Geophysical Research Abstracts
Vol. 15, EGU2013-1504, 2013
EGU General Assembly 2013

Crack networks in damaged glass

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We investigate how cracks develop and propagate in synthetic glass samples. Cracks are introduced in glass by a thermal shock of 300^oC. Crack network is documented from optical and electronic microscopy on these samples that have been submitted to a thermal shock only.

Samples are cylinder of 80 mm length and 40 mm diameter. Sections were cut along the cylinder axis and perpendicular to it. Using SEM, crack lengths and apertures can be measured. Optical microscopy allows to get the crack distribution over the entire sample. The sample average crack length is 3 mm. The average aperture is $6 \pm 3\mu m$. There is however a clear difference between the sample core, where the crack network has approximatively a transverse isotrope symmetry and the outer ring, where cracks are smaller and more numerous. By measuring before and after the thermal treatment the radial P and S wave velocities in room conditions, we can determine the total crack density which is 0.24.

Thermally cracked samples, as described above, were submitted to creep tests. Constant axial stress and lateral stress were applied. Several experiments were performed at different stress values. Samples are saturated for 48 hours (to get an homogeneous pore fluid distribution), the axial stress is increased up to 80% of the sample strength. Stress step tests were performed in order to get creep data. The evolution of strain (axial and radial strain) is measured using strain gages, gap sensors (for the global axial strain) and pore volume change (for the volumetric strain). Creep data are interpreted as evidence of sub-critical crack growth in the cracked glass samples.

The above microstructural observations are used, together with a crack propagation model, to account for the creep behavior. Assuming that (i) the observed volumetric strain rate is due to crack propagation and (ii) crack aspect ratio is constant we calculate the creep rate. We obtain some value on the crack propagation during a 24 hours of constant stress test. At each of these test, crack propagate of 0.3 to 0.4 mm. From the initial average crack length of 3 mm, the crack reach the size of 5.8 mm at the end of a complete creep test (with 8 constant stress step of 24 hours).