XFEL observation of shock-compressed highly oriented graphite

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High power laser-driven shock is widely used to investigate the states and behaviors of material in extreme conditions associated with warm dense matter (WDM) physics, planetary sciences, and inertial fusion energy research[1]. At the high pressure and extremely high strain rate conditions, it is known that mechanical properties and behaviors of material can change significantly more than expected. Such properties change is influenced by the micro-structure of material. We here present experimental results on X-ray free electron laser (XFEL) observations of shock-compressed highly oriented materials at the SACLA-HEDS platform [2, 3, 4]. We shock compressed highly oriented pyrolytic graphite (HOPG) samples along the [002] orientation using a 3-4 ns optical laser pulse and observed the lattices under the shock compression using the XFEL pulse with changing the time delay between the optical and X-ray pulses. Once the HOPG interlayers were compressed uniaxially up to $\sim$20% or more, and then a high pressure form of carbon was created on picosecond time scale above $\sim$20 GPa pressures. This sequence might be different from reported very recently [5, 6].

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