X-Ray Diffraction of Shock-Compressed Gibeon Meteorite to 130 GPa

Sabrina Tecklenburg (1), Arianna E. Gleason (1,2), Wendy L. Mao (1)
1 Department of Geological Sciences, Stanford University, Stanford, CA 94305
2 SLAC National Accelerator Laboratory

Iron meteorites represent core fragments from differentiated terrestrial planetesimals. The Gibeon meteorite is a differentiated iron meteorite that was discovered in 1836 and fell in Nambia, Africa. Several pre-shock sample characterization methods, e.g., electron backscatter diffraction, electron microprobe, micro X-ray diffraction (XRD) and scanning electron microscopy were used to understand the starting microstructure and composition, finding the Gibeon meteorite (FeNi7.9) composition exists in two phases: kamacite and taenite, with clear Widmanstatten lamellae. In this work we use these natural kamacite and taenite samples from the Gibeon meteorite as a proxy for terrestrial core composition and examine the phase transition kinetics under laser shock compression to over 100 GPa. Using the Matter in Extreme Conditions (MEC) end-station at the Linac Coherent Light Source (LCLS), the 4th generation x-ray free electron laser (xFEL) at SLAC National Accelerator Laboratory, we collect in situ time-resolved XRD of transformations to high pressures structures (e.g., hexagonally close packed and face-centered cubic) during shock compression with sub-nanosecond temporal resolution. These lattice-level structural measurements were made in concert with traditional velocimetry methods to benchmark pressure on the Hugoniot; temperature estimates are also constrained by the Hugoniot. Results of this study will be presented focusing on phase transition kinetics and structural evolution.