Thermal diffuse scattering effect on neutron holography

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In the previous experiment, we measured efficiently the neutron hologram of a palladium hydride single crystal using the powder diffrcatometer of HERMES in JRR-3M reactor, and found the thermal diffuse scattering effect in the measured hologram.1) In this study, we used again a palladium hydride single crystal as the measured sample and evaluated the temperature dependence of the sample on the thermal diffuse scattering in the hologram. The sample dimension was 10 mm in a diameter and 5 mm in a thickness, and it was coated by Cu not to desorb the hydrogen gas. Wavelength of the neutron was 0.182 nm. Sample was rotated in the range of 0 - 359 deg with the step of 1 deg, where rotation axis was parallel to the incoming beam direction. Neutrons incoherently scattered by hydrogen nuclei in the sample were detected by HERMES 150 He3 counters at each sample rotation angle. Polar angle of the measured hologram defined by the counter ranged from 7 deg to 157 deg. Dwelling time at each angle was 480 sec. The average neutron intensity at each pixel was about 500 counts. To reduce the effect of thermal diffuse scattering the cryostream cooler (Oxford: cryostream 70 series) was used for keeping the sample temperature at 100 K. Figures 1 (a) and (b) show the 2D angular distributions of the neutron intensities around the sample at room temperature and 100 K, respectively. The observed data were four-fold symmetrized using sample crystal symmetry in order to suppress statistical error, and then they were low-pass filtered. The displayed patterns exhibit strong spots reflecting the sample crystal symmetry, due to thermal diffuse scattering. However, the contrast of the pattern in Fig.1 (b) is weaker than that in Fig. 1 (a). Figure 1 (c) shows the intensities changes as a function of azimuthal angle at polar angle of 80 deg. The amplitude of the intensity change at room temperature was twice as much as that at 100 K. These results revealed that the effect of the thermal diffuse scattering effect was reduced by the sample cooling.

1) K. Hayashi, K. Ohoyama, S. Orimo, Y. Nakamori, H. Takahashi and K. Shibata, Jpn. J. Appl. Phys. in press.

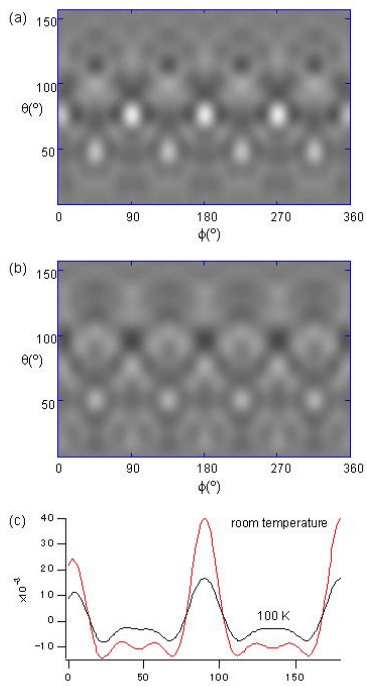

Fig. 1. Fig.1 2D angular distributions of the neutron intensities around the sample. (a) room temerature. (b) 100 K. (c) Intensities change at polar angle of 80 deg.