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# Experimental investigation of structures and rheology on halite single-crystals: In-situ approach.

D. Picard, A. Dimanov, and J. Raphanel

UMR 4976 Laboratoire de Mécanique des Solides, Ecole Polytechnique, 91128 Palaiseau Cedex, France (picard@lms.polytechnique.fr)

Intracrystalline plasticity, coupled with the rheological properties, are key parameters to constrain the flow behavior of rock salt. Crystal plasticity is inherently anisotropic and therefore polycrystalline materials always exhibit heterogeneous behavior which results from local scale incompatibility and involves additional accommodation mechanisms (micro-cracking, grain sliding…). It is thus important to understand the interaction between neighboring grains and inside single crystals. For this reason, we investigate crystal plasticity of halite single-crystals (NaCl) with compression experiments performed inside a scanning electron microscope (SEM).

Starting materials consist of high purity halite single crystals of approximately 5x5x10mm. Micro droplets of gold are deposited on the polished sample surface in order to provide very fine markers for the Digital Image Correlation (DIC) technique used to evaluate the surface displacement field at several steps of the loading process. The DIC method allows to compute the strain field and to evaluate quantitatively the heterogeneity of the local deformation which can be related to local mechanisms such as intracrystalline slip. Compression experiments were performed along {001} using an uniaxial press installed inside a SEM. Tests were performed at room temperature, a strain rate $9.4 \times 10^{-5}$ $s^{-1} < \dot{\varepsilon} < 4.9 \times 10^{-4}$ $s^{-1}$ and up to strains $\varepsilon$ of $\sim$13%.

For all applied strain rates, the rheological behavior is characterized by an elastic deformation followed by plastic flow with constant strain hardening. The transition from elastic to plastic deformation occurs at lower strain with increasing strain rate, i.e. at $\varepsilon$= 1% at $\dot{\varepsilon} = 9.4 \times 10^{-5}$ $s^{-1}$ and $\varepsilon$= 0.5% at $\dot{\varepsilon} = 4.9 \times 10^{-4}$ $s^{-1}$. Strain hardening increase with increasing the strain rate. This is expressed by a decrease of the stress exponent n from n$\sim$14 at $\varepsilon$= 2% to n$\sim$3 at $\varepsilon$= 10%.

Crystal plasticity is induced by slip lines observed using SEM images. Dislocation glide was actived in {110}<110> slip systems. The DIC technique indicates that the number of slip systems decrease with increasing the strain rate. Four slip systems are actived at the beginning of the plastic deformation at lower strain rate, whereas only two conjugate slip systems are actived at higher strain rate. These slip systems also seems to be strain depend. At lower strain rate two of four slip systems accommodate all the deformation, whereas the two other systems do not develop further with strain. Finally, the strain field given by the DIC analysis reveals that the heterogeneity increases with strain. The deformation evolves from a regular arrangement of thin slip bands at the onset of the plastic deformation to local concentration in ten times larger bands at $\varepsilon > 5\%$. Moreover, from one step to another, the deformation accommodated by a slip band can vary from 1% to 10%.

These preliminary results indicate that, even with simple loading tests and easy slip systems, important heterogeneity of deformation occurs. Further experiments at higher temperature and with different loading orientation will also be presented.