PS-11.02.20 X-RAY SCATTERING TOPOGRAPHIC OBSERVATION OF MIGRATION ENHANCED EPITAXIAL GROWN GaAs LATTICE-MISMATCHED HETEROEPITAXIAL LAYERS ON Si
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X-ray scattering topography, which the present authors proposed, has been successfully applied to lattice-mismatched heteroepitaxial layer systems, an MBE (molecular beam epitaxy) grown InAs on GaAs, MO-CVD (metal-organic chemical vapor deposition) grown GaAs on Si and InAs on Si, of which systems have crystal mosaicities which give a local rocking curve of X-ray diffraction as broad as several hundreds arc sec. Since, for such a locally imperfect crystal, conventional X-ray diffraction topography (e.g. Langer images) provides little significant information, X-ray scattering topography has been applied to characterizing lattice-mismatched heteroepitaxial layer systems. Microcomputer-assisted X-ray scattering topography has enabled us to observe a quantitative orientation distribution. And crystalllographical correlation between the epilayer and substrates have been also discussed.

The result of MO-CVD grown GaAs on Si indicated the following. The bending was concave. The bending mechanism is determined by the difference in thermal expansion coefficients between the epilayer and the substrate. It was proposed that close motion of misfit dislocation may cause the anisotropic lattice bending of the epilayer. In this congress we report the X-ray scattering topographic observation of MBE (migration-enhanced epitaxy) grown GaAs on Si. The structure revealed were different from that of MO-CVD grown GaAs on Si. One of the feature of MBE growth method exists in comparable lower growth temperature and the method made an epilayer with lower dislocation density. It was found that the epilayer and the substrate have lattice isotropically concave bend 3-4 arc min and 2-arc min, respectively, in a specimen of 10x2 mm² dimensions. Comparing the results of the previous MG-CVD grown GaAs on Si system, the epilayer and the substrate were concave bent with 5-arc min and 2-3 arc min, respectively, of which lattice was bent around the different direction between the epilayer and the substrate. It is suggested that on account of lower temperature growth the MBE grown epilayer layers are smaller bending, and that amount of defects and motion of defects are smaller than those of MO-CVD grown one.

References


The surface structure of vapour deposited InSe films was observed by recording various images using a Scanning Tunneling Microscope. A thorough study of these images revealed that these films deposited at room temperature are amorphous. A columnar type of growth consisting of numerous flakes, arranged one after another with thickness around 40 Å and height around 300 Å was observed.

The growth direction is normal to the substrate. The column of flakes are in turn arranged step wise as shown in the figure.

X-ray diffraction intensities have been recorded and structure of these has been studied using radial distribution analysis technique. Inter atomic peaks are observed at values equal to 2.70, 3.80, 4.40, 5.30, 6.60, and 7.20 Å. The structure at r = 2.70 Å and r = 4.40 Å very nearly satisfies the ratio for a regular tetrahedron (r₁ = 0.612r₂), r₂ = 2.70 Å corresponds to the In-Se and r₁ = 3.80 Å corresponds to In-In bond length, r₁ = 4.40 Å corresponds to Se-Se distances. The effect of annealing for different duration on the structure of the film has been investigated and it is found bond distances progressively approaches towards their corresponding crystalline values.


X-ray standing waves (XSWS) and scattering along the surface normal (XSASn) were used to determine the atomic structure and stoichiometry of CaSrF5/GaAs(111) and CaF2/ GaAs(111) heteroepitaxial interfaces at a synchrotron radiation source. Lattice-matched CaSrF5 alloy films on the As surface of GaAs(111) have a high crystalline order with a first F monolayer missing at the heteroepitaxial interface. (Ca, Sr) atoms are located in the F sites on top of the first-layer As atoms with little random disorder in the vertical direction. Least-squares fits of the XSASn data favored missing first-layer As atoms (R[mis]) model with As atoms shifted to the stacking-fault high sites (T[shift] model). The As-Ga double layers in the interface region are relaxed to the outward direction.