Poster Presentation

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Evolution of Epilayer Tilt in InGaAs Metamorphic Buffer Layers Grown by HVPE

K. Schulte[1], T. Kuech[1]

[1]*University of Wisconsin-Madison, Department of Chemical and Biological Engineering, Madison, USA*

Tilt behavior in InxGa1-xAs metamorphic buffer layers (MBLs) grown by hydride vapor phase epitaxy (HVPE) was measured by high resolution x-ray diffraction (HRXRD). Step- and continuously-graded structures were grown on exactly (001) oriented GaAs substrates as well as on substrates with a miscut of 4° → (111)B of (001). Growth temperature and final In composition were varied as well. HRXRD Ω-Φ mapping was employed to independently resolve both the magnitude and direction of tilt as a function of depth throughout each structure. Tilt azimuth was initially random in growths on nominally (001) oriented substrates and changed as grading continued, moving closer to [110]. Tilt magnitude increased more linearly and to larger values as a function of xInAs in the step-graded vs. continuously graded samples. MBLs grown on 4° miscut substrates tilted in the opposite direction of the miscut surface normal, and the tilt magnitude for a given xInAs was greater than for planar samples. When the tilt vectors of the miscut samples were resolved along the orthogonal [-110] and [110] directions it was found that the tilt was much stronger along the direction that the miscut was aligned, or [-110]. Tilt in the planar samples increased monotonically and to larger magnitudes along [110] compared with [-110]. The behavior on miscut samples can be attributed to the preferential generation of dislocations on slip systems which experience a larger resolved shear stress due to the miscut [1]. The tilt anisotropy in planar samples can be attributed to the fact that dislocation cores and core energies in III-V semiconductors are also anisotropic [2]. Dislocation nucleation along [110] has a higher activation energy, so a larger proportion of dislocations is likely generated by multiplication sources, creating arrays of dislocations possessing the same burgers vector. Dislocation distributions in samples grown at high temperature were found to be more uniform, overcoming these barriers.

[1] *J.E. Ayers, S.K. Ghandhi and L.J. Schowalter, Journal of Crystal Growth, 1991, 113, 430-440,* ***[2]*** *S. Oberg, P.K. Sitch, R. Jones, et. al., Physical Review B, 1995, 19, 138-146*

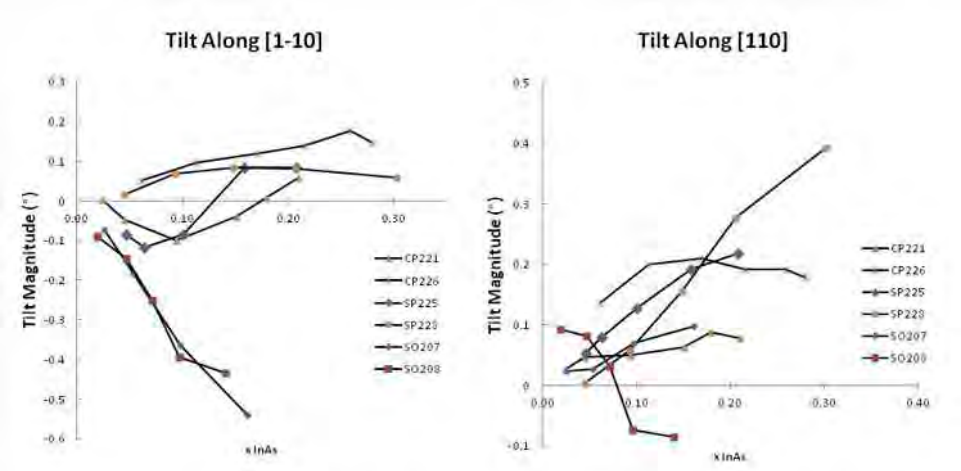

Figure 1 – Tilt along [-110] (left) and [110] (right) for a series of HVPE-grown InGaAs metamorphic buffer layers as a function of x in $In_xGa_{1-x}As$. x is depth dependent in these forwardly graded samples, with x = 0 at the substrate buffer interface, increasing linearly up to the surface. The first letter in the sample name, C or S, indicates a continuously-graded or step-graded sample, respectively. The second letter, P or O, indicates a sample grown on a planar (100) substrate or a substrate with a miscut of 4° -> (111)B off 100, respectively.

Keywords: dislocations, III-V semiconductors, Vapor Phase Epitaxy