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2023.12.22 (Fri.) 16:30 ~

Venue: Meeting Room #486
Science Research Bldg. 1, 4th floor.
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History and current status of Kawai-type multi-anvil high-pressure technology

Since the large-volume press with a double-stage multi-anvil system was invented by late Professor Naoto Kawai, this apparatus (Kawai-type multi-anvil apparatus or KMA) has been developed for higher pressure generation, in situ X-ray and neutron observations, deformation experiments, measurements of physical properties, synthesis of high-pressure phases, etc., utilizing its large sample volume and ability in stable and homogeneous high temperature generation relative to those of competitive diamond anvil cell. Such developments in KMA technology have been made mainly by Japanese scientists and engineers, which provided a number of new experimental data on phase transitions, melting relations, and physical properties of minerals and rocks, leading to important constraints on the structures, chemical compositions, and dynamics of the deep Earth. Moreover, KMA technology has also been used for synthesis of novel functional materials such as nano-polycrystalline diamond and transparent nano-ceramics, opening a new research field of "ultrahigh-pressure materials science". Here, I review the development of KMA technology toward higher pressure generation. Current status of large-volume KMA as a tool for novel materials synthesis under pressures of the ultrahigh-pressure regime (>10 GPa) is also summarized.