Phase determination in transmitted wave by ptychographical experiments on thin crystals: theoretical modelling.

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Introduction

We present a theory and analysis of the phase variation in the transmitted beam after a thin crystal in a combined ptychography-diffraction experiment [1]. The small deviation from the constant phase is explained by the coupling between diffracted and transmitted wavefields in the crystal. It can be obtained both through numerical solution of the Takagi-Taupin equations [2] and using analytical approach [3]. Near-kinematical approximation to phase analysis is also developed here [4].

Experiment [1]

1. Experimental setup

- Fresnel Zone Plate
- Sample
- Transmitted beam
- Laue diffracted beam
- Detector 1
- Detector 2

2. Diffraction scheme

- Cylindrical grains of gold with 100 nm thickness and 250 nm diameter were measured.
- Grains were deposited on SiN membrane.

3. Phase from experiment

(a) – phase as a function of coordinate at different rocking angles
(b) – phase dependence on the rocking angle

The crystal is rotated near the Bragg position. For each angle, ptychography measurements are performed and phase difference between the waves after crystal grain and membrane is determined.

Phase of the transmitted beam simulated for experiment [1]. Numerical and analytic solutions coincide. The phase is close to the observed one in the experiment [1].

Theory [4]

1. Takagi-Taupin (TT) equations

2. Simulation

- Phase of the transmitted beam simulated for experiment [1]. Numerical and analytic solutions coincide.
- The phase is close to the observed one in the experiment [1].

3. Near-kinematical approximation

Features and Analysis

1. Conditions of validity

- Phase as a function of coordinate at different rocking angles

2. Thickness dependence

- Phase as a function of coordinate at different rocking angles

Conclusions & Outlook

References


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