Potassium nitrate (KNO₃) exhibits complex polymorphism with seven polymorphs in the pressure range 0.0-4.0 GPa. We have studied this material at room temperature as a function of pressure up to 9.3 GPa using energy-dispersive powder diffraction at the SRS Synchrotron Radiation source (SR5). We have confirmed the structure of phase IV refined by neutron diffraction at 0.36 GPa (Hobson et al., Physical Review B 1986; 503), orthorhombic Pnma, z = 4. The compressibility measured in the range 0.3-9.3 GPa is found to be anisotropic with the axial compression ratio a:b:c = 1.00:0.64:0.50. The differing merits of both X-rays and neutrons for high pressure studies are discussed.

This experiment is at a preliminary stage to develop techniques to get over all difficulties and is limited to temperatures of 4 K region. However, we have to solve some inevitable technical difficulties caused by irradiation heating, the small atomic scattering form factor of helium and the uncontrolled orientation of a helium single crystal.

Solid helium is a representative of quantum crystals, because of very large zero point amplitude of about 30 % of lattice spacings. SR X-ray topography is the only feasible method for in situ observation of quantum mechanical behaviors of dislocations in helium crystals at temperatures of K region. However, we have to solve some inevitable technical difficulties caused by irradiation heating, the small atomic scattering form factor of helium and the uncontrolled orientation of a helium single crystal.

We took sectio topographs in beam of 0.1 × 6.5 mm² to obtain well-resolved images of sub-structures as shown in Fig. (a), (b) and (c). The topograph (a) is a part of the reflection from (211) plane of an as-grown hcp crystal. We confirmed dislocations grew steadily in whist part in (a). After the transformation to bcc, the spot in the same reflection point as in (a) consists of a lot of crystalites almost in the same orientation within several tens minutes as is seen in (b). Internal stresses induced in the martensitic transformation from hcp to bcc are easily relaxed mainly by slip. With decreasing temperature, a part of the crystal (b) transform into the hcp structure with very large strain as seen in (c). In the martensitic transformation from the hcp into bcc structures, the (0001) plane is converted into the (110) plane uniquely. Meanwhile, in the reverse transformation each of six (110) planes has equal possibility to transform into the (0001) plane. Therefore a hcp crystal transform into a bcc crystal containing some imperfections, but a bcc crystal transform into a large number of hcp crystal grains via the state shown in (c).

Figure. A part of section topographs of the martensitic transformation in helium-4 from (a) hcp phase at 27.9 atm via (b) bcc phase at 28 atm and (c) mixed state at 28 atm to hcp phase.