

Growth studies of thin films with total scattering in real time

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Thin films of thickness 100 nm or less are typically deposited on a much thicker substrate, making it difficult to obtain the required high-quality total scattering data for analysis in real-space with pair distribution functions (PDF) [1]. In recent years, total scattering in reflection geometry at grazing incidence (GI), that is, below the critical angle of total external reflection, has been used with success to increase the surface sensitivity and scattering intensity [2, 3]. GI-PDF gives high-quality PDFs from films as thin as 3 nm with a 20 x 2.5 μm^2 focused X-ray beam with 100 keV photon energies at PETRA III [2]. Using this same setup we have developed a novel ultra-high vacuum compatible deposition chamber, that allows for the demanding sample alignment of the thin film sample under vacuum conditions as well as a 180 degree in-plane rotation [4]. Via a rotary feedthrough and bellows combination the surrounding vacuum chamber is not affected by translation of the sample, allowing for film deposition equipment such as a magnetron sputter source. This has been employed at the P07-EH2 beamline with a radio-frequency magnetron sputter source, as pictured in the figure below. We will show how this has been applied to observe the formation of thin films during the initial stages of deposition in real time with sub-second time resolution.

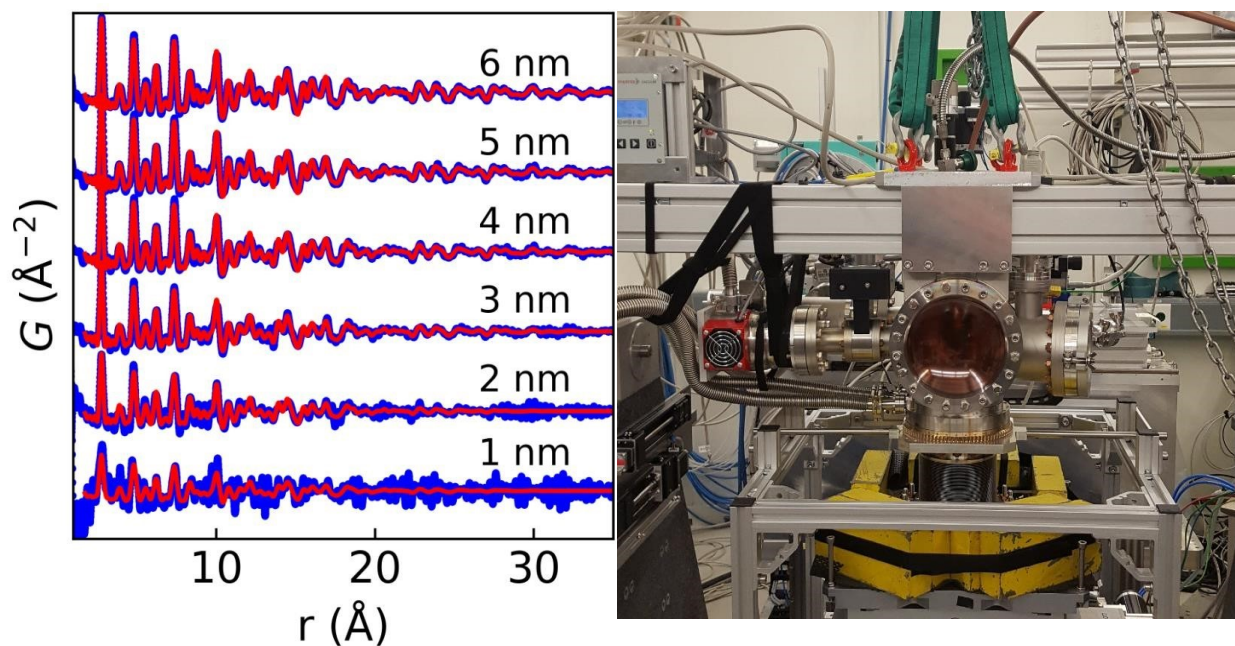


Figure 1. PDFs of a Pt thin film at 10, 20, 30, 40, 50 and 60 seconds of sputter deposition with approximately 1 $\text{\AA}/\text{s}$ and a picture of the equipment installed on the surface diffractometer at beamline P07-EH2, PETRA III, Hamburg, Germany, as seen from the detector side.

1. K. M. Ø. Jensen *et al.*, IUCrJ 2 (2015), 481
2. A.-C. Dippel *et al.*, IUCrJ 6 (2019), 291
3. K. Stone *et al.*, APL Materials 4 (2016), 076103
4. M. Roelsgaard *et al.*, IUCrJ 6 (2019), 299