

OpenECCI - A Streamlined Open-Source Workflow for Electron Channelling Contrast Imaging of Crystal Defects

Date: Thursday, 20th June 2024

Time: 2:00 – 3:00PM

Venue: Theatre S9,
16 Rainforest Walk, Monash Clayton Campus

Abstract

Quantitative analysis of crystal defects, such as dislocations, stacking faults, etc., has traditionally been exclusive to transmission electron microscopes (TEM) [1]. This technique involves stereo-tilting of a crystal to the “two-beam” diffraction orientations with the assistance of transmission Kikuchi pattern projected on a phosphor screen or a camera. In recent years, Electron Channelling Contrast Imaging (ECCI) techniques in SEM, including accurate ECCI [2], controlled ECCI [3] and rotational ECCI [4], have gained increasing interest for quantitative defect analysis in bulk specimens. Unlike TEM, ECCI in SEM offers easier, less intrusive sample preparation and fewer sample-preparation-induced artifacts. Additionally, ECCI enables examination of larger polished surfaces, yielding more statistically representative results. Nevertheless, several challenges hinder its widespread adoption:

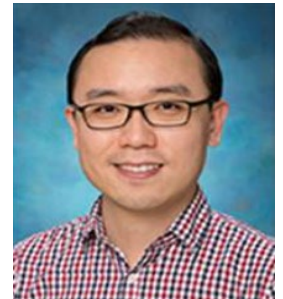
- High spatial resolution accurate ECCI requires modified SEM column alignment for orientation control [2].
- Controlled ECCI requires proprietary software and additional hardware for precise orientation control [3, 5].
- There is a lack of reliable method for measuring and controlling the SEM electron beam convergence angle.
- Absence of a quantitative method for assessing sample stage tilt/rotation accuracy and repeatability for ECCI.
- For controlled ECCI, correlating a feature in the electron backscattered electron diffraction (EBSD) map with the SEM image, while also applying stereo-tilt without losing the feature of interest can be challenging.

Hence, our current work aims to address these issues by leveraging the open-source software community to develop a more accurate and user-friendly ECCI workflow assisted by our open source Python package

<https://github.com/IMBaENce/openECCI>.

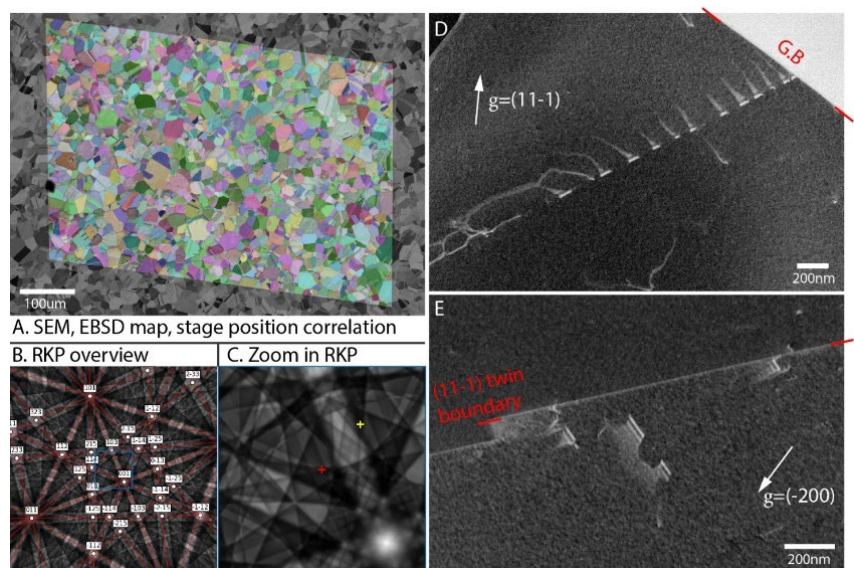
References:

1. Williams, D.B., C.B. Carter, D.B. Williams, and C.B. Carter, *The transmission electron microscope*. 1996: Springer.
2. Mansour, H., et al., *Accurate electron channelling contrast analysis of dislocations in fine grained bulk materials*. Scripta Materialia, 2014. **84-85**: p. 11-14.
3. Zaefferer, S. and N.-N. Elhami, *Theory and application of electron channelling contrast imaging under controlled diffraction conditions*. Acta Materialia, 2014. **75**: p. 20-50.
4. L'Hôte, G., et al., *Rotational-Electron Channelling Contrast Imaging analysis of dislocation structure in fatigued copper single crystal*. Scripta Materialia, 2019. **162**: p. 103-107.
5. Harte, A., et al., *The effect of solid solution and gamma prime on the deformation modes in Ni-based superalloys*. Acta Materialia, 2020. **194**: p. 257-275.



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