

A Paris-Edinburgh cell for high-pressure liquid structure studies using monochromatic radiation with multi-channel collimators at the GSECARS beamline

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We have set up a Paris-Edinburgh Press (PEP) combined with a multi-channel collimator (MCC) assembly at the GSECARS beamline of the Advanced Photon Source for monochromatic X-ray diffraction. The PEP is mounted on a general-purpose diffractometer, with a single-photon counting area detector (Pilatus3 X 300K-W) mounted on the two-theta arm. The incident Si(111) or Si(311) monochromatic beam is focused both horizontally and vertically with large Kirkpatrick-Baez mirrors. With this setup, background scatter from the surrounding pressure media is completely removed at 2θ angles above 10° for samples larger than 0.5 mm in diameter by oscillating the MCC during data collection. About 10 min. is sufficient to collect signals of a 2 mm diameter borosilicate glass sample (a weak scatterer), with minimal background scatter. The system is modularized into a few permanent units, allowing fast installation in station 13-ID-C. Atomic bond lengths acquired from sodium disilicate glass structure data at ambient conditions agree well with previous studies based on neutron scattering (Misawa et al., 1980) and theoretical calculation (Smith et al., 1995), demonstrating the reliability of our setup. Structure data of sodium disilicate melts has been collected up to ~ 5 GPa and ~ 1600 °C. The derived structure factors and atomic pair distribution functions will help us understand how bond lengths (Si-O, Na-O, O-O, Si-Si) and bond angles (Si-O-Si) respond to pressure and temperature and their possible roles in affecting transport properties in silicate melts.