Coherent superposition in grating-based directional dark-field imaging.

Abstract:

X-ray dark-field scatter imaging allows to gain information on the average local direction and anisotropy of micro-structural features in a sample well below the actual detector resolution. For thin samples the morphological interpretation of the signal is straightforward, provided that only one average orientation of sub-pixel features is present in the specimen. For thick samples, however, where the x-ray beam may pass structures of many different orientations and dimensions, this simple assumption in general does not hold and a quantitative description of the resulting directional dark-field signal is required to draw deductions on the morphology. Here we present a description of the signal formation for thick samples with many overlying structures and show its validity in experiment. In contrast to existing experimental work this description follows from theoretical predictions of a numerical study using a Fourier optics approach. One can easily extend this description and perform a quantitative structural analysis of clinical or materials science samples with directional dark-field imaging or even direction-dependent dark-field CT.

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