Recent progress in in situ X-ray reflectivity (XRR) measurements: quick millisecond XRR and artificial intelligence XRR analysis

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In my talk I will present our work on *in situ* real-time XRR measurements for studying thin film deposition processes. In a first case study I will discuss how we achieve the fastest XRR measurements to date with acquisition times down to 1.4 milliseconds. To this end we use a rotating sample on a wedge to quickly change the incident angle while making use of the high photon flux and quick 2d-detector read-out at beamline P08 of PETRA III at DESY (Hamburg). Using ms-XRR during spin coating of PMMA films, we find that indeed fast processes with time constants of tens of milliseconds occur during spin coating and are directly visible with ms-XRR.

In a second case study I shift the focus to artificial intelligence / neural network analysis of XRR data. I demonstrate that a neural network analysis followed by a least mean square fit is yielding better results than state of the art differential evolution algorithms. Beyond yielding better results, a neural network analysis is also significantly faster than a conventional fitting routine, which is useful when analysing many 10000 XRR curves from the above ms-XRR measurements. Lastly, we show that XRR is possible at lower photon flux or with only sparse measurement points when physical information about thin film growth is included in the neural network (or conventional) fit model. This will in the future enable faster measurements and lower beam damage in *in situ* XRR measurements.

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