MONASH University

MONASH CENTRE FOR ELECTRON MICROSCOPY

Phase Imaging in TEM: Phase Plate and Near-Field Ptychography Using Structured Electron Beam

Date: Monday, 10th February 2025
Time: 11:00 – 12:00PM
Venue: Theatre S2,
16 Rainforest Walk, Monash Clayton Campus

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Abstract

Phase imaging in TEM is a useful technique for the evaluation of soft-materials and characterization of electric and magnetic structures in materials. In this talk, two different approaches for phase imaging are introduced. First, we introduce a contact-potential-type phase plate that enables controlling electron phase utilizing work function differences of metals. This simple yet robust design enables a stable phase control, allowing high-contrast imaging of biological specimens without staining. Furthermore, aiming at quantitative phase evaluation and imaging of larger structures, we have developed a near-field ptychography using full-field illumination with a structured electron beam [1]. This approach targets the phase imaging of large-scale structures over 100 nm, which is challenging and crucial for evaluating soft-materials. The method uses a non-uniformly structured electron beam as an illumination beam. A series of in-line holograms formed in the Fresnel region below the specimen are obtained at different beam positions by scanning the illumination beam. Then, both the wavefield of the illumination beam and the complex transmission function of the specimen are reconstructed from the obtained holograms through a ptychographic procedure. Simulation studies demonstrated phase reconstruction accuracy of 1/3,485 of wavelength for large-scale structure (400 nm). Experimental validation using MgO particles showed a phase distribution consistent with the specimen shape, indicating the validity of the method (Fig. 1). These techniques expand the capabilities of phase imaging in TEM, offering powerful tools for both high-contrast imaging of soft-materials and quantitative analysis of electric and magnetic structures.

[1] H. Tamaki, K. Saitoh, Microscopy 74 (2024) 10-19

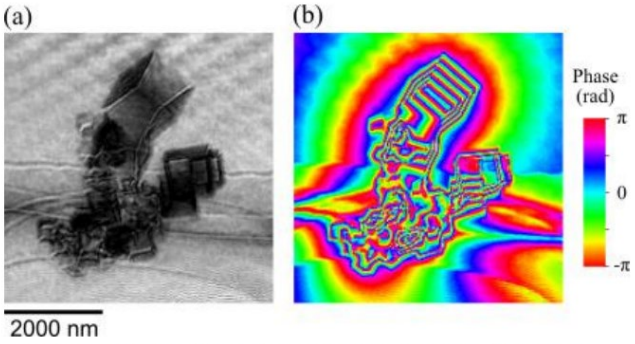

Fig. 1 Reconstructed complex transmission function of MgO particles. (a) amplitude component. (b) phase component.

Biography

Hirokazu Tamaki is a chief researcher at Hitachi Ltd. He received his M.S. and Ph.D. in Engineering from Nagoya University in 2010 and 2024, respectively. Since joining Hitachi in 2010, his research has focused on advanced phase imaging techniques, particularly in ptychography and phase-plate for electron microscopy. As a chief researcher in the R&D department of Hitachi Ltd., he drives the development of transmission electron microscopes and their application techniques. His work aims to integrate advanced microscopy techniques with next-generation electron microscopes, contributing to the advancement of materials science.

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