X-RAY STUDY OF THE PHASON STRAIN IN THE $Al_{70}Ni_{10}Co_{20}$ DECAGONAL QUASICRYSTAL

Broadening and shifts of Bragg peaks, induced in a characteristic manner by phason strain, are of great interest in the study of quasicrystal-crystal transformation. Precise measurements for the profile and position of the Bragg peaks in a single-phase decagonal $Al_{70}Ni_{10}Co_{20}$ quasicrystal have been carried out using an off-centered (Huber) 7-axis diffractometer at beamline **BL02B1**. The beam is monochromatized by Si(111) double-crystals, generating an energy of 18.00 keV. A needle-like single crystal with decaprismatic morphology was oriented with its 10-fold axis parallel to the ϕ-axis and perpendicular to the scattering plane. The peak positions and shapes of Bragg reflections along the 2-fold axis were measured precisely over the course of a θ-2θ step-scan. A suitable step width and counting time was selected for each reflection peak. The 0.25 mm-wide receiving slit was placed 900 mm from ϕ-center. Using this slit system, the 2θ angle resolution is 0.016° and the corresponding momentum resolution along the L(θ–2θ)-direction is 0.048×10^{-2} Å^{-1}. To increase resolution, an analyzer system was used for several reflections with small $Q_\perp$ values. A Si (220) analyzer crystal was placed 700 mm from ϕ-center, with a 0.5 mm-wide receiving slit 200 mm from the crystal. The momentum resolution in this system is less than 0.01×10^{-2} Å^{-1}.

Using a 5D indexing scheme, the 2-fold symmetry

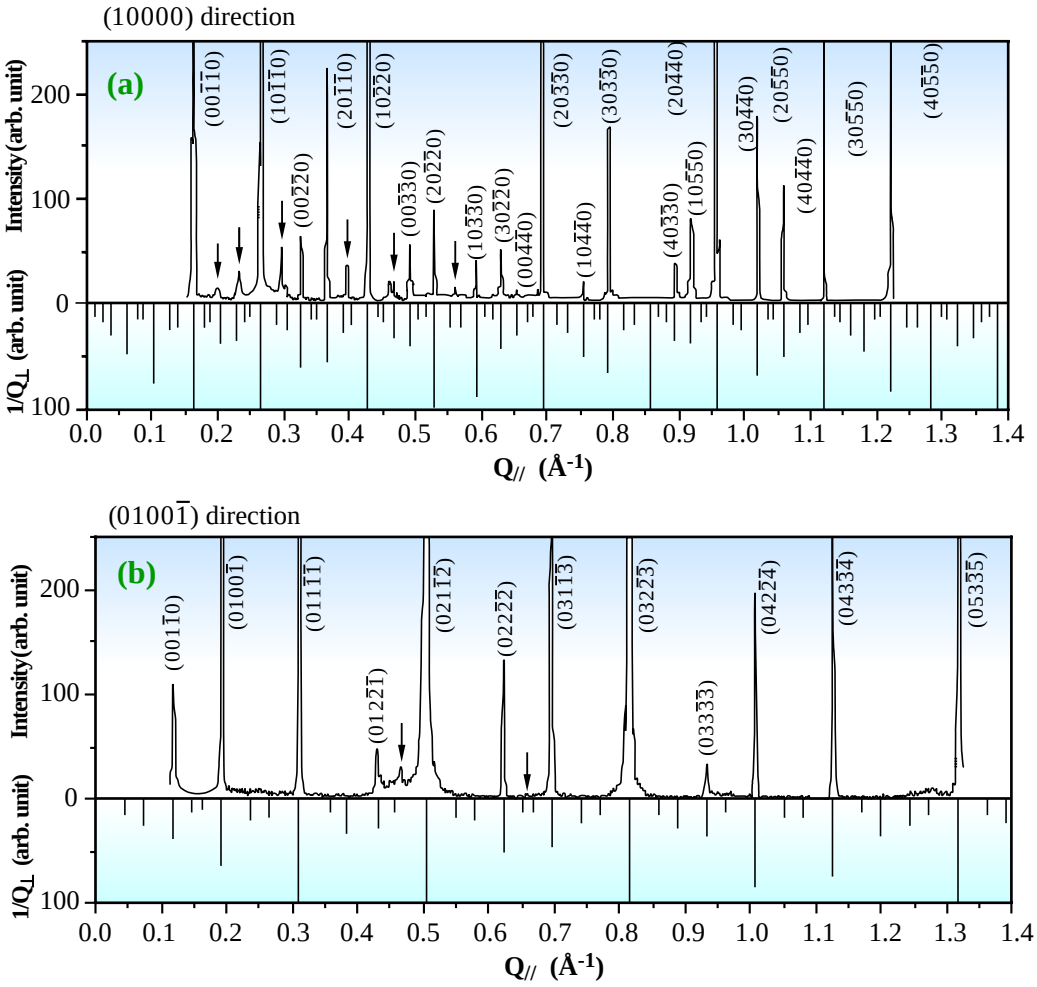

*Fig. 1. X-ray diffraction patterns along the (10000) and (01000) directions (**(a)** and **(b)**, respectively), and calculated peak positions.*

axes in the quasiperiodic plane are designated to be (10000) and (01001̄) . Figure 1 shows the X-ray diffraction patterns along the (10000) and (01001̄) directions and their calculated peak positions, calculated using a five dimensional (5D) lattice parameter of A_{5D} = 0.6333 nm. This value was estimated from three strong peaks indexed as (10$\bar{2}\bar{2}$0), (20$\bar{3}\bar{3}$0) and (30$\bar{5}\bar{5}$0). Most peaks are very sharp and indexed as the decagonal phase, except for some weak peaks indicated by the arrows. Since these unindexed peaks are located at the center of calculated peak positions, they appear to be superlattice reflections. Shifts from the ideal Bragg peak positions were estimated, and no notable peak shifts were observed. Figure 2 shows typical peak profiles along the L-direction for the (10$\bar{1}\bar{1}$0) reflection obtained with and without the analyzer spectrometer. The FWHM along the L-directions are plotted against $Q_{//}$ and $Q_{\perp}$ in Fig. 3(a) and 3(b), respectively. Solid and open circles indicate reflections along the (10000) and (01001̄) directions, respectively, obtained without the analyzer, while solid squares represent reflections along the (10000) axis obtained with the analyzer. These data show that FWHM along the L-direction increases linearly with increasing $Q_{\perp}$. This means that the $Al_{70}Ni_{10}Co_{20}$ decagonal phase exhibits random phason strains.

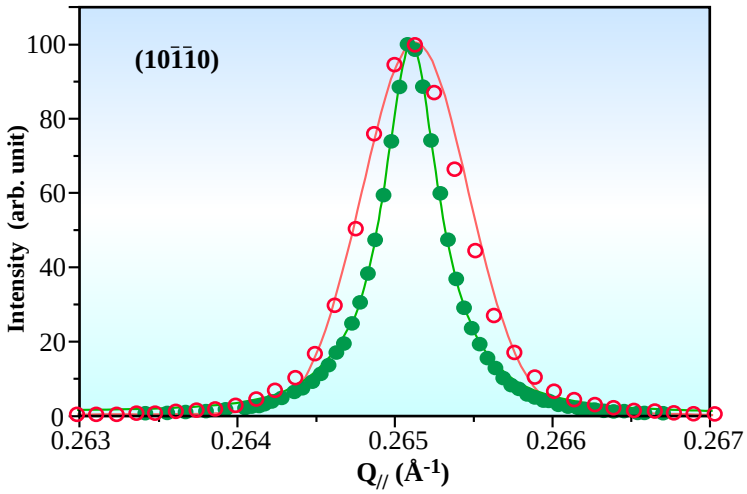

Fig. 2. Peak profiles along the L-direction for the (10$\bar{1}\bar{1}$0) peak. Solid and open circles indicate data obtained with and without analyzer, respectively.

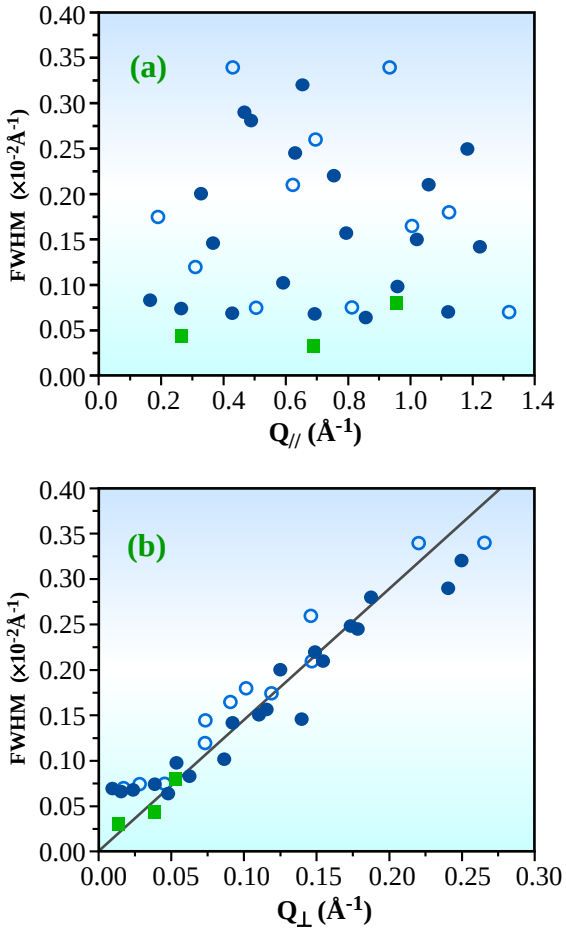

*Fig. 3. FWHM versus $Q_{//}$ **(a)** and $Q_{\perp}$ **(b)** along L-direction. Solid and open circles represent the (10000) and (01001̄) directions, respectively. Solid squares indicate reflections in the (10000) direction obtained with the analyzer.*

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