Experimental report form
Proposal HS/1473

Proposal title: "Determination of dislocation Burgers vectors and strain in InGaAs and InP wafer crystals by means of local lattice tilt measurement"

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Participants

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Aims of the experiment and scientific background

The experiment was aimed at investigating the Burgers vector distribution and the residual strain distribution in semiconductor wafers threading dislocations. Wafers with dislocation densities in the range 10^4-10^5 cm^{-2} exhibit large variations of the planarity of lattice planes. Local lattice tilts of several tens of seconds of arc can be detected by measuring the shift of local Bragg angle condition in crystals of large size [1]. The formation of local lattice tilts even in nearly perfect crystals is associated with a distribution of dislocations Burgers vectors. The purpose of the experiment is to confirm the theoretical prediction of the paper.

Experimental method

The measurements has been performed at the ID19 beamline using a vertical Si 111 monochromator to obtain a monochromatic beam. The energy of the beam has been set at 8.5 KeV.

According to the proposal summary two samples have been investigated:

a) a semiinsulating 2 inches (100) oriented GaAs wafers with a threading dislocation density of 10^5 cm^{-2} and

b) a nearly dislocation free S:doped InP crystal (100) oriented.

The sample b) was used as a reference sample. Dislocation free samples should exhibit zero Burgers vector density maps even in the case of curved lattice planes caused by the residual strains.

The symmetrical 004 reflection has been used as the Bragg condition for the two samples.

The FRELON 1024x1024 camera set at a 12 μm resolution has been used as a detector [2]. To investigate the whole surface of the 2 inches wafers fours scans have been repeated with different vertical offsets of the samples. For the purpose of the experiment, the scans have been repeated after rotation of the wafer along the surface normal at 0°, 90° and 180°. Every scan has been made on an angular interval of 0.16° with a step of 0.0015°. Due to the resolution and the 14 bit levels of the FRELON camera a huge 2Gbyte amount of data has been recorded making the numerical analysis quite complex.

Partial results of the investigation are reported

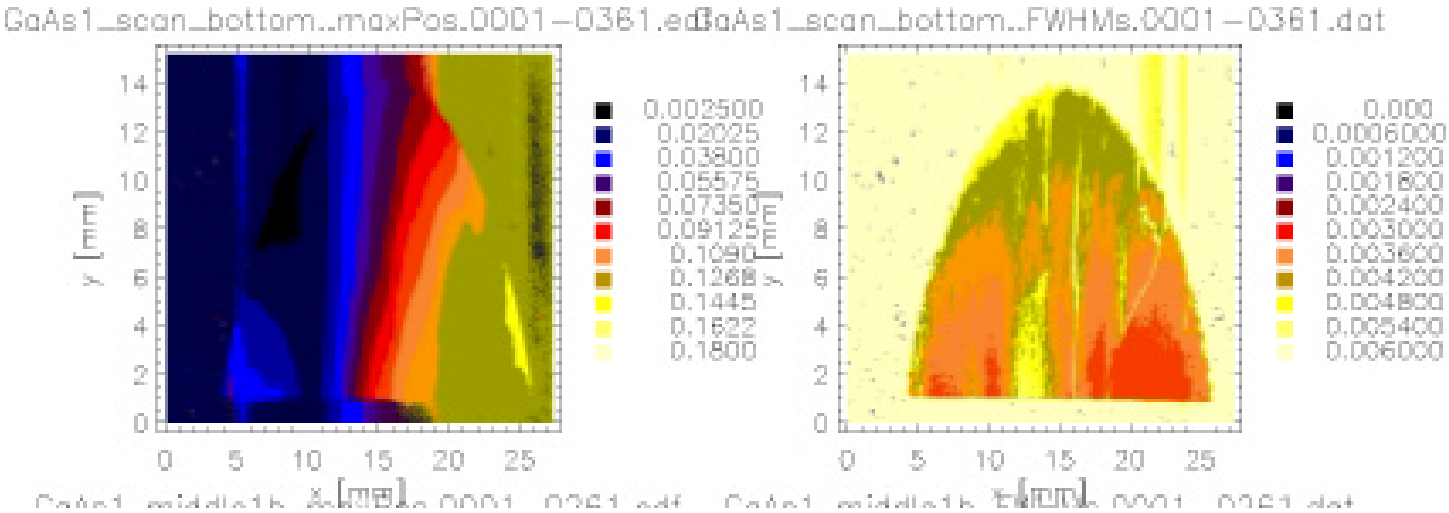

Fig 1: local deviation from Bragg angle of the GaAs wafer. Top part

Fig. 2: full width at half maximum of the Bragg peak. GaAs wafer

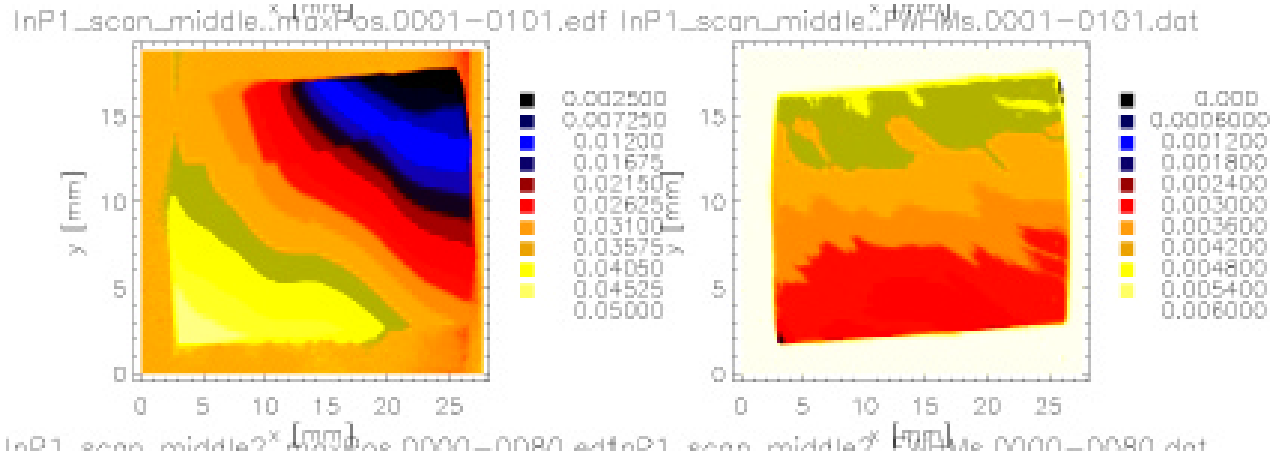

Fig 3: local deviation from Bragg angle of the InP wafer. Middle part

Fig. 4: full width at half maximum of the Bragg peak. InP wafer

To analyse the huge amount of data MATLAB programs are beeing developed. The MATLAB code should be used to merge and to scale the different maps to obtain a single map for the whole wafers. A preliminary analysis confirms the validity of the model [1].

References

[1] C. Ferrari, D. Korytar and J. Kumar, Il nuovo Cimento, V. 19D, N. 2 (1997) 165
[2] D. Lübbert, T. Baumbach, E. Boller, J. Härtwig, E. Pernot, *Nucl. Inst. Method. B* **160** (2000) 521