Geophysical Research Abstracts, Vol. 9, 08112, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08112

The evolution of microstructure and crystallographic preferred orientation of synthetic rocksalt with increasing shear strain: Insights from torsion experiments

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We carried out torsion experiments on wet synthetic rocksalt up to a high shear strain (γ ~8) to investigate how microstructure and crystallographic preferred orientations (CPO's) change with increasing shear strain by applying different temperatures (100-300˚C) and different strain rates (10^{-5}-$10^{-3}s^{-1}$).

Samples deformed at 100˚C at a strain rate of 10^{-5}-$10^{-4}s^{-1}$ show a 'strain hardening microstructure'. This microstructure consists of polygonal grains containing subgrains and wavy slip bands. Dynamic recrystallisation remains minor in samples deformed to a shear strain up to γ ~3 at a strain rate of $10^{-4}s^{-1}$. Electron backscatter diffraction (EBSD) revealed an oblique crystallographic preferred orientation (CPO) with respect to the shear plane and shear direction. The CPO shows several maxima of different strength around the pole figure periphery. A dynamic recrystallisation texture evolved at larger shear strains (γ ~6) which approached orthorhombic symmetry with {100} preferentially parallel to the shear plane. A large amount (50%) of newly recrystallised grains appeared in the deformed matrix of this sample. These grains are free of an internal deformation structure, indicating that the grains are not dynamically recrystallised and formed in the latest stages of the experiment. The CPO is characterised by $<100>$ maxima oriented diagonally between shear plane and direction. One sample deformed at $10^{-5}s^{-1}$ to a shear strain of γ ~0.3 shows polygonal grains that are either free of deformation structures or contain wavy slip bands and subgrains. The CPO is weaker and identical to samples deformed with a strain rate of $10^{-4}s^{-1}$.

At 200˚C and a strain rate of 10^{-5}-$10^{-4}s^{-1}$ recrystallisation is more general than at 100˚C. The CPO of these samples up to a shear strain of γ ~3 is oblique to the shear plane and to the shear direction and shows several maxima of different strength around the pole figure periphery, as at 100˚C, with a predominant {111}$<$110$>$ component. The microstructure in the sample deformed with a strain rate of $10^{-3}s^{-1}$ is characterised by a fine grained dynamically recrystallised matrix with {100} preferentially parallel to the shear plane.

In conclusion, the microstructure at 100˚C is a ‘strain hardening microstructure‘ up to a shear strain of γ ~3 that changes into a dynamic recrystallisation microstructure up to a shear strain of γ ~6 and a recrystallisation microstructure. At 200˚C dynamic recrystallisation is the characteristic microstructure up to a shear strain of γ ~8. These microstructural observations are consistent with the development of the crystallographic preferred orientations that, in a similar way, can be separated in a deformation texture followed by a dynamic recrystallisation texture and a texture indicating recrystallisation in the latest stage of the experiment.