Application of Automated Crystallography for Transmission Electron Microscopy (ACT) in Material Characterization

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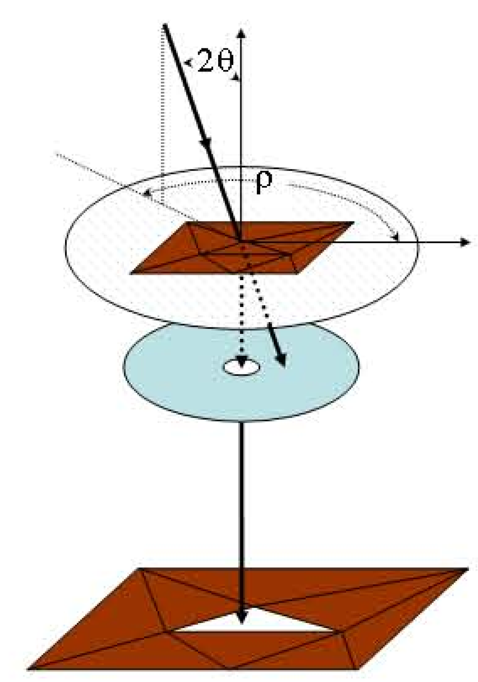
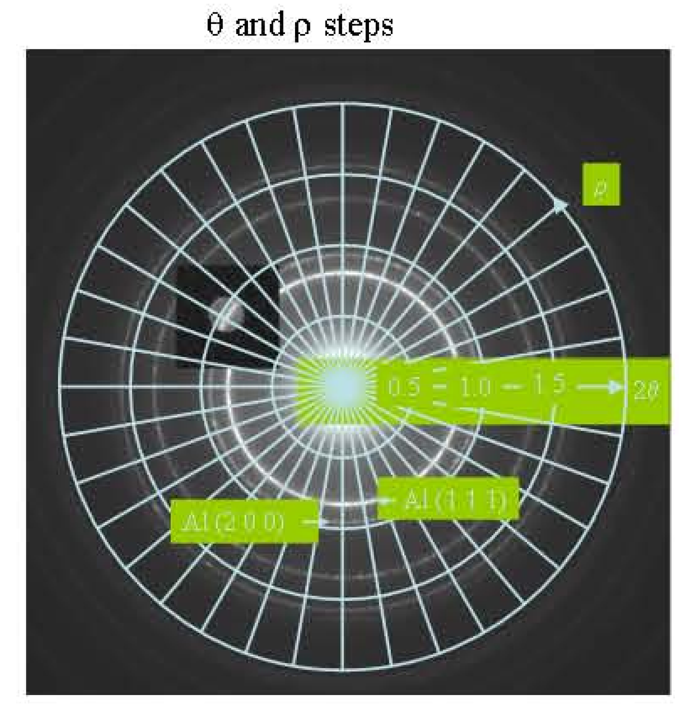
ACT represents Automated Crystallography for Transmission Electron Microscopy. It was developed by TSL/EDAX as the counterpart of widely accepted Electron Back Scattering Diffraction (EBSD) and is expected to provide information regarding grain size, grain orientation, and misorientation between neighboring grains. Since ACT is based on TEM, higher resolution is expected as compared to EBSD, which is based on Scanning Electron Microscopy (SEM).

How does ACT work?

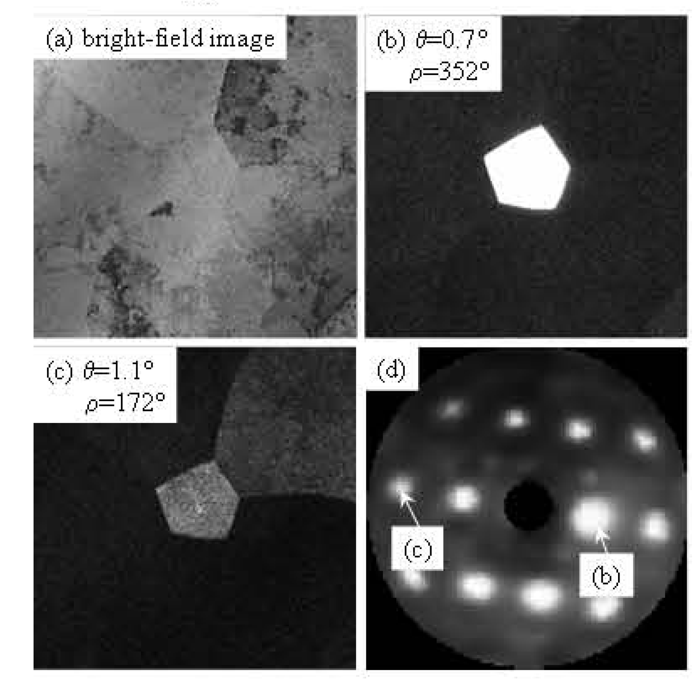
- **Tilt incident beam to different θ and ρ angles at suitable steps**
- **Recording dark-field images at each position**
- **Reconstruct diffraction patterns**
- **Do analysis for grain orientation, misorientation et al.**



θ and ρ steps



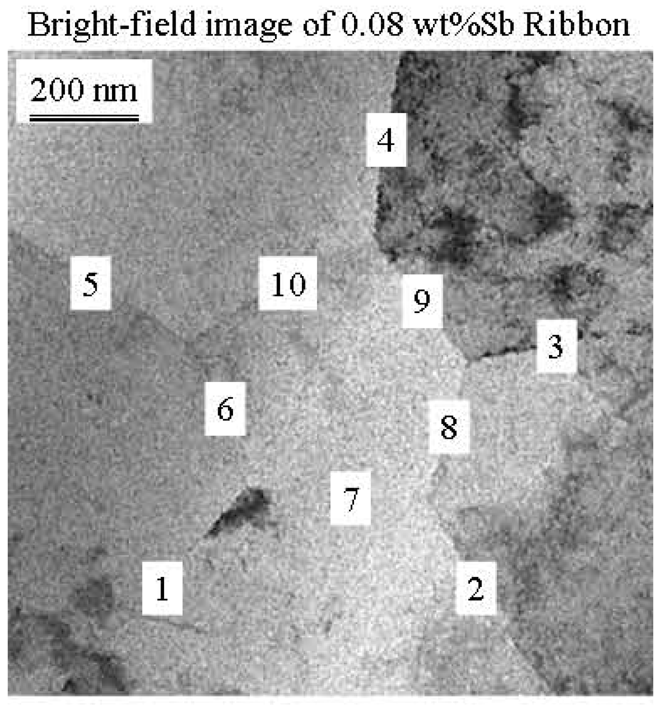
Typical ACT results



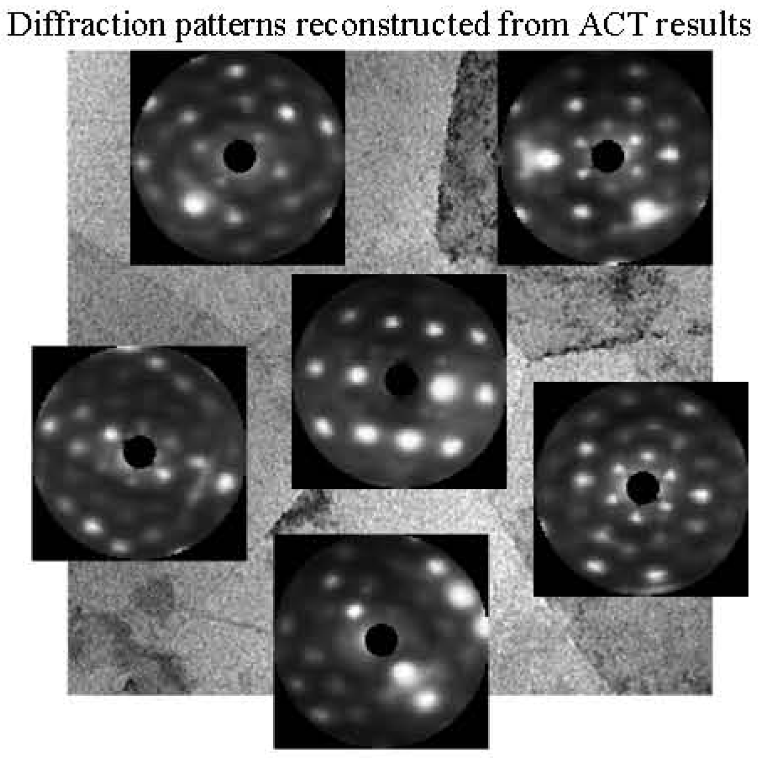
ACT enables automatic grain and grain orientation mapping

The brightness of one pixel in the dark field images can be drawn as functions of θ and ρ, which corresponds to a diffraction pattern. By comparing the diffraction patterns of adjacent pixels, grain or grain orientation mapping can be accomplished.

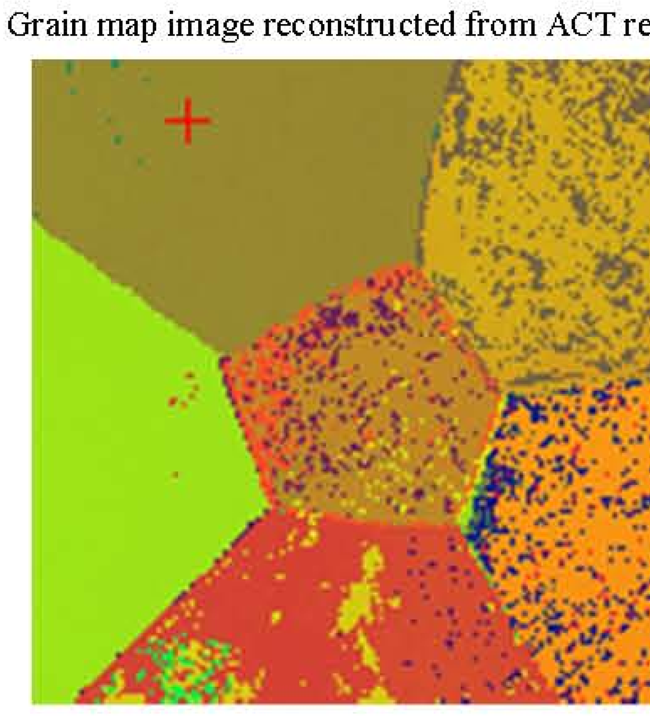
Bright-field image of 0.08 wt%Sb Ribbon



Diffraction patterns reconstructed from ACT results

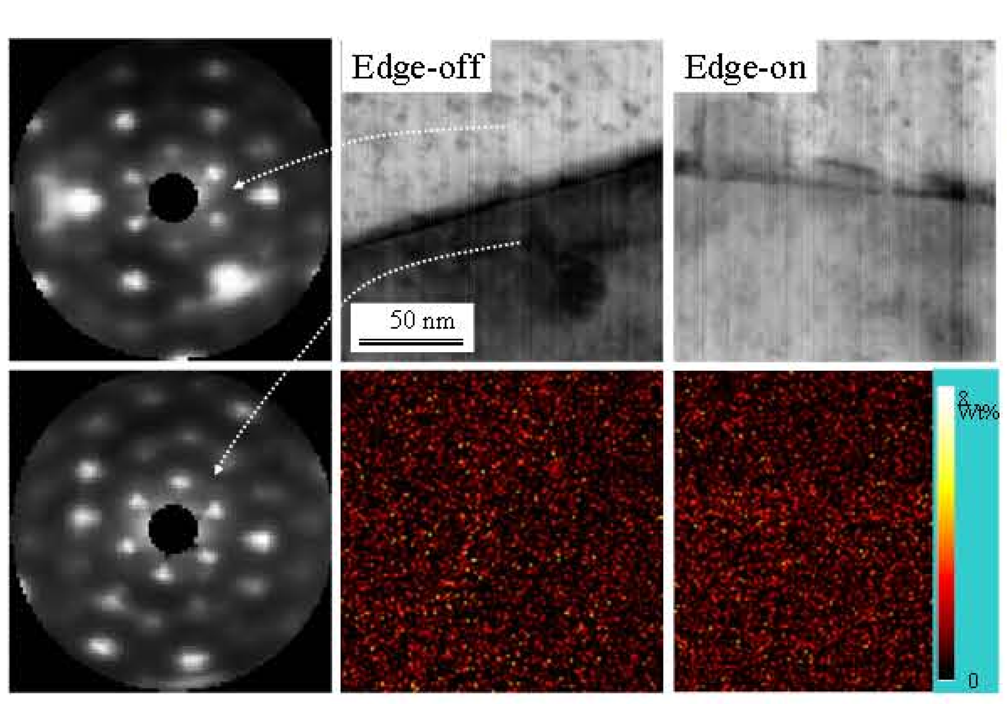


Grain map image reconstructed from ACT results



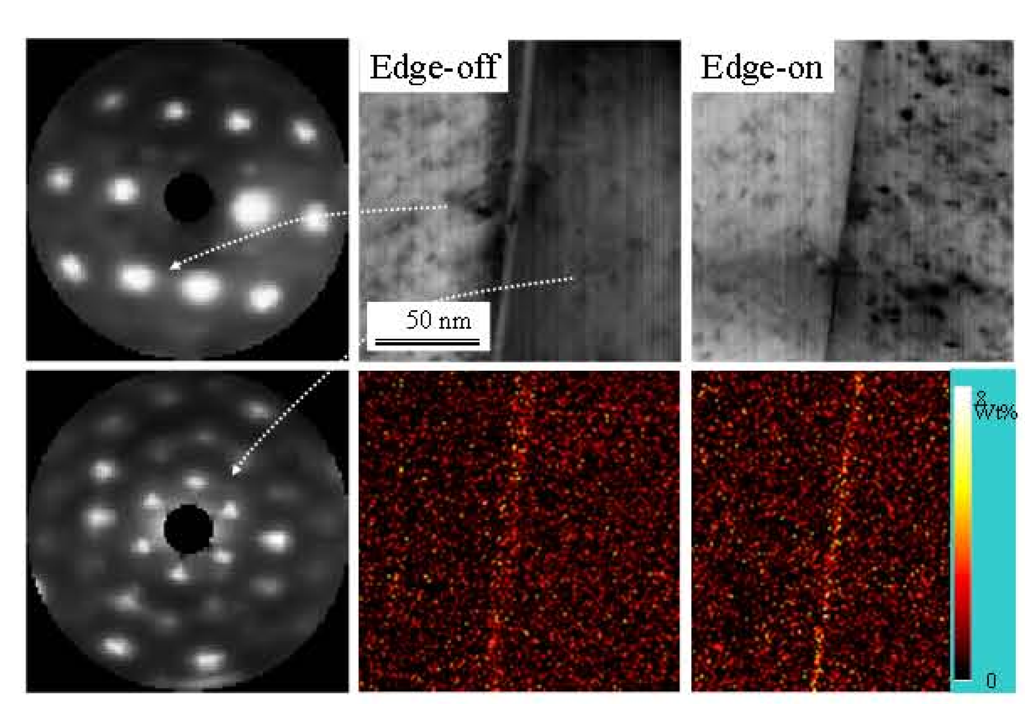
Misorientation analysis with ACT

Misorientation between adjacent grains can be calculated from their corresponding diffraction patterns. In the present example, Sb grain boundary segregation in a Cu was studied by X-ray mapping in a Scanning Transmission Electron Microscope and the results were coupled with boundary structure analysis of ACT.



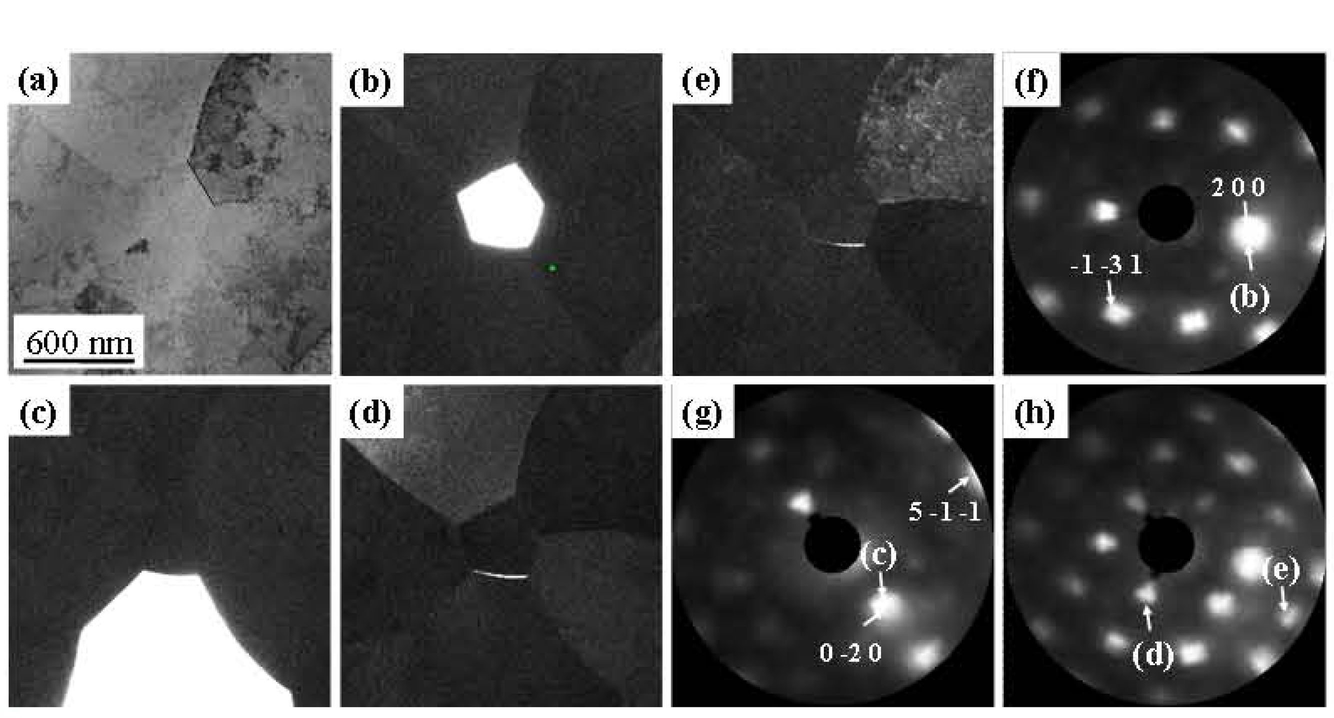
No Sb grain boundary segregation was found on a Σ3 boundary.

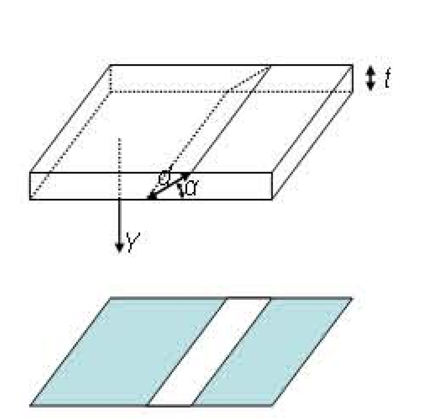
Sb segregated to a regular grain boundary.

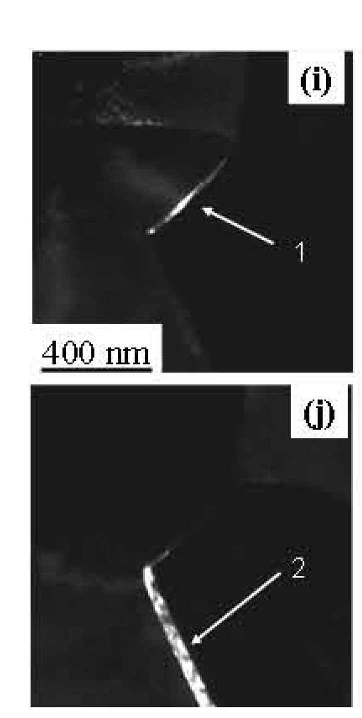


Projection of grain boundary overlapping with ACT

Incident electron beam can be scattered twice due to overlapping of two grains on boundary, generating double diffraction spot. In the dark field image of ACT formed with such double diffraction spots, the overlapping area only show bright contrast, which can be used to evaluate the degree of grain overlapping.







• Bright contrast of the grain boundary areas in (d) and (e) is due to the double diffraction spots marked in (h).

* The degree of grain overlapping on boundary #2 is larger than that of #1.