Solidification phenomena of water monitored by using an advanced dynamic-diamond anvil cell

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A real-time measurement has been carried out using an advanced dynamic-diamond anvil cell (d-DAC) for pressure-induced solidification. In this advanced d-DAC system, a precise control of diamond anvil movement has been achieved by combining piezoelectric actuators and Michelson interferometry. Moreover, pressure, molecular vibration, and image of sample have been simultaneously recorded during dynamic compression.

In present study, we have applied the dynamic pressure to liquid water, which causes the solidification; dynamic compression with different rates is applied to water-only and water-ice VI coexisting systems. In case of the water-only system, dynamic compression can make supercompression bypassing the equilibrium melting pressure of the ice VI phase. Then freezing of the ice VI is observed via optical image, Raman spectroscopy and also X-ray diffraction. Moreover, the higher supercompression above the extended water-ice VII boundary to ambient temperature makes the water transform into the metastable ice VII phase with sequential transition toward ice VI. When the ice VI crystal is dynamically compressed, the crystal morphology dramatically changes with compression strain rates; an anomalous two-dimensional crystal grows from the bulk ice VI on fast compression, while the ice VI grows with facets on slow compression.[1], [2]

These experimental results show the applicability of the advanced d-DAC system to study complex nucleation and crystal growth of molecular liquids under dynamic compression.

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