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A detailed investigation of the microstructure formed during torsion experiments on synthetic rocksalt at 100-300˚C

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Torsion experiments were carried out to study the evolution of microstructure as a function of shear strain, shear strain rate and temperature using synthetic rocksalt. Experiments were conducted at temperatures of 100-300˚C, at strain rates of 10^{-5}-$10^{-3}s^{-1}$ and at a confining pressure of 250MPa. The microstructures were studied by reflected light microscopy and by orientation mapping through electron backscatter diffraction (EBSD).

Shear deformation leads to elongated and flattened grains in approximate agreement with the finite strain ellipse. The deformed grains contain slip bands with a wavy character, which is assigned to cross-slip of screw dislocations with $<110>$ Burgers vector. Grains contain a dense network of subgrains with blocky or polygonal shape. Blocky subgrains formed preferentially at low temperature (100˚C) and are due to the intersection of two sets of slip bands. Polygonal subgrains are formed at higher temperature (200-300˚C) by the process of climb controlled recovery.

At larger shear strain dynamic recrystallisation becomes dominant. Dynamic recrystallisation occurred by two processes; subgrain rotation recrystallisation and grain boundary migration recrystallisation. Subgrain rotation recrystallisation occurred in samples with a shear strain $\gamma \geq 3$ and becomes dominant at shear strains of $\gamma \sim 6$ at 100˚C and of $\gamma \sim 8$ at 200˚C, which causes a major grain size reduction. Grain boundary migration recrystallisation is indicated by irregular shaped grains with a cuspate/lobate or bulged grain boundary geometry and the presence of an internal deformation structure in form of subgrains. It becomes important at higher temperatures (200 and 300˚C) and dominates the microstructure at 300˚C.

The occurrence of subgrains and slip bands as well as pronounced crystallographic preferred orientations suggests that deformation of rocksalt at all investigated temperatures was mostly controlled by dislocation processes. At 100˚C and moderate strain, the process of dislocation glide is dominant, at larger strain and at higher temperature slip was accommodated by climb-controlled recovery resulting in dislocation creep as the rate-controlling mechanism. An increase in shear strain at 100 and 200˚C leads to more pervasively recrystallised microstructures with a more dominating fine-grained matrix and decreasing amounts of larger porphyroclasts, which indicates subgrain rotation recrystallisation. At higher temperature, the recrystallised grain size is larger which is coupled with a reduced flow stress at the same strain rates and grain boundary migration dominates.