14.X-1 CHARACTERIZATION OF GRAIN BOUNDARIES AND DISLOCATIONS CORE STRUCTURE BY HIGH RESOLUTION ELECTRON MICROSCOPY. By A. Bourret, J. Thibault and J.M. Penisson, Service de Physique, CEN-Grenoble - 85 X - 38041 Grenoble, France.

High resolution electron microscopy (HREM) has been used to investigate the core structure of grain boundaries (GBs) and dislocations for several years.

HREM technique has a resolution limit of 1.5 Å at 400 kV and is able to image directly the atomic columns parallel to the observation axis. In the simple case where the atomic columns are displaced as a whole around the defects a direct read out of the projected structure can be obtained. This technique is therefore much easier with straight dislocations seen end-on or pure tilt GBs. In more general cases complementary techniques with lower resolution should be used : the weak beam technique or the dark field on forbidden diffraction spots. The accuracy with which atomic columns are located is of the order of one tenth of the resolution limit. However the number of atoms contained in one column is only very approximate and its determination is limited to within 50% error. Planar interfaces such as a GB can be observed along several observation axes contained in the interface plane, thus overcoming the limitations of the poor resolution obtained along the observation axis.

Several examples will be given to illustrate the potentialities of the HREM technique. Firstly the core structure of several dislocation types in semiconductors will be described particularly for dissociated 60° dislocation, the Lomer 90° dislocation and stair-rods. Then the structure of special coincidence twins in germanium and silicon will be described. It will be shown that there is a variety of new structural units in periodic GBs, however they do not contain dangling bonds for a <011> common axis. For high energy GBs splitting into microcrystals is sometimes observed, and the defect content is high.

Secondly the interaction between incoming lattice dislocation and $\Sigma=9$ GB in Si during bicrystal deformation has been studied. It has been clearly established that the GB acts generally as a sink for lattice dislocations. The dislocations enter the GB where they decompose into perfect grain boundary dislocations (GBD's) which Bürgers vectors belong to the DSC lattice. Within the GB the GBD's interact by glide and climb to form new residual GBD's. It has been evidenced that, depending on temperature deformation condition or strain conditions, the climb of GBD's is sufficiently high to lead to the formation of a subgrain boundary superimposed to the initial GB.

Finally pure (001) tilt boundaries have been observed in molybdenum bicrystals. In an out of coincidence low angle boundary, several different structural units are present in a non periodic distribution. Atomic steps are also present. Comparison between experimental and simulated images shows that the core of the primary b = (100) dislocations is empty. In high angle boundaries, structural units can also be observed but only in the boundaries which are not too far from the symmetrical position.

As a conclusion the HREM technique will be compared to the X-ray or electron diffraction technique and its advantages and limitations discussed.

14.X-2 DEFECTS AT INTERFACES AND SURFACES STUDIED BY TRANSMISSION ELECTRON MICROSCOPY. By J. M. Gibson, AT&T Bell Laboratories, Murray Hill, NJ, USA

The structure of interfaces between epitaxial layers and semiconductors has been studied by high resolution transmission electron microscopy. In particular, the introduction of misfit dislocations and other defects which have important effects on physical properties is examined. In-situ studies of molecular beam epitaxy in a transmission electron microscope will also be presented which reveal the dynamic behaviour of these phenomena. The transition from clean surface to buried interface is continuously examined with the penetrating power of the electron microscope.

14.X-3 SURFACE CHANNELLING IN RHEED, REM AND EELS. By J.M. Cowley, L.-M. Peng and Z.-L. Wang, Department of Physics, Arizona State University, Tempe, Arizona, 85287, USA.

In the glancing-incidence, high energy electron diffraction mode, the resonance condition, in which electrons are channelled along the surface planes, plays an important role in the diffraction, imaging and microanalysis if surfaces especially for orientations close to a zone axis. The conditions for the occurrence of this effect are simply predicted by considerations of geometry. The form of the wave field in the crystal, with high concentrations of electrons in the surface atom planes can be derived from many-beam dynamical calculations such as those of Peng and Cowley (Acta Cryst. A42, 545 (1986)). This method of calculations allows investigation of the perturbation of the wave field by defects such as surface steps and so allows predictions of the effects of surface channelling on REM images. From the calculations of wave fields in crystals it is also possible to predict the effects of channelling on secondary signals such as X-ray and Auger electron emission and on electron energy losses.

The EELS spectra obtained in this reflecton mode differ in some respects from those obtained in transmission with shifts of edge positions of about 15eV for heavy metals. For GaAs(110) surfaces the ratio of Ga and As L edges varies with orientation under resonance conditions around the [100] direction but not around the [111].

Acknowledgement: This work has been supported by NSF grant DMR8510059 and DOE grant DE-FG02-85ER45228.