High-resolution microbeam x-ray diffractometry applied to narrow-stripe selective MOVPE grown InGaAsP/InP layers

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Selective metal-organic vapor phase epitaxial (MOVPE) growth of InGaAsP layers on a narrow stripe region (*e.g.* 0.5 to 2 μm wide) along the [011] direction of an InP(100) substrate between a pair of dielectric stripe masks is an attractive methods for fabrication of photonic integrated devices. This is because multilayer thickness, composition, and lattice strain can be varied between different regions of the same wafer by changing only the dielectric mask width, and ideal optical waveguide structure surrounded by (100) and (111)B crystal planes, can be formed automatically without a semiconductor etching process. With this growth technique, however, the lattice strain of the selective MOVPE layers is relatively difficult to control. This is because high-resolution x-ray diffraction (HRXRD), which has a high-angle and/or high-reciprocal space resolution, and is usually used as a strain characterization tool for epitaxial layers grown onto full wafers, cannot be used because of insufficient spatial resolution. Therefore, HRXRD with micrometer-scale spatial resolution is needed.

Recently, we developed x-ray microbeam with low angular and energy divergence by using perfect-crystal x-ray optics with undulator radiation x rays from the synchrotron light source[1]. The low angular divergence and low energy bandwidth of this x-ray microbeam make it suitable for HRXRD measurements. We have applied this x-ray microbeam in the strain analysis of InGaAsP narrow-stripe selective (NS) MOVPE layers on 1.7-μm-wide stripe regions of InP between a pair of SiO_2 mask stripes whose width varied from 4 to 40 μm.

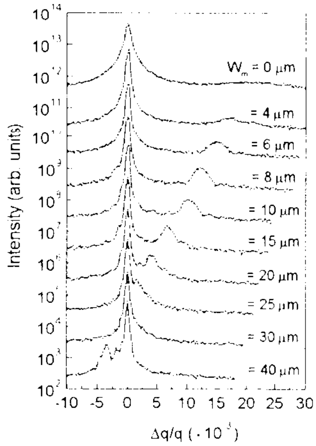

Fig. 1 A series of the rocking curves from the NS MOVPE grown regions and the non-selective growth region (W_m = 0 μm).

Figure 1 shows a series of the rocking curves from the NS MOVPE grown regions and the non-selective growth region of the sample. The rocking curves revealed clear peak shifts in the InGaAsP layers from the higher angle side to the lower angle side of the substrate peaks as the mask width increased. Analysis of the rocking curves enables precise strain determination, which is very important for making a well-controlled waveguide structure with excellent crystal quality.

Reference

[1] S. Kimura et al., *SPring-8 Users Experimental Report No. 3* (1999), p. 298.