High pressure neutron scattering at Oak Ridge National Laboratory

B. Haberl*, J.J. Molaison, and R. Boehler

Neutron Scattering Division, Neutron Sciences Directorate,
Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA

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*e-mail: haberlb@ornl.gov

Due to relatively low neutron fluxes, neutron experiments require sample volumes many orders of magnitude larger than comparable X-ray experiments. In the past, this need for large samples has limited the maximum pressures available for *in situ* neutron scattering. Although break-out experiments have been conducted, diffraction experiments are typically not conducted at pressures abvove ~20 GPa and inelastic experiments not at pressures above ~4 GPa.

Concerted efforts to address these challanges are underway at Oak Ridge National Laboratory. These efforts leverage the two neutron sources availabe, the Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR), better collimation for high pressure cells and significant development and improvements in high pressure cell technology, specifically neutron diamond anvil cells. An express aim of these developments is the availability of these new capabilities to a wide audience in the neutron user program as well as new record experiments.

A key aspect is clearly the development of a group of neutron diamond anvil cells based on very large diamond anvils, single crystal anvils grown by chemical vapour deposition (CVD) and polycrystalline diamond anvils. These latter anvils are for pressures to ~15 GPa only and are typically used for the study of single crystal samples at a variety of instruments at SNS and HFIR. The CVD anvils are used for diffraction studies that require above ~15 GPa but also diffraction and spectroscopy studies focused on liquid or gaseouos samples. Thereby, refinable diffraction data have been obtained at record pressures above 60 GPa.

Additionally, efforts are being made to adapt Paris-Edinburgh cells for new capabilities at SNS. Specifically, tests for inelastic and quasi-elastic measurements are underway. Furthermore, a very robust anvil design has recently been demonstrated for syntheses that require low temperature or control over (de-)compression rates.

Finally, advanced collimation is being developed based on 3D-printing of neutron absorbing materials (e.g. boron carbide) in combination with Monte Carlo ray tracing simulations of instrument and pressure cell. These simulations aim to optimize signal-to-background ratios while outputting printable collimators.

This presentation here will give an overview over these recent developments and achievements and their application to diverse science questions as well as discuss future directions.

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