the form of individual thin layers as well as structures of multilayers (s. figure 1). The underlying ALD process with its spatially separated process zones offers the possibility of significantly increased coating rates compared to conventional processes. Taking into account the additional degrees of freedom resulting from this concept, the process must be specifically adapted in order to meet the above-mentioned challenges. A central point of the work is the functionalization of optical components, whereby process stabilization is to be carried out by means of new control approaches on the basis of in situ sensor technology.



ALD surface functionalization: SEM cross section of a nanolaminate structure [1].

[1] Liu, H. (2018): Atomic layer deposition for high power laser applications: Al_2O_3 and HfO_2, Diss., Gottfried Wilhelm Leibniz Universität, Hannover, DOI: 10.15488/4208

This is a PhD-project of *SAM* "School for Additive Manufacturing". *SAM* is a structured PhD-programme of the Leibniz Universität Hannover in cooperation with the Hochschule Hannover, the Laser Zentrum Hannover e. V., the TU Braunschweig and the TU Clausthal.

Students interested in this or any other project of *SAM* can apply for fellowships. Please have a look at https://www.iw.uni-hannover.de/de/forschung/school-for-additive-manufacturing/projekte/ for details.