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The effect of temperature on the rheology and microstructure of synthetic rocksalt deformed in torsion

M. Armann (1), L. Burlini (1), C.J. Spiers (2), Y. Podladchikov (3) and J.-P. Burg (1)

(1) Institute of Geology, Structural Geology and Tectonics Group, ETH Zürich, Switzerland (marina.armann@erdw.ethz.ch), (2) HPT Laboratory, Department of Earth Sciences, Utrecht University, The Netherlands, (3) Physics of Geological Processes, University of Oslo, Norway

Torsion experiments were performed to understand how temperature influences the mechanical behaviour and the microstructure of wet synthetic rocksalt (>30ppm water) deformed to shear strains up to γ ∼8. The experiments were done at constant angular displacement rates corresponding to shear strain rates from 10^{-5}-$10^{-3}s^{-1}$ (at the outer margin of the sample), at a confining pressure of 250 MPa and at temperatures from 100-300˚C (0.3-0.5 Tm).

Samples deformed at 100˚C showed an apparent yield point at 25-30 Nm internal torque, depending on the shear strain rate (10^{-5}-$10^{-3}s^{-1}$). Beyond that, the internal torque continued to increase (strain hardening) showing occasional irregular undulations. In the experiments conducted at higher temperatures, the samples yielded at 18-23 Nm at 200˚C and 20-22 Nm at 300˚C. However, beyond the yield point, the material generally showed a sharp yield drop, then strain hardening followed by a gradual weakening. Steady state flow was approached at shear strains γ >2. In this region the internal torque vs shear strain curves were gently undulating. Preliminary, jacket uncorrected strain rate stepping tests point to a stress exponent larger than 4.

The microstructure observed at 100˚C consists of elongated polygonal grains defining a foliation oblique to the shear plane. Subgrains and wavy slip bands are well developed and provide evidence of recovery processes. Dynamic recrystallisation occurred to a limited amount. At 200 and 300˚C the microstructure is dominated by dynamic recrystallisation involving grain boundary migration and possibly subgrain rotation.

By linking the mechanical behaviour to the observed microstructure, we can interpret the undulations that appear, especially at 200-300˚C at $\gamma > 2$, in terms of repeating cycles of dynamic recrystallisation. This confirms the results of low strain experiments previously conducted in compression and demonstrates that grain boundary migration is an important microstructural process in salt deformed to large shear strains. Since it is not observed in dry samples ($<$5ppm water), the mechanism of grain boundary migration must be one of fluid assisted grain boundary migration.