High-resolution X-ray Diffraction Study on Artificially Grown Quasi-periodic Superlattices

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Artificial superlattces have been proposed by Esaki and Tsu.[1] Superlattces have been realized by progressing the crystal growth technique, such as molecular beam epitaxy(MBE). Moreover, precise control by one atomic layer could be achieved by monitoring the total reflection intensity of RHEED(Reflection High-Energy Electron Diffraction) patterns.

Terauchi *et al*.[2] have reported low and high resolution X-ray diffraction patterns of one dimensional quasi-periodic superlattices such as Fibonacci lattices. In this experiment, we carried out the diffration measurements of the Fibonacci superlattice which have been measured in Photon Factory, Tsukuba. The sample consisted of alternating layer of 28Å-thick GaAs , 28Å-AlAs and 28Å-$(Al_{0.5}Ga_{0.5}As)$ to form one-dimensional Fibonacci series with order of 14 and total thickness was 27000Å.

X-ray diffraction measurements were performed at BL02B1 with monochromatized radiation of 35keV. The synchrotron was operated with the ring currnt of 20mA. Figure 1(a) shows the X-ray diffraction profile of just lower side for GaAs 004 ($2\theta=14.414°$, not shown in the figure). Peak span between two intense peaks is specified as q_0/τ^3,where $q_0=a_0/5$ (a_0 is the mean lattice parameter) and t is the golden rule, 1.618. Weaker peaks are also specified as a same manner, q_0/τ^m, m=4,5,... . Figure 1(b) shows the precise scan of the shaded area shown in the figure 1(a). X-ray diffraction pattern looks like the figure 1(a). These peak spans are also characterized by the same manner.

In point of evaluating of the optical system and diffractometer, small span of 0.05° between superlattice reflection can be resolved clearly. On the other hand, the signal qulaity of the spectra almost the same as that taken in

BL-4C, PF with 200 seconds. From the peak intensity, flux of the incident beam was estimated10 times stronger than that of the bendng magnet source in PF. It is expected that the beam intensity will be increased by 100mA operation and by grading-up the monochromator of the beamline.

References
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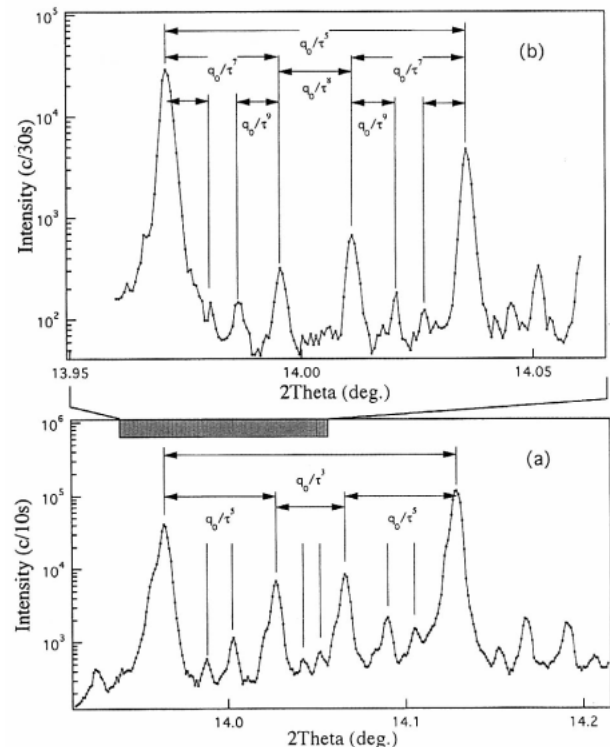
Figure 1 X-ray duffraction profile of Fibonacci superlattice with total thickness of 27000Å. Sapn between peaks are indexed with q_0/τ^m, m=1,2,..