Nucleation of semiconductor material from solution onto templated SAMs

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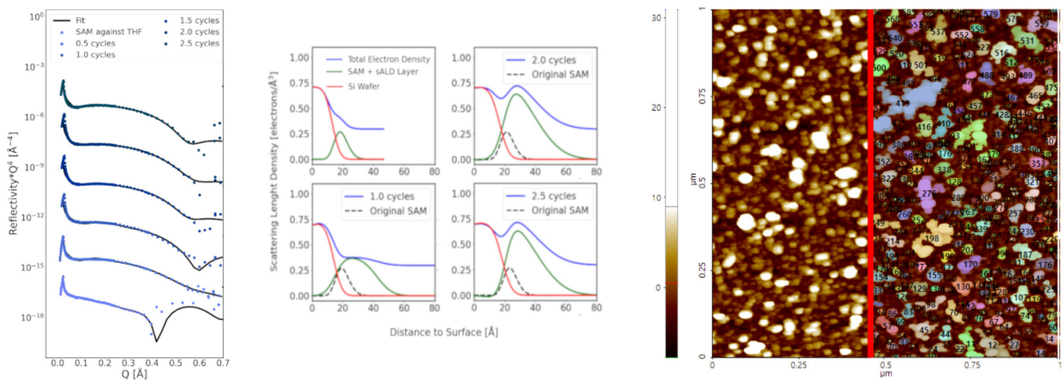
Solution based atomic layer deposition (sALD) is an emerging technology that aims to transfer high vacuum atomic layer deposition (ALD) into a wet chemical environment. The technique aims to enable large scale processes for printing of functional materials. It has been used to succesfully create layers of antimony selenide [1], perovskites[2] and perovskite solar cells[3].
The nucleation process of precursors in the first cycles of an sALD procedure and the resulting layer structure plays an integral part in the final quality of the produced layers.[4] An in-situ study of the nucleation of SnS_2 from the precursors tetrakis(dimethylamido) tin(IV) (TDMASn) and H_2S at the interface of a self-assembled monolayer (SAM) of (3-Mercaptopropyl)trimethoxysilan (MPTMS) from tetrahydrofuran (THF) revealed an island growth mechanism. This was attributed to the mismatch in density of thiol groups on the surface of a dense MPTMS SAM and the density of sulfur atoms in crystalline SnS_2, favoring the growth in islands instead of continuous layers.[5]
Therefore SAMs with different thiol densities were prepared by using mixes of functionalized and non-functionalized, long-chained organic phosphonic acids. Combining XRR with atomic force microscopy (AFM) a correlation of nucleation site density and the structure of the produced layers was found.

Keywords:
x-ray reflectometry, xrr, self assembled monolayer, SAM, atomic layer deposition, ALD, AFM, atomic force microscopy, nucleation, semiconductor



XRR data and model fits (left) and resulting electron density profiles (EDPs) of the SAM and sALD layers (middle). Shown are in-situ data of 2 sALD cycles. AFM data evaluated with grain analysis(right) of the sample after coating shows island growth with densities comparable to XRR.

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