Development of a High-Angular-Resolution Microdiffraction System for Reciprocal Space Map Measurements

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X-ray reciprocal space mapping is a powerful method for characterizing the strain status of strained thin layers because the variation in orientation of the crystal planes (mosaic structure) can be distinguished from the variation in lattice spacing. This method becomes much powerful with using x-ray microbeam. We therefore developed a new high-angular-resolution x-ray microdiffraction system.

The new diffractmetor is setup at the BL46XU of the SPring-8 (Fig. 1). A phase zone plate is employed for a focusing device. A narrow slit is placed in front of the phase zone plate in order to partially irradiate the zone plate. This realizes the focused beam with small size and small angular divergence. The beam size and angular divergence are measured to be 1.0 μm × 2.8 μm and 60 μrad, respectively at an x-ray energy of 15 keV. The sample stage consists of high precision stepping motor driven stages including θ-2θ rotation stages and XYZ linear stages.

We demonstrated that the local strain and the crystallinity of SiGe layers can be analyzed using this system. Figure 2 shows two-dimensional reciprocal-space map around the Si 004 and SiGe 004 diffraction spots. The profile of the SiGe 004 peak, broadened along the Q_x direction, consists of several small peaks. This result indicates that submicrometer-sized crystal domains exist in the SiGe layer.

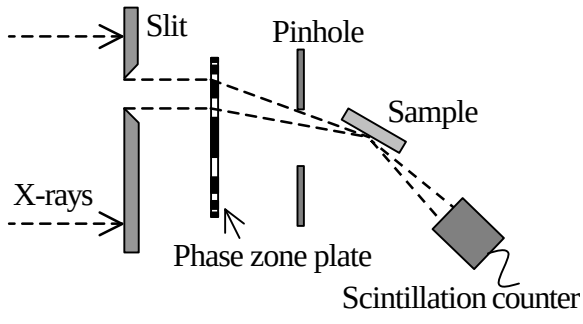

Figure 1. Top view of the system used for X-ray microdiffraction.

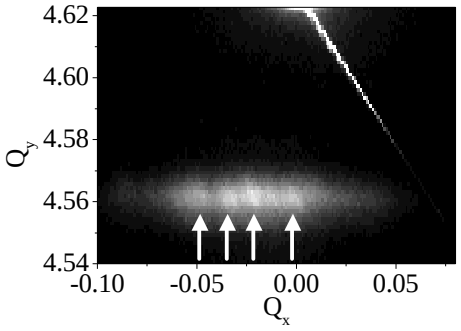

Figure 2. The reciprocal-space maps around the Si 004 and SiGe 004 spots of samples.