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Development of a pixelated STEM-in-SEM detector for microstructural features characterization

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Background incl. aims:

Microstructural investigations provide engineers with information to computationally predict the performance of components and electron microscopy is a well-versed technique for analyzing micro/nanostructural features. Two types of electron microscopes are commonly used and provide complementary information: Transmission Electron Microscope (TEM) at the micro/nanoscale and Scanning Electron Microscope (SEM) at the macro/mesoscale. Historically, Scanning Transmission Electron Microscopy in Scanning Electron Microscope (STEM-in-SEM) techniques were predominantly used by biologists due to their user-friendly nature and their ability to analyze specimens at low accelerating voltages (30 kV or below). This made STEM-in-SEM techniques complementary to conventional TEM ones as the latter generally use high accelerating voltages (~200 kV). Recent advances in electron guns and electromagnetic lenses have sparked growing interest in STEM-in-SEM techniques across various scientific disciplines. However, researchers often face challenges in establishing the precise imaging conditions required to obtain comprehensive micrographs, thus limiting their interpretation and analysis.

Methods:

In this study, we propose a novel STEM-in-SEM approach, which aims to overcome the practical limitations of traditional techniques for microstructural characterization in thin foils. The technique leverages an advanced detector designed to replicate TEM-like characterizations while minimizing the presence of artifacts that commonly hinder comprehensive analyses. In addition, this STEM-in-SEM technique benefits from On-Axis Transmission Kikuchi Diffraction (On-Axis TKD), thus allowing diffraction pattern acquisition with a high signal-to-noise ratio.

Results:

First results already show the possibility to acquire diffraction patterns and to image dislocations under modulable bright-field and dark-field conditions.

Conclusion:

By implementing this pixelated STEM-in-SEM technique, we anticipate significant advancements in the field of microstructural characterization by obtaining TEM-like and TEM-complementary information. Ultimately, the developed technique should facilitate studies to obtain detailed information about thin foil specimens, thereby contributing to a broader range of scientific applications.

Keywords:

Electron microscopy, STEM-in-SEM, On-Axis TKD, Microstructures characterization

Reference:

Brodu, E., Bouzy, E., Fundenberger, J.-J., Guyon, J., Guitton, A., & Zhang, Y. (2017). On-axis TKD for orientation mapping of nanocrystalline materials in SEM. *Materials Characterization*, 130, 92-96.
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