SIT42-P06 Room:Convention Hall Time:May 22 17:15-18:30

LPO development of single crsytals of wet synthetic quartz sheared at low temperature

KANEKO, Hideaki[1*], MUTO, Jun[1], NAGAHAMA, Hiroyuki[1]

[1]Inst. Geol. Paleontol., Tohoku Univ.

Shear zone develops through strain softening of rocks during progressive deformation. One of the strain softening mechanisms is geometrical softening caused by crystal changes its orientations for easier slip system. Geometrical softening causes development of lattice preferred orientation (LPO) closely related to dynamic recrystallization.

The mechanism of dynamic recrystallization of quartz which is a common crustal mineral is separated into regimes 1-3 by increasing the temperature and decreasing the strain rate. The c axis LPO of quartz changes from a crossed-girdle LPO to Ymax LPO with increasing the temperature and strain (Hirth and Tullis, 1992JSG).

Heilbronner and Tullis (2002Geol. Soc. Spec. Publ.) conducted general shear experiment in each of the three dislocation creep regimes of Hirth and Tullis (1992JSG) and examined the LPOs in each regime. Heilbronner and Tullis (2006JGR) sheared quarzite samples experimentally at regime 3 conditions of Hirth and Tullis (1992JSG) where grain boundary migration is the dominant recrystallization mechanism, and examined the changes in c axis LPO with increasing shear strain and degree of recrystallization. Muto et al. (2011JGR) have undertaken an experimental study using single crystals of wet synthetic quartz to investigate the development of LPO in dynamically recrystallized grains and its effect on the flow strength of quartz aggregates. They observed that domains of recrystallized grains with a Y max LPO developed at moderate to high shear strain in all cases by grain boundary migration.

Although Heilbronner and Tullis (2006JGR) and Muto et al. (2011JGR) clarified that the effect of dynamic recrystallization on LPO development in regime 3 conditions, the effect of dynamic recrystallization in lower temperature where sugrain rotation is the dominant recrystallization mechanism is not clear yet because Heilbronner and Tullis (2002) have used the natural quartzites. The use of single crystals of known initial crystallographic orientations makes it possible to determine relationships between the initial crystallographic orientation and those of recrystallized grains.

In this study, we conduct general shear experiments in a Griggs apparatus using single crystals of synthetic quartz in order to investigate the development of LPO in dynamically recrystallized grains at a low temperature where subgrain rotation is a dominant recrystallization mechanism.

Experiments are conducted at Pc=1.5 GPa, P=600-700oC at a constant strain rate of 10-5 /s. Starting materials oriented to activate three main slip systems are sandwiched by alumina pistons that cut at 45o from the maximum compression direction. Before experiment, water content of samples are measured by FTIR analysis. After deformation experiments, crystallographic orientations were measured using EBSD analysis. We investigate the development of LPO of recrystallized quartz aggregates in three different initial orientations with increasing shear strain and degree of recrystallization.

The basal<a> sample (gamma ~ 0.7, no recrystallization) show the c axis LPO of a symmetric single broad peripheral maximum, rotated 35o with the sense of shear. Other basal<a> sample deformed to gamma ~2.5 shows strain hardening after yielding at gamma ~1. Its c axis LPO has a symmetric single broad peripheral maximum, rotated 90o with the sense of shear from initial Z axis to X axis. This indicates that the shear deformation and thinning rotates crystal that causes the activation of hard prism[c] slip system. The prism<a> sample deformed to gamma ~2.5 becomes steady state with a flow stress of 300MPa after yielding at gamma~0.5. In the presentation, we will show the experimental results on the LPO development in three different initial orientations as a function of strains and degree of dynamic recrystallizations.