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Materials behavior under Fast Compression or Decompression

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Phase transformation pathways are strongly influenced by the time dependence of the driving mechanism (compression, thermal transfer, strain, irradiation, etc). While thermal rate has been widely used for centuries for enhancing materials properties such as hardened steels or metallic glasses through rapid cooling, the application of compression rate is relatively new. Yet it drives rich new physics, novel chemistry, exceptional energy materials, and new routes of materials synthesis, and has become an important impetus in studying materials metastability, phase growth, and transition kinetics. In this talk, we will outline recently developed capabilities at HPCAT at the Advanced Photon Source for studying materials behavior under fast compression or decompression, including both single event loading or unloading and multiple, repetitive ramping events. A few recent studies will be highlighted. For example, a compression rate of 17 TPa per second has been reached in a piezo-driven diamond anvil cell; fast compression experiments significantly improve the precision in thermal equation of state determinations; the feasibility of controlled formation of metastable phases of Si and Ge has been demonstrated under controlled decompression rate; the phase transition kinetics of B1-B2 transitions in NaCl and KCl have been studied under various compression and decompression rates.

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