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In situ X-ray based characterization of atomic layer deposition

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Atomic layer deposition (ALD) is a thin film deposition technique which relies on alternating, self-limiting chemical reactions between gas-phase precursor molecules and functional groups on a solid surface. ALD is capable of producing highly conformal and pinhole free coatings with a thickness controlled at the atomic scale, which makes it of high interest for applications in microelectronics, catalysis, energy storage systems and biomedical devices.

An important part of ALD-research is in situ characterization. The alternating nature of ALD processes allows the involved growth mechanisms to be studied in situ with a wide range of characterization methods. For example, by adding a mass-spectrometer to the exhaust line of an ALD reactor, the reaction products of the ALD surface reactions can be detected for each of the precursors. By installing windows which are transparent for a specific part of the electromagnetic spectrum, one can characterize the growing film with either X-rays, IR or optical light, once the precursor molecules have been purged from the ALD-reactor.

In this talk we will focus on X-ray based in situ characterization of ALD processes. It will be demonstrated that by using a dedicated mobile ALD setup, it is possible to study an ALD process in situ at a synchrotron facility. Two examples that will be covered are grazing incidence small-angle X-ray scattering (GISAXS) and X-ray fluorescence (XRF). In addition, it will be shown that by connecting an ALD reactor to a lab-based XPS instrument, it is possible to study an ALD process in vacuo with XPS.