Scilight

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Neutron diffraction in the megabar realm made possible using novel diamond cells

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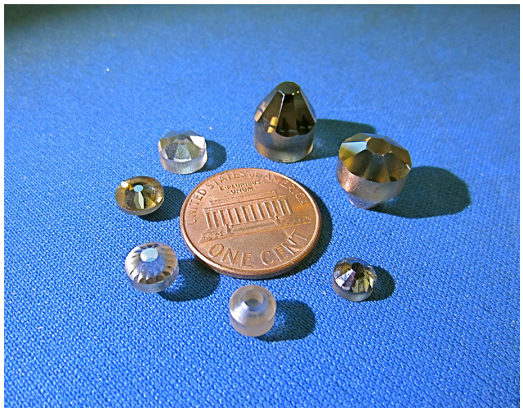
New large-volume diamond anvil cells tested at high pressure, yielding high quality diffraction spectra.



While high pressure neutron diffraction techniques are successful with many materials, other materials, such as D2O-ice, require large sample volumes, as well as increased forces that neutron diffraction sources' diamond anvils cannot sustain. To address this, a research team working at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory developed a novel diamond cell, expanding the application of high-pressure neutron diffraction to these materials. The researchers present their findings in *Review of Scientific Instruments.*

Lead author geophysicist Reinhard Boehler says scaling up conventional small anvils was not an option, because large culets demand huge forces causing seat deflections. Moreover, since diamond has little shear strength, stress concentrations must be avoided. The researchers combined accurate seat match and just the right hardness to create a cell capable of high quality diffraction patterns with significantly larger Q-range in much less time than previous neutron diamond cells. Researchers first tested a cylindrical anvil/seat but anvils split at about 2 tons. They then developed newer conical anvil/seats, delivering improved performance without anvil damage.

The team then tested the new cell with nickel, which has one of the highest neutron coherent scattering cross-sections. Next, to demonstrate probing disordered materials, the researchers tested disordered glassy carbon, taking spectra at pressures from ambient to 15, then 45 GPa, the largest pressure range used to study a disordered material. The cell generated high quality diffraction spectra with sample sizes of ~0.15-0.2 mm^3 in shorter exposure times and provide a considerably expanded Q-range, ranging from 1.25 Å-1 to Q=22 Å-1 (d range 5-0.29 Å), using a compact, low weight cell/press with easier handling and cooling.

Next, the team will combine conical support of even larger anvils using multi-anvil or piston-cylinder designs.

Source: "Novel diamond cells for neutron diffraction using multi-carat CVD anvils," by R. Boehler, J. J. Molaison, and B. Haberl, *Review of Scientific Instruments* (2017). The article can be accessed at https://doi.org/10.1063/1.4997265.