XMaS	**Experiment title:** The structure of InSb Quantum Dots	**Experiment number**: 28-01-63
Beamline: **BM 28**	**Date of experiment**: from: 12 July to: 18 July 2000	**Date of report**: 16/10/2000
Shifts:	**Local contact(s)**: Dr. Anne Stunault	*Received at XMaS:*

Names and affiliations of applicants (* indicates experimentalists):

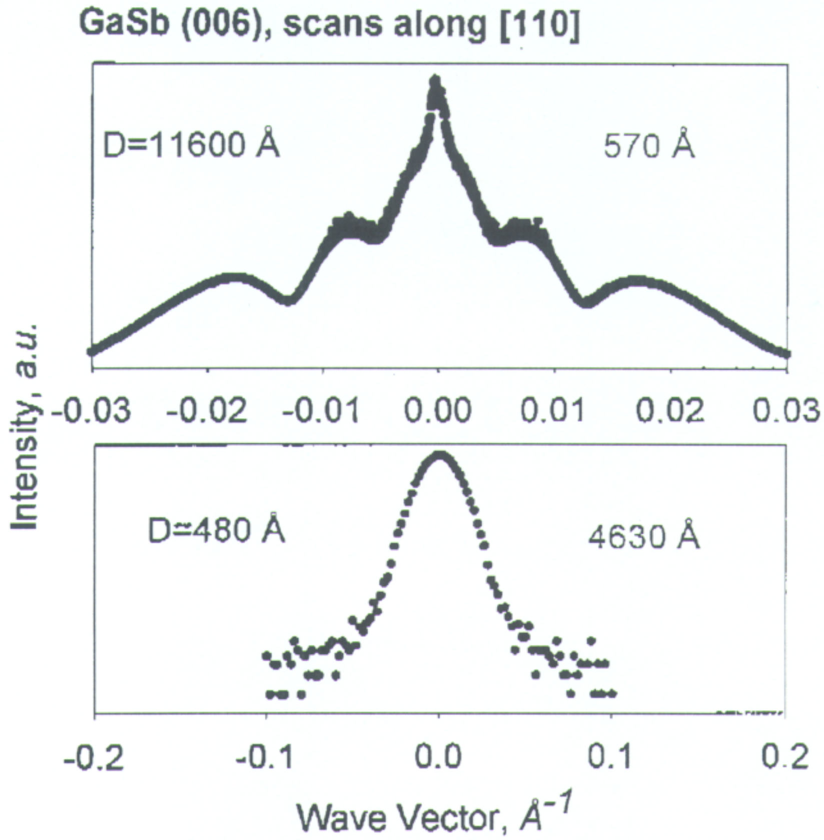
Prof. R.A. Cowley, Dr. A. Babkevich
Oxford Physics
Clarendon Laroratory
Parks Road
Oxford OX1 3PU

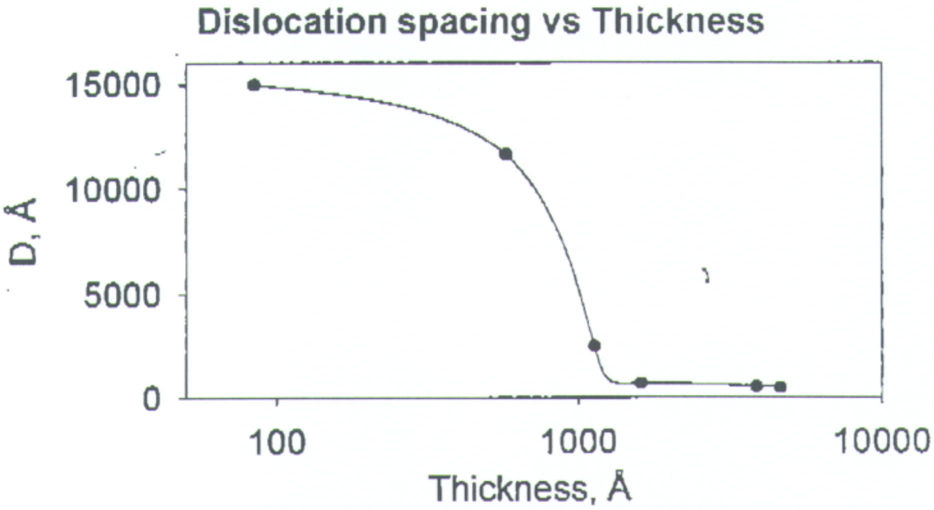
Report:

The experimental efforts were concentrated on a second part of the original proposal due to some technical problems with a MOCVD facility and unavailability of new samples of InSb. Some preliminary measurements were made on Si/Ge wavy superlattices instead of InSb for which we had samples. These showed an indication of scattering from quantum dots which we would like to investigate more carefully in a separate project.

We have measured x-ray scattering from GaSb epilayers grown on InAs substrate with the thickness from 80 Å to 4630 Å. We have studied the x-ray scattering for wave-vector transfers near the (002), (004), (006) and (115) reflections. Scans were performed by varying the wave-vector transfer along the [110] and [001] directions. Thickness of the film, lattice constants of GaSb and InAs and uniform strain were reduced from the measurements.

We have found two stages of lattice relaxation: one with low dislocation density and the other with high density of dislocations. A quick transition between the two regimes is taking place between 1100 Å and 1600 Å and we called it a critical thickness T_{C2} to distinguish it from the critical thickness at which very first misfit dislocations are formed. Below 570 Å the GaSb films are almost lattice matched but scans parallel to the [110] direction already show clear evidence of diffuse scattering typical for systems containing low density of 60^0 dislocations, see a figure. Scans parallel to [001] direction through the satellites shown in the figure reveal a coherence length similar to the film thickness. This means that the 60^0 dislocations cross the whole film and therefore they probably originate from the threading dislocations. An average separation distance between the dislocations D was calculated from





a carefully measured in-plane lattice mismatch $f_{||}$ as $D=b_{eff}/f_{||}$, where b_{eff} is an effective Burger's vector. Variation of D with a film thickness is shown in the figure. A peak aspect ratio ($\Delta q_{[001]}/\Delta q_{[110]}$) for thick (3855 Å and 4630 Å) samples was found to be about 0.34. According to a theory by Kaganer et al. [Phys. Rev. B 55 (1997) 1793] this indicates that in a high dislocation density regime ($T> T_{c2}$) the dislocations are of 60^0 type and the D values calculated from the theory using the measured aspect ratio are comparable to those found from the in-plane lattice mismatch.

A uniform strain shows a sharp increase when the thickness changes from 570 Å to 1600 Å and indicates the first stages of a rapid relaxation taking place between 1100 Å and 1600 Å.