MS10.03.07 QUANTITATIVE ANALYSIS OF WEAK DEFORMATION FIELDS IN CRYSTALS BY X-RAY PLANE WAVE TOPOGRAPHY A.E.Voloshin, I.L.Smolsky, S.S.Sorokin Shubnikov Institute of Crystallography of RAS, Moscow, Russia.

Plane wave X-ray topography has been successfully used for studies and measurements of a weak, spread both elastic and quasiplastic strains in nearly perfect crystalline plates due to high sensitivity to lattice distortions. Such a technique is particularly useful at studying of various inhomogeneities in distribution of impurities. It combines a wide observation area (up to 10 cm^2) with a relatively good locality (1-10 μm) and rather high sensitivity to crystal lattice distortions (up to 10^{-7}-10^{-8}). Quantitative estimation of a distortion field provided by the effective applying of computer image processing tools.

The surface elastic strain measurements by plane wave X-ray topography require only a series of the object images under different diffraction conditions. Number of topographs depends on the dimension of the existing distortion field. These topographs serve also as initial data for the calculations of quasi-plastic strains. A one-dimensional case of the inverse problem of the theory of elasticity was solved providing a direct calculation of quasi-plastic strains in a crystal with weak zonal striations. In two- and three-dimensional cases only the direct problem was solved so the computer simulation of the total deformation state of a body is necessary.

Described technique being illustrated by examples of the analysis of one-dimensionally distributed striations in silicon plate and vicinal sectoriality in (101)-plate of KDP crystal.

PS10.03.08 X-RAY AND NEUTRON DIFFRACTION STRAIN MEASUREMENT DEVELOPMENTS AT ORNL. C.R. Hubbard, T.R. Watkins, K.J. Kozaczek, S. Spooner, X-L. Wang, M.C. Wright, E.A. Payzant, and X. Zhu, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6064.

The Residual Stress User Center at Oak Ridge National Laboratory is a DOE designated User Facility for characterization of macro and micro residual stresses in materials. Flexibility and adaptability are required of the ORNL facilities to meet industrial and academic needs. Stress characterization in thin films, functionally graded ceramic to metal joints, and weldments in aluminum and steel, for example have been conducted. Recent developments to be presented include (1) use of grazing incidence x-ray diffraction methods for subsurface strain measurement in ground ceramics, (2) application of through thickness strain mapping to stresses from welding and casting, and (3) design and initial development of a new neutron residual stress facility.

Grazing incidence x-ray diffraction utilizing near parallel beam optics has been used to characterize changes in the in-plane, near surface stresses in thin metallic films and in ground ceramics using laboratory and synchrotron x-ray sources. Non destructive measurement of subsurface stresses provides a unique capability to characterize stresses introduced via grinding and to study the influence of grinding variables. Results for alumina and silicon nitride ground ceramics will be presented.

Through thickness, macro residual stress mapping in both research and industrial scale specimens is used to develop and validate FEM models for welding, forging, and casting processes. Stress mapping in a 2" thick by 12x12" plate with a multipass weld and in ceramic to metal joints (e.g. 6 mm diam. rods) are representative of the specimen range. New facilities with at least a 10-fold enhancement in capabilities are under development and involve focussing monochromators and an array of position sensitive detectors.

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PS10.03.09 TRIPLE AXIS X-RAY DIFFRACTION STUDY OF POLISHING DAMAGE IN III-V SEMICONDUCTORS. C.D.Moore, I.Pape and B.K.Tanner Physics Department, Durham University, Durham. DHI 3LF, UK

High resolution x-ray diffraction has been performed on single crystals of GaAs and InP which have been polished by various techniques. Chemical techniques include polishing with bromine methanol, hydrogen peroxide/ammonia, and sodium hydrochloride solution with alumina powder. The GaAs samples used the same substrate, whereas the InP crystals were produced by various companies, to show the applicability of this method as a means of substrate screening. A BEDE D^3 diffractometer was used to record triple axis reciprocal space maps, to allow tilt and strain contributions to be resolved. Use of symmetric and asymmetric reflections enabled the depth penetration to be varied and the in-plane and out-of-plane components of strain to be separated.

The FWHM and FW1/50M have been extracted from the maps, and compared, in both the q_y direction (corresponding to lattice tilts) and in the q_z direction (corresponding to changes in lattice parameter). We find that for 004 symmetric reflections the lattice strain normal to the surface does not vary with sample preparation, but the tilt component to the rocking curve varies greatly. In the 224 asymmetric scans, where only approximately the top 1μm contributes to the rocking curve, the strain present in the GaAs is again virtually independent of the polishing technique. The tilt contribution is seen to vary, but less substantially than in the 004 scans. This implies that polishing results in significant damage in the region of crystal below the very top surface, and that refinement of polishing technique serves to remove tilts from the crystal, but does not affect the crystal strains. Triple axis diffraction has thus been shown to provide a quantitative comparison of polishing standards in III-V semiconductor wafers.

PS10.03.10 APPLICATION OF X-RAY SCANNING COMBINED WITH ACOUSTIC WAVES EXCITATIONS TO THE STRAIN STUDIES IN SILICON WAFERS. E.Raitman, E.Iolin, B.Kuvaldin, V.Gavrilov, L.Rusevich, Institute of Physical Energetic, Riga, LV-1006, Latvia

High resolution many crystals X-ray diffractometry is now widely accepted for small strains studying in perfect crystals. However it is partly impractical for the industry because these techniques are complicated and need a lot of time for measurements. Recently [1,2] it was shown that the effects of high frequency acoustic waves (AW) on the X-ray diffraction are qualitatively different for perfect and slightly deformed silicon single crystals. These results were applied to the studies of the strain distribution in industrial silicon single crystal wafers. It has been shown that the quantity R=(Is-Io)/Io is proportional to the value of the static deformation gradient in the many- phonons AW excitation regime (Is, Io are the intensities of the diffracted X-ray beams, when an AW are excited and without AW, respectively). The specific results of such technique application are obtained, namely: a) distribution of strains in the "perfect" plates over the diameter D=120 mm; b) the same on the some wafers after their different finishing treatments; c) distributions of strain around the microwires soldered to the wafer; d) strain distributions inside and outside the windows made in the SiO_2 coating, (a scanning step 0.1mm). The fine structure of strains over the scanning path was observed. It is shown (in general) that the X-ray scanning technique combined with simultaneous AW excitations has sensitivity at least not worse than the traditional ones.

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