X-ray standing wave coherence length in grazing exit geometry

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Angle-resolved X-ray fluorescence is a powerful tool for elemental depth distribution characterization of thin films. This technique is based on the formation of an X-ray standing wave (XSW), which is strictly dependent on the coherence length of the propagating wave. In grazing incidence geometry finite coherence length leads to a wave modulation which reduces interference fringes contrast [1]. Coherence length in modern lab-based X-ray sources is mostly influenced by transverse coherence length which is given by an angular divergence.

In grazing emission geometry a fluorescent specimen radiates spherical waves in all directions. In the far field, the wave can be considered as a plane wave and XSW is formed due to interference effects in the structure. As such, the signal is smeared only by the detector strip opening angle. We assume that the incident wavefield transverse coherence length doesn't take part in XSW formation.

To check this assumption, we investigate the effect of transverse coherence length in both grazing incidence and grazing emission geometries by varying the beam footprint on a [W/B4C/Si/B4C]x50 multilayer sample. We show that, while in grazing incidence the experimental features "smear out" with an increasing footprint, for grazing emission the smearing is less pronounced due to the independence of XSW formation on transverse coherence length.

These results show proof of the principle that a natural limitation for the measurable layer thickness stated in [1] is not applicable in grazing emission fluorescence geometry, and may help in further optimization of XSW measurements in GE geometry.

[1] D. Ingerle, 2017, Ph.D. thesis, University of Vienna, p. 30