

ones deduced from double crystal X-ray diffraction. Integrated circuits with submicron features are a promising field of application of this technique; the determination of strain profiles in local isolation structures in silicon and their agreement with the corresponding simulated ones will be reported.

MS10.03.04 PRECISION, ACCURACY AND RESOLUTION OF STRAIN MEASUREMENT WITH ELECTRON MICRO-DIFFRACTION. J.M. Zuo, Dept. of Physics and Astronomy, Arizona State University, Tempe, AZ 85287

Electron microdiffraction formed with a convergent beam is capable of probing crystalline strain field associated with mismatching interfaces and grain boundaries in nanometer resolutions. The diffraction pattern formed with disks contains both low order structure factor and lattice parameter information. However, application of electron microdiffraction is complicated by the dynamic effects or multiple scattering in electron diffraction. It has been shown that under weak scattering conditions in a off zone axis orientation the position of high order zone lines (HOLZ) (similar to the Kossel lines in x-ray) can be approximated kinematically. In cases where the choice of diffraction condition is limited by the nature of strain field, for example, edge on orientation in the case of interface, effects of dynamic scattering in the HOLZ line positions need to be estimated and taken into considerations in the simulation. Examples in and off zone axis cases will be given together with the practical applications in semiconductor interfaces. A simple practical procedures in diamond and zinblende structures will also be described. The recent development of 25 micron pixel imaging plates for electrons makes it possible to record whole electron diffraction with sufficient resolution digitally. The pixel registry of imaging plates plus the intensity data make it possible to analyse the whole pattern geometry with sufficient accuracy. Its benefit for the strain measurement will be discussed together with other possibilities with this new detector.

MS10.03.05 MEASUREMENT OF LATTICE STRAIN IN METALS BY QUANTITATIVE CONVERGENT BEAM ELECTRON DIFFRACTION. J. Mayer, C. Deininger, S. Streiffer*, A. Weickenmeier, Max-Planck-Institut für Metallforschung, Seestr. 92, 70174 Stuttgart, Germany, *now at: Dept. of Materials Science and Engineering, North Carolina State University, Raleigh, NC 27695-7907

Lattice strain in metals or alloys is an important factor controlling the performance and failure mechanisms in compound systems. In combination with ceramics or semiconductors, the metal is always the elastically and plastically softer material. Therefore most of the strain is localised within the metal. In such systems, temperature changes lead to lattice strain caused by the difference in thermal expansion coefficients. Convergent Beam Electron Diffraction (CBED) makes it possible to measure lattice strain with high spatial resolution. Strain can e.g. be measured as a function of distance from an interface. We have studied Al thin films on SiC and Si substrates. In particular the latter one serves as a good model system for interconnects in semiconductor devices. The samples were studied in cross-section and plan-view geometry. The CBED patterns were acquired on an energy-filtering Zeiss EM 912 Omega transmission electron microscope. The energy-filter removes the inelastically scattered electrons which increases the accuracy of the measurements and makes possible to study thicker specimen areas. The CBED patterns were recorded at different temperatures to study the effect of the differences in thermal expansion coefficients. The arrangement of the higher order

Laue zone (HOLZ) lines in the central disc was simulated using a fully dynamical Bloch wave program. A refinement algorithm was used to vary the strain state in the simulation until a best fit between the experimental and simulated patterns was obtained. The results indicate that in the thin films strains of up to 0.5% can occur. Strong deviations from a simple equibiaxial strain state were observed in a polycrystalline $\langle 111 \rangle$ textured film. A sensitivity to variations in lattice parameter of approximately 10^{-4} was obtained. Possible stress relaxations in the thin TEM sections will be discussed.

MS10.03.06 MEASUREMENTS OF SPATIAL DISTRIBUTION OF STRAIN IN QUANTUM WIRE STRUCTURES BY COHERENT GRATING X-RAY DIFFRACTION. Qun Shen, Cornell High Energy Synchrotron Source (CHESS), Cornell University, Ithaca, New York

One of the fundamental elements for better understanding and better engineering of nanostructure materials, such as quantum wires and dots, is the knowledge of intrinsic crystalline quality and the state of strain in these ultra small structures. In many cases, the effect of crystal lattice distortion on electronic band structures can be equally or more important compared to quantum confinement effects.

In recent years there are increasing interests in using high-resolution x-ray diffraction to study the structures of these quantum wire and dot arrays. Constructive interference among the wires or the dots within the coherence width of an x-ray beam produces diffraction satellite peaks around each crystal Bragg reflection. This phenomenon of *Coherent Grating X-ray Diffraction* (CGXD) enhances the scattering signal from individual wires or dots, much like the case of large-unit-cell crystallography. The grating x-ray diffraction pattern contains the information not only on geometric surface profiles of the wires or dots, but also on possible imperfections in the array, and crystalline registry with respect to substrate. In addition, the coherent interference within the individual wire or dot can give rise to distinct satellite peak intensity modulations in reciprocal space that are determined by the spatial distribution of the interfacial strain field. Thus this method can provide a way of directly mapping the strain distribution in a quantum wire. It also eliminates or greatly reduces the usual problem of poor strain sensitivity due to the inherent size-broadening in diffraction from small crystals.

We have applied the CGXD technique to various nanostructure arrays, including a series of 10 nm-thick InGaAs/GaAs (001) quantum wire samples, with wire widths ranging from 50 to 300 nm and array period from 400 to 1000 nm. Our measured values of strain in these wires show a substantial increase when the wire width becomes smaller. This result strongly suggests that the strain is the principle cause for the extra blue shifts in the photoluminescence spectra of the quantum wires.