Capabilities of model free X-ray standing wave analysis of periodic multilayer structures.

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Development of state-of-the-art periodic multilayer structures, as used for instance in x-ray optics, requires advanced interface engineering. The ability to measure changes of the structure of multilayers caused by variation of growth conditions is essential for the understanding of physics of multilayer growth. The combination of grazing incidence X-ray reflectivity with fluorescence measurements, referred to as the X-ray standing wave (XSW) technique, proved to be a powerful tool for the analysis of multilayer structures, but the ambiguity in the data interpretation is still a major drawback in its applicability. The atomic specific fluorescence gives information about subnanometer interface diffusion barriers which is especially useful if their materials have a low optical contrast with the main materials of the multilayer. To avoid uncertainty in data analysis caused by the fitting procedure at this scale, we developed a set of model independent procedures. Our free-form approach[1] allows the reconstruction of the electron density profile from the GIXR measurement, the latter being used for the direct calculation[2] of the atomic distribution profiles from the XSW data. We will demonstrate the analysis of a complex structure of a periodic multilayer coating with sub-nm inter-diffusion barriers and show the enhanced sensitivity of our model free approach.

1. A. Zameshin , et. al., J. of Appl.Cryst. **49** (4), (2016).

2. S. N. Yakunin, et. al., J.Appl.Phys. **115** (13), (2014).