ADVANCES IN MATERIALS RESEARCH ON HED FACILITIES: DEVELOPMENT OF TECHNIQUES TO MEASURE PHASE CHANGES AND EOS IN PREVIOUSLY UNCHARTED HIGH PRESSURE MATTER

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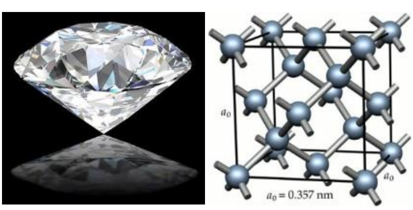
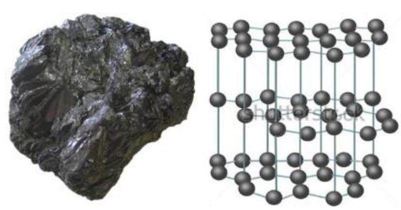
Dynamic ramp-compression experiments have become an important technique in high-pressure materials research. Lasers offer many advantages, including access to the most extreme pressures available in the laboratory, excellent control of the time-dependent drive, variable drive area, small sample size, and rapid shot rate. Large lasers capable of reaching pressures in the TPa regime have been built around the world, and several FEL and synchrotron x-ray light sources have or are planning laser drivers.[1] These lasers are becoming true user-access facilities aiming to be accessible to a broad user community. I will describe several common experiments and diagnostics used in laser-compression experiments, highlight some of our group's recent results, and offer a vision for the future of the field.

The primary attribute of the laser-driven compression platform lies in the extreme flexibility of stress-loading paths and compression geometries available. Single-shock, multiple-shock, pure-ramp, various shock-ramp combinations, unsupported shocks, and purposefully-unsteady shocks are all finding applications in laser-compression experiments. Monochromatic or broad-band x-rays, generated with exquisite timing precision by external sources or by the laser itself, are employed for a variety of diffraction, radiography, absorption, and phase-contrast imaging experiments. Using standard diagnostics, laser platforms are used to measure the, crystal-structure and phase-diagram, stress-strain EOS, melting, phase-transitions, Gruneissen-parameter, sound-speed, temperature, and non-equilibrium dynamics of compressed materials.



Diamond



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Materials with properties as disparate as diamond and graphite are understood at the atomic beginning with the crystal structure. We can now make such atomic-scale determinations using laser-driven compression above 10 Mbar.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.