European Mineralogical Conference
Vol. 1, EMC2012-683, 2012
European Mineralogical Conference 2012

Texture development in $CaIrO_3$ post-perovskite.

S. A. Hunt (1) and A. M. Walker (2)

(1) University College London, United Kingdom (simon.hunt@ucl.ac.uk), (2) University of Bristol, Bristol, United Kingdom

The D′′ layer of the mantle exhibits significant seismic anisotropy which contrasts with the rest of the lower mantle which is seismically isotropic. This, otherwise anomalous anisotropy, was explained with the discovery of a new post-perovskite phase of $MgSiO_3$ at pressures and temperatures in excess of 135 GPa and 3500 K. The post-perovskite phases exhibits large elastic anisotropy and with the correct lattice preferred orientation can at least partially explain the seismic observations.

However, in order to generate the required anisotropy the deformation of the post-perovskite has to be accommodated by a dislocation glide mechanism. Due to the extreme conditions under which $MgSiO_3$ post-perovskite is stable determining its deformation mechanism is extremely difficult and so analogue materials have been used to investigate the deformation mechanism. The results of these studies show a range of dislocation glide mechanisms, only some of which can explain the lower mantle anisotropy (e.g. Wookey et al., 2005). Attempts to model the development of seismic anisotropy via the development of a deformation induced lattice preferred orientation are made difficult by a shortage of data on the relative activity of the various slip systems and a lack of information on the rate of its development with strain (Walker et al. 2011).

To investigate the rate of lattice-preferred orientation and the active deformation mechanisms in post-perovskite, we undertook simple shear deformation of $CaIrO_3$, the low-pressure analogue of $MgSiO_3$ post-perovskite, at 400°C and 1 GPa. The experiments were performed in the deformation-DIA, at the NSLS on beam line X17B2. During deformation, we recorded diffraction patterns from the sample using the 10-element energy dispersive detector. Nine of the detectors are arranged in a semi-circle, which gives good coverage of the Debye rings in the sample. From these diffraction patterns, the evolution of elastic strain and the stresses in the sample can be observed as a function of bulk sample shear strain (γ). The distribution of the elements is such that pole figures can be calculated from the diffraction patterns. The change in the pole figures with time allows the development of lattice-preferred orientation in the sample to be tracked.

We anticipate that the results of these experiments will offer an opportunity to better parameterize models of the development of lattice preferred orientation in post-perovskite analogues.

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Walker et al., (2011), Elastic anisotropy of D′′ predicted from global models of mantle flow, Geochem. Geophys. Geosyst., 12, Q10006.

Wookey et al., (2005) Efficacy of the post-perovskite phase as an explanation for lowermost-mantle seismic properties, NATURE, 438, pp.1004-1007