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Names and affiliations of applicants (* indicates experimentalists):

Dr A Babkevich, Oxford University, Physics Department

Prof Roger A. Cowley, Oxford University, Physics Department

Report:

GaSb p-n junctions grown on <001> GaAs have been studied for both on-axis and 2.5^0 mis-cut off axis substrates. The photovoltaic behaviour of the junctions has been characterised and in all cases the devices grown on the 2.5^0 mis-cut substrates displayed superior performance. Since the performance is related to the dislocations, x-ray masurements have been made to compare the dislocation stucture in the GaSb layer for both the mis-cut substrates and the on-axis substrates [1].

The lattice mis-match between GaAs and GaSb is large and about 7.8%. We earlier reported [1] that for on-axis growth the mis-match is largely taken up by two orthogonal arrays of Lomer dislocations with a spacing of about 56Å along the [110] or [1-10] directions. These dislocations are localised within about 50Å of the GaSb-GaAs interface. A small amount of the mis-match was taken up by 60^0 dislocations that arise from the intial island growth of the GaSb layer. These latter dislocations can then propagate through the thicker GaSb layers and presumably dominate the electrical properties.

Four layers were grown with the substrates mis-cut by 2.5^0 and with thicknesses of 100Å, 200Å, 600Å and 1000Å. Each sample was then aligned at room temperature on the diffractometer at BM28 operated in a triple crystal mode with germanium monochromator and analyser. The samples were aligned so that the vertical scattering plane contained the (004) and (110) directions, and detailed measurements were performed particularly around the (004) Bragg reflections.

Scans along the [100] direction through the main GaSb and GaAs Bragg relections showed sattelite reflections displaced from the Bragg reflections by 0.11, 0.22 and $0.33Å^{-1}$ corresponding to scattering from a regular array of Lomer dislocations as observed for the on-axis samples. A comparison of the results from the off-axis samples with those obtained from the opn-axis samples showed that the main differences were:

1. The reflections from the GaSb and from the GaAs were relatively displaced by $0.0134Å^{-1}$.
2. The scattering on the GaSb layer was about 5 times larger than that from the GaAs layer showing that the dislocations perturb the GaSb more than the GaAs unlike the results from the on-axis samples.

These results can be understood as a result of the off-axis cut. The displacement of the Bragg reflections arises from the different angle, 0.19^0, of the GaSb planes and the GaAs planes due to the different atomic sizes at the interface. The spacing of the steps of a/2 on the GaAs surface is 77Å which is approximately 4/3 the spacing between the dislocations. Many of the dislocations are then pinned by the substrate. The second difference shows that the Lomer dislocations are localised in the GaSb rather than in the GaAs. This is because they are pinned by the steps on the GaAs surface and so do not have the need to penetrate into the substrate.

A small amount of the mis-fit is taken up by island formation for the thinner samples but then the thicker GaSb layers become a mosaic crystal. The width of the mosaic spread depends on the number of dislocations and for the 1000Å thick layer the mosaic spread is the same, within 10%, as that of the on-axis samples of the same thickness. We therefore find little evidence of a change in the dislocation density in contrast to the measurements of the p-n junction.

The results are being written up for publication

1. A. Yu. Babkevich et al. J. Phys: Condens. Matt. 14 7101 (2002)