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Strain field evolution during creep on ice. Impact of dynamic recrystallization mechanisms.

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Discontinuous Dynamic Recrystallization (DDRX) occurs in minerals, metals, ice and impacts on texture and microstructure evolution during deformation. It therefore impacts on large scale mechanisms as seismic anisotropy, mechanical properties inside the Earth mantle, material forming and anisotropic flow in polar ice sheet, for instance. In this frame, ice can be considered as a model material due to a strong viscoplastic anisotropy inducing strong deformation heterogeneities, that are precursors of recrystallization.

During creep deformation at high temperature in the laboratory, DDRX occurs from 1% strain and involves grain nucleation and grain boundary migration. As DDRX induces an evolution of microstructure and texture, it strongly affects the mechanical behavior (1,2), and it is expected to modify the strain field at the grain and/or the sample scale.

Compressive creep test (σ=0.5-0.8 MPa) were performed at high temperature (T/Tf 0,98) on granular polycrystalline ice (grains size 1mm) and columnar polycrystalline ice (microstructure 2D 1/2 in plane grain size 10mm) up to 18 % strain. Columnar ice provides interesting feature as it contains only one grain through the thickness and the columns are parallel.
Post-deformation texture analyses with an Automatic Ice Texture Analyzer (AITA) and with EBSD (CrystalProbe MEB of Geoscience Montpellier) were used to investigate DDRX mechanisms at high resolution, and deduce their impact on texture and microstructure, at different scales.
During the experiment, local strain field is measured on the surface of the sample by Digital Image Correlation (DIC) (3) with a spatial resolution between 0.2 and 0.5 mm, and a strain resolution between 0.2% to 1%. Grain size being large, we obtain a relatively good intra-granular resolution of the strain field. Thanks to the 2D configuration of the columnar ice samples, we can superimpose the initial microstructure to the strain field measured by DIC.

We will present an overview of the impact of DDRX on texture, microstructure and strain field evolution, over entire 2D-1/2 samples down to a close focus on a triple junction.
We will focus on nucleation mechanisms which can occur by involving different processes such as nucleation by bulging, nucleation by sub-grain rotation and tilt sub-grain boudary formation investigated with EBSD.
Furthermore, we will provide original observations of strain-field evolution associated with the nucleation of new grains and subboundaries close to a triple junction. Associated with post-deformation analyses by AITA and EBSD, these observations enable to follow the strain redistribution due to nucleation.

Reference

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