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Cryogenic EBSD and X-ray Laue diffraction: Data on subgrain boundaries in Antarctic ice samples

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Mechanical properties and deformation behaviour of ice in the huge polar ice masses control the internal flow of ice sheets and material supply towards the oceans. As intracrystalline dislocation glide is presumed to be the main deformation process in the creep deformation of natural ice, knowledge on dislocation activity and dislocation types is of high importance for the complete understanding of ice deformation.

Novel results from comprehensive combinations of full-crystal orientation measurements (X-ray Laue diffraction[1] and Electron backscattered diffraction[2]) and microstructure observations by light microscopy (LM microstructure mapping[3]) provide first insight into activity of different dislocation types generated by deformation in ice from an Antarctic ice core (EDML). High-resolution measurements of lattice distortions across small-angle grain boundaries localized and pre-characterized by optical means, reveal characteristic configurations, which can be interpreted in terms of dislocation activity. The peculiar nature of dislocations in hexagonal ice leads to a limited number of stable dislocation wall configurations.

The characteristic low-angle grain boundary types observed and identified by this study are (a) basal tilt boundary comprised of basal edge dislocations (b) basal twist boundary comprised of basal screw dislocations (c) non-basal tilt boundary comprised of non-basal edge dislocations.

An overview along an ice core will be given by data from X-ray Laue diffraction which can use standard sample sizes (~50 x 100 mm), because the complete set-up is installed in a cold laboratory. Small samples are needed for examination in an SEM, but as EBSD is widely used in geo- and material sciences, fully automated data acquisition techniques are available, which can be used to measure significant numbers of subgrain boundaries at a particular depth.

We therefore can further present measurements, analysis and interpretation of examples of significant subgrain boundary numbers per selected depths.

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[3]Weikusat, I.; Kipfstuhl, S.; Faria, S. H.; Azuma, N. & Miyamoto, A. Subgrain boundaries and related microstructural features in EPICA-Dronning Maud Land (EDML) deep ice core. J. Glaciol., 2009, 55, 461-472, doi: 10.3189/002214309788816614