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Heavy ion irradiation of molecular solid at high pressures

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Swift heavy ions (SHIs) are high-mass ions with high kinetic energies in the MeV–GeV range produced by large accelerator facilities. Upon traversing a material, SHIs induce various physical and chemical effects within the material, including extended defects, phase transitions, amorphization, or chemical reactions. The combination of high pressure and heavy ions is anticipated to induce unusual physical and chemical transformation in matter, such as yielding non-equilibrium phases or stabilizing high-pressure phases that are challenging to recover under ambient conditions.

We have developed an experimental setup at GSI (Helmholtzzentrum für Schwerionenforschung GmbH) in the framework of a BMBF funded project (05K22RF3). The setup is capable of simultaneously subjecting samples to high static pressures up to 100 GPa and SHI beams within diamond anvil cells (DACs). Here, we present data obtained from the initial experiments using various samples, including benzene, carbon monoxide, and carbon dioxide, demonstrating the significant effect of SHIs on the materials under high pressure.

Further research into phase transitions or chemical reactions induced by SHIs at high pressure will deepen our understanding of how SHI interacts with matter at the atomic and molecular levels in extreme conditions. Moreover, this method presents opportunities to synthesize novel materials by providing conditions that are otherwise inaccessible.

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