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IT-9-P-2385 Investigation of dislocation structures by cross-correlation based EBSD mapping and TEM imaging

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During unaxial compression of copper single crystals an inhomogeneous dislocation structure develops. With the use of cross-correlation based analysis of electron backscatter diffraction (EBSD) patterns it is possible to map plastic strain variations in deformed polycrystalline samples [1]. In this work this method is applied to visualize the dislocation structures and corresponding distortion fields in Cu single crystals compressed to different levels. The maps created by this method show inhomogeneous cell structure. Furthermore transmission electronmicroscopy is widely used to create micrographs that directly show dislocation arrangement within the sample.

Sample surface preparation plays a key role in creating ideal conditions for both TEM and EBSD measurements. Firstly, we applied various preparation techniques and investigated the efficiency of those methods. We used focused ion beam to create TEM foils of approximately 100 nm thickness. From samples with high dislocation content it's difficult to carve out such lamellas because during the thinning process the foil can spontaneously bend due to the inner stress field. We also made TEM samples with traitional electopolishing and ion polishing processes and compared the resultant TEM micrographs.

Then the distortion maps of the specimen are computed with the cross-correlation technique. This method is capable of detecting changes of the crystal orientation to higher accuracy than the commercial software provided for standard EBSD devices that analyse each EBSD pattern individually. The good qualitative agreement found between the two methods indicate that the cross-correlation method is capable of giving distribution characterization of the cellular dislocation structure. The results measured on the same surface area by cross-correlation based EBSD and TEM methods were compared and evaluated.

Reference:

[1] T.B. Britton and A.J. Wilkinson, High resolution electron backscatter diffraction measurements of elastic strain variations in the presence of larger lattice rotations. Ultramicroscopy 114 (2012) 82-95.

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