Use of X-ray Imaging Techniques at High Pressure and Temperature for Strain Measurements

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We have developed a method for measuring the macroscopic strain in a polycrystalline or single crystal sample under high pressure and temperature using an x-ray shadowing method. The 1-mm^3 sample is contained inside a cell assembly similar to that use for a DIA-type cube anvil high-pressure apparatus. Transmitted x-rays are incident on a fluorescent crystal; a CCD camera views the resulting image. By varying the geometry of the anvils and/or the cell contents, we can alter the stress field. These experiments have been carried out at about 10 GPa at temperatures up to 1100^o C.

Linear strain measurements (Figure 2) are useful for rheological measurements, and to measure the change in length of a sample under pressure for ultrasonic wave velocity measurements.

Two-dimensional deformation (Figure 3) gives more information about the strain field.

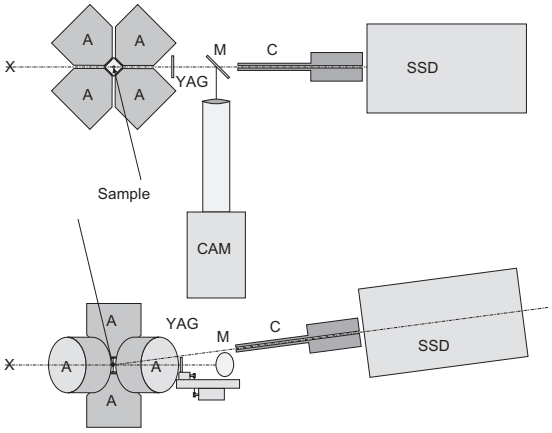

Figure 1. Plan view (above) and side view (below). This system uses synchrotron x-rays for two purposes: conventional energy-dispersive diffraction in a vertical diffraction plane, and imaging. The x-rays (**X**) pass between the four anvils (**A**) and through the sample. The transmitted x-rays impinge on a fluorescent YAG crystal, where an image of the sample is generated. The visible light generated by the YAG is reflected by the mirror (**M**) into a CCD camera (**CAM**).

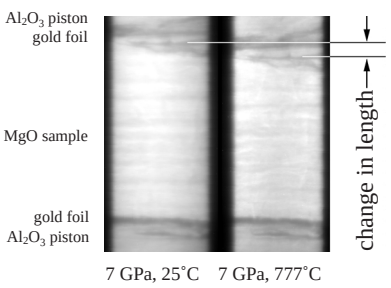

Figure 2. A typical linear strain measurement. A hard piston of alumina is placed above and below an MgO sample to greatly increase the deviatoric stress. Between the sample and the alumina pistons are placed gold foils.

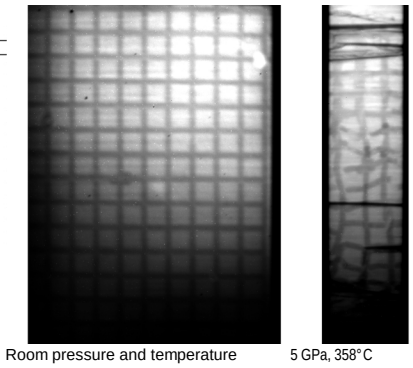

Figure 3. Two-dimensional deformation. A cylindrical sample of olivine was cut in half vertically and a gold TEM grid sandwiched between the two halves. The resulting images before and after compression and heating are illustrated. The distortion of the sample is mimicked by the distortion of the grid field inside the crystal.