Grazing-incidence small angle X-ray photoncorrelation spectroscopy: limitations and opportunities

Christopher R. Greve[1], Meike Kuhn[1], Fabian Eller[1], Michael A. Buchhorn[1], Dinesh Kumar[2], Alexander Hexemer[1], Guillaume Freychet[3], Lutz Wiegart[3], Eva M. Herzig[1]

[1]Herzig Group – Structure Formation & Dynamics, University Bayreuth, Universitätsstr. 30, Bayreuth, 95447, Germany,
[2]Center for Advanced Mathematics for Energy Research Applications (CAMERA), Lawrence Berkeley National Laboratory, 1 Cyclotron Rd, Berkeley, CA, 94720, USA,
[3]National Synchrotron Light Source II, Brookhaven National Laboratory, 98 Rochester St, Upton, NY, 11973, USA

christopher.greve@uni-bayreuth.de

X-Ray Photon Correlation Spectroscopy (XPCS) is a flexible tool to quantify dynamics on the nanometer to micrometer scale in bulk samples and was used in the recent years in grazing incidence (GI) geometry for application to thin film samples, such as quantifying thin film growth [1]. Measurements in GI geometry introduce distortions of the detected signal. These distortions are due to refraction and reflection and known from the Distorted Wave Born Approximation (DWBA), which leads to superpositions of signal within detector areas [2]. Zhang et al. [3] showed that these superpositions also influence GI-XPCS measurements and can alter observation quantities like decorrelation times and stretching exponents. We present an approach to quantify the influence these refraction and reflection effects due to the DWBA have on decorrelation analysis by conducting grazing incidence transmission (GT) XPCS and Gi-XPCS simultaneously for a thin film sample of Methyl Ammonium Leadiodide, showing non-equilibrium dynamics. A combination of the GI- and GT XPCS results with calculations of Fresnel reflectivities and transmissivities within the simplified DWBA allows to determine the origin of scattering contributions for GT and GI regions. Considering calculations of the non-linear effect of refraction in GISAXS and GTSAXS, comparable regions to XPCS experiments in transmission are identified and differences for phenomena like altered decorrelation times and decay stretching are elucidated. This allows the use of this technique to analyze dynamics in thin films for certain experimental conditions. [4]

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