Dynamic Compression Studies and X-ray Diagnostics using the Linac Coherent Light Source at MEC

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The behavior and physical properties of matter under extreme conditions are of fundamental scientific interest since extremes induce new physical phenomena that don't exist in ordinary conditions. Furthermore, it provides a clue to the understanding of dense matter phase in Earth's inside and planetary science. Extreme conditions created by intense light source generate dense matter state with densities of up to several times of solid density, temperatures of 1000s K to 1,000,000s K, and pressures of 10s GPa to 100s GPa. Model calculations in this regime predict electronic and structural phase transitions with new atomic and electronic band structure, anomalous transport, and changes of scattering properties and opacity.

The unique characteristics of free electron lasers with high peak brightness, quasi-monochromaticity, and tunable x-ray photon energy over femtosecond timescales has given rise to many new opportunities expanding our understanding of the kinetics and dynamics of material change in high pressure phase. Several x-ray diagnostics using the x-ray free electron laser source are tailored and improved at Matter in Extreme Conditions (MEC) instrument to study wide range of extreme conditions in phase space. The MEC instrument features high power short pulse and long pulse optical laser systems as well as x-ray diagnostics including diffraction, spectroscopy, and imaging. The research utilizing these light sources and diagnostics has addressed dynamic behaviors under high-pressure and phenomena of shock-compressed condition. In this talk, the details of x-ray diagnostics, highlight of several experiments, and future upgrade plan of MEC will be presented.