In situ observation of graphite to diamond transition using catalysts

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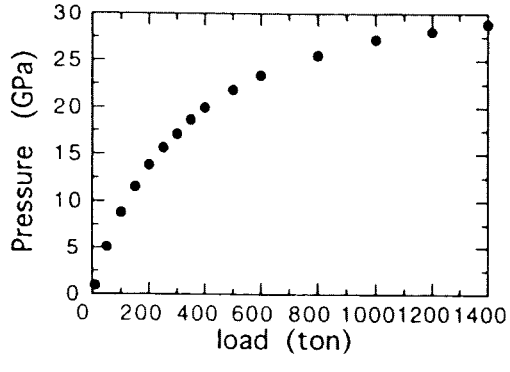
High Pressure Generation with SPEED-1500

The high pressure mineral physics group has designed a new multi-anvil high pressure apparatus for in situ x-ray observations at the SPring-8. The new system, named SPEED-1500, is installed in the upstream experimental hutch of BL04B1 beamline. High pressure in situ x-ray diffraction experiments by energy dispersive method can be made using white x-rays from the bending magnet. As a first experiment of SPEED-1500, we have compressed NaCl at room temperature to check the performance of high pressure apparatus. Using tungsten carbide anvils with truncation size of 1.5mm, powdered NaCl specimen in a MgO pressure medium was compressed. The unit cell volume of the NaCl were determined by its x-ray diffraction profiles and it was converted to the accurate pressure value using the well authorized equation of state of NaCl. Figure shows a pressure generation curve as a function of applied load. Pressures up to 29GPa could be generated with this system.



Diamond Synthesis using Non-Metal Catalysts

Many studies have been previously made on the diamond synthesis using catalysts. However, most of them are based on the information of the recovered specimen at ambient condition, and very few in situ experiments have been reported. The aim of this study is to make an in situ observation of graphite to diamond transition under high pressure, and to clarify the role of catalysts in the diamond formation process. Experiments were carried out using SPEED-1500 at BL04B1. Using tungsten carbide anvils with truncation size of 8.0mm, diamond synthesis were made under high pressures and high temperatures up to 10 GPa and 1800C. In this study, $MgCO_3$ or $K_2Mg(CO_3)_2$ were used as catalysts. These powdered catalysts were mixed with graphite and placed in the sample chamber of the high pressure cell assembly. When using $K_2Mg(CO_3)_2$ as a catalyst, diamond did not appeared yet at the temperature where catalyst started to melt. This means that melting of the catalyst is not a sufficient condition for the diamond formation. In order to synthesize diamond using this catalyst, higher temperature than its melting point is needed. This result is contrast to the fact that when metal catalyst such as Ni or Co is used, diamond is always formed just at their melting temperatures. For $MgCO_3$ experiment, this catalyst did not melt up to the present experimental condition and diamond formation was not confirmed. Graphite - diamond transition may occur at higher temperature without melting of the catalyst, which is a different diamond formation process from that with $K_2Mg(CO_3)_2$.