European Mineralogical Conference
Vol. 1, EMC2012-36-1, 2012
European Mineralogical Conference 2012

Deformation of olivine single crystals under lithospheric conditions

S. Demouchy (1), A. Tommasi (1), and P. Cordier (2)

(1) Geosciences Montpellier, CNRS & Universtié Montpellier 2, place E. Bataillon, Montpellier, France (demouchy@um2.fr),
(2) Unité Matériaux et Transformations, Université Lille 1 & CNRS, UMR 8207, 59555 Villeneuve d'Ascq, France

The rheology of mantle rocks at lithospheric temperatures (<1000°C) remains poorly constrained, in contrast to the extensive experimental data on creep of iron-bearing olivine single crystals and polycrystalline aggregates at high temperature (T > 1200°C). Consequently, we have performed tri-axial compression experiments on oriented single crystals and polycrystalline aggregates of San Carlos olivine at temperatures ranging from 800o to 1090oC. The experiments were carried out at a confining pressure of 300 MPa in a high-resolution gas-medium mechanical testing apparatus at constant strain rates ranging from 7 × 10-6 s-1 to 1 × 10-4 s-1. Compression was applied along three different crystallographic directions: [101]c, [110]c and [011]c, to activate the slip systems [100](001) and [001](100), [100](010), or [001](010), respectively. Yield differential stresses range from 88 to 1076 MPa. To constrain hardening, stick-and-slip, or strain localization behaviors, all samples were deformed at constant displacement rate for finite strains between 4 to 23 %. Hardening was observed in all experiments and the maximum differential stress often overcame the confining pressure. EBSD mapping highlights macroscale bending of the crystalline network in three crystals. TEM observations on several samples show dislocations with [100] and [001] Burgers vectors in all samples, but dislocation arrangements vary. The results from the present study permit to refining the power-law expressing the strain rate dependence on stress and temperature for olivine, allowing its application to the lithospheric mantle.