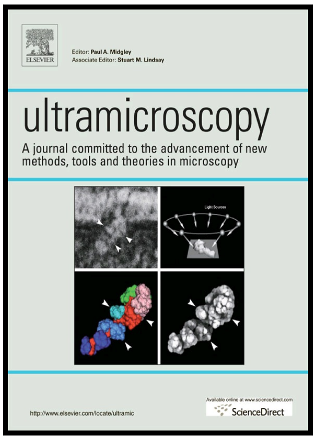

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Highlighting material structure with transmission electron diffraction correlation coefficient maps

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Abstract

Correlation coefficient maps are constructed by computing the differences between neighboring diffraction patterns collected in a transmission electron microscope in scanning mode. The maps are shown to highlight material structural features like grain boundaries, second phase particles or dislocations. The inclination of the inner crystal interfaces are directly deduced from the resulting contrast.

Keywords: Transmission electron microscopy (TEM), electron diffraction, correlation coefficient map, automated crystal orientation mapping (ACOM).

Introduction

Diffraction patterns are routinely acquired on transmission electron microscopes (TEM) and analyzed to study the crystal structure of solids. While selected area electron diffraction (SAED) and convergent beam electron diffraction (CBED) have long been the main diffraction modes used for this purpose, the decreasing size of the features of interest (grains, phases, particles, interfaces, etc.) leads to strong interests for nano-beam diffraction mode [1]. In the present context, nano-beam diffraction, refers to a small but nearly parallel beam focused on the sample and differs from more convergent beam conditions used for example in scanning transmission electron microscopy (STEM) and for EDS analyses. Indeed, a small convergence angle - typically few milliradians - leads to spot type diffraction patterns with well distinct reflections that can be indexed as in SAED, for further characterization of the sample.

The spot diffraction pattern obtained for crystallized material contains a significant amount of information related to the structural state of the material: lattice parameter, symmetries, crystal orientation, etc. There is currently a trend that consists in acquiring full series of patterns for a given sample in order to gain a more complete knowledge of the overall structural state. As an example, the reciprocal lattice is reconstructed by tilting the sample every degree or so and by acquiring the reflection intensities for each reciprocal lattice point [2-4]. This process, known as automated diffraction tomography (ADT) enables unknown phases to be identified especially when it is combined with precession electron diffraction (PED) for decreasing the detrimental effect of multiple scattering to which electrons are prone [5,6]. Diffraction scanning analysis is another technique that gains increasing interest. In this approach, the nano-sized beam is scanned over the selected area of interest as for STEM and the successive diffraction patterns are collected for post-processing analyses. The technique was combined to fluctuation electron microscopy for studying medium-

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