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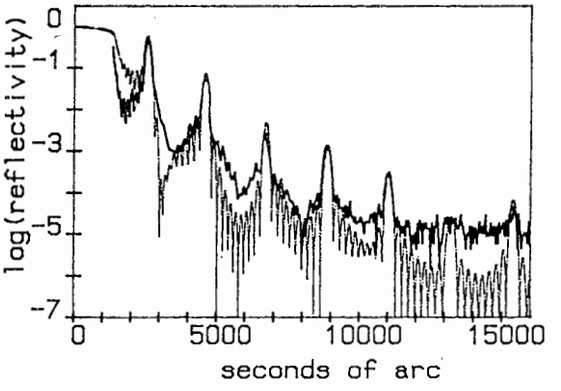
PS-13.02.26 A HIGH RESOLUTION X-RAY DIFFRACTION STUDY OF BIAXIAL STRESS INDUCED BY COSPUTTERED $MoSi_2$ FILMS IN SILICON SUBSTRATES. By Krishan Lal and Reshmi Mitra*, National Physical Laboratory, New Delhi - 110 012, and G. Srinivas and V.D. Vankar, Physics Department, Indian Institute of Technology, New Delhi - 110 016, India.

(100) silicon wafers with 1000 Å thick cosputtered molybdenum - silicon films have been investigated before deposition, just after deposition and after rapid thermal annealing. Biaxial stress, σ, was determined from curvature measurements (LAL, GOSWAMI, WURFL AND HARTNAGEL, 1990, *J. Appl. Phys.*, **67**, 4105-4113) by employing a double crystal X-ray diffractometer designed and developed at NPL. Diffractometry and topography was used to monitor crystalline perfection of substrate crystals (symmetrical Laue geometry; (+,-) configuration). We chose blank wafers with a range of radii of curvatures (33m to 250 m). For determining the value of biaxial stress in wafers with deposits, curvature of blank wafers was taken into account. A typical value of σ is 9.0 x 10^9 dyn/cm^2 (compressive) for as - deposited films. The wafers with higher initial bending showed higher values of stress. Deposition led to degradation of perfection. Distribution of stress was investigated by recording stationary topographs at different orientations on the diffraction curve.

Rapid thermal annealing at 1000 °C for 4 min formed $MoSi_2$ phase. It led to notable relaxation of stress. A typical value of σ is 2.63x10^9 dyn/cm^2 (tensile). Annealing improved the degree of crystalline perfection. The final value of stress is lower for blank wafer with small bending.

PS-13.02.27 LOW ANGLE X-RAY DIFFRACTION STUDY OF Mo-Si MULTILAYERED STRUCTURES. By #C. Bocchi*, #C. Ferrari, #L. Lazzarini,°G. Leonardi and °L. Tullii; #MASPEC Institute, via Chiavari 18/A-43100 Parma-Italy; °Ce.Te.V. (Vacuum Technology Centre)-67061 Carsoli(AQ)-Italy.

Multilayer structures containing alternating layers of high and low atomic number elements, have recently became very interesting due to their applications in soft X-ray optics such as spectroscopy, X-ray lithography, astronomy and synchrotron research. A quantitative structural characterization of the multilayers can be achieved by Low Angle X-Ray Diffraction (LAXRD). This powerful technique provides nondestructively detailed informations about the multilayer periodicity, the thickness of the individual layers and the interface roughness. The above informations can be derived by comparing the experimental diffraction profile and that calculated on the basis of an optical theory in which the scattering from the whole structure is calculated recursively, adding sequentially the reflectivity of each interface (J.H. Underwood and T.W. Barbee,Jr., Appl. Optics, 1981, 20, 3027-3034). This communication deals with a LAXRD and transmission electron microscopy (TEM) investigation of Mo-Si multilayers prepared by Ion Beam Sputtering (IBS). The IBS technique permits an extremely controlled deposition to be achieved in which the mass of deposited material is proportional to a previous calibrated deposition time; however, quartz crystals are also used to monitor in situ the amount of deposited material. Fig.1 shows an example of low angle x-ray diffraction profile of a Mo-Si 10 periods multilayer. The better simulation (dashed-dotted line) of the experimental profile (full line) has been obtained by assuming asymmetric graded interfaces and a root-mean-square deviation of the interface atoms from the perfectly smooth plane of 0.6 nm.



PS-13.02.28 STRAIN MEASUREMENTS IN MISMATCHED SEMICONDUCTOR CRYSTAL HETEROSTRUCTURES. By C. Bocchi, C. Ferrari* and P. Franzosi; MASPEC Institute, via Chiavari 18/A-43100 Parma-Italy.

Strained semiconductor heterostructures are of considerable interest in device application because of the possibility of modifying the electronic or the optical properties of the semiconducting material, as in the case of InGaAs/GaAs based heterostructures. The measurement of the difference Δθ of the Bragg angles of the structure by means of high resolution diffraction techniques is a well established method for determining the parallel ε and the perpendicular ε strain components of the layers with respect to the interface.

This work is aimed at showing the best experimental conditions for allowing accurate measurements of both strain components. For CuKα X-ray wavelength the 117 and 335 reflections are much more sensitive to the perpendicular and the parallel strain components on 001 oriented substrates than the usual 004 and 115 reflections. The lattice plane tilting due to the tetragonal deformation are seen to introduce a systematic deviation if the Bragg angle difference

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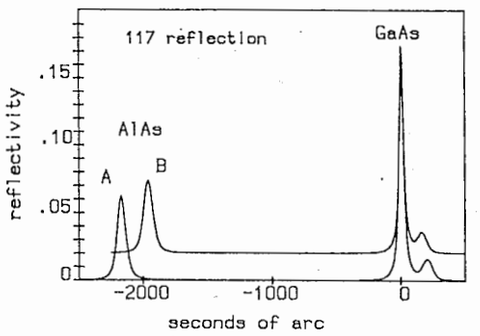
is measured in the θ–2θ geometry on asymmetric planes. On the contrary the open window detector geometry, though affected by a higher diffuse scattering, is not affected by the lattice tilting.
For large values of the splitting angles Δθ, exact formulae are derived for the calculations of the components of the strain.
As an application of the method accurate measurements in fully strained and partially relaxed AlAs/GaAs and InGaAs/GaAs heterostructures are presented. From these measurements the AlAs lattice parameter and Poisson ratio are obtained.



CuKα 117 diffraction profiles of a GaAs/AlAs/GaAs heterostructure. The small peak on the right side of the GaAs substrate peak comes from the strained GaAs 1 μm thick cap layer.

PS-13.02.29
CHARACTERIZATION OF SI-TASI$_2$ *IN SITU* COMPOSITES BY SYNCHROTRON WHITE BEAM TOPOGRAPHY. By S.R. Stock(1), Z.U.Rek(2)*, B.M. Ditchek(3), 1) School of Materials Engineering, Georgia Institute of Technology, Atlanta, GA 30332, 2) Stanford Synchrotron Radiation Laboratory, Stanford, CA 94309, USA, 3) GTE Laboratories, Waltham, MA 02254.

Directional solidification of semiconductor-metal eutectic mixtures commonly yields aligned arrays of metallic rods in a single crystal semiconductor matrix. Si-$TaSi_2$ composites are the most promising for device applications such as diodes. Topographic and rocking curve data indicate that these crystals might also be useful as a optical element for synchrotron x-ray beams. The characterization of the (111) oriented wafers was performed using transmission Laue topography, section topography and a double crystal rocking curve. Transmission Laue topography reveals sharp defined topographs of Si wafer and diffuse radial streaks that reflect the symmetry of the Si matrix. The diffuse streaks are characterized by using absorption edges of various filters placed in the incident beam. This study indicates that streaks are due to the diffraction from $TaSi_2$ rods and that the rods have a very strong preferred orientation relative to the Si matrix. Double crystal rocking curves of (111) and (333) reflections are a factor of 20 wider than those of perfect Si crystals. The application of white beam synchrotron radiation and absorption edges of filters to study the texture of the very small volume fraction of the phase of interest will be discussed.

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PS-13.03.01 STUDY ON DEFECT AND STRUCTURE IN A NONLINEAR CRYSTAL OF LITHIUM BORIC OXIDE (LBO). BY Q. L. Zhao*, Y. S. Huang and D. Y. Tang, Fujian Institute of Research on the Structure of Matter, Academia Sinica, China.

The crystal of LBO is a new nonlinear optical material with good SHG (C. Chen, 1987, Intern. Laser Conf., Xiamen, China). It crystallizes in the orthorhombic system (S. Q. Zhao, et al, J. Synth. Crys., 1989, 18, 9—17). The chief defects observed by X-ray topography are the grown-in dislocation, inclusions and the inclusion-induced dislocation. All dislocations run in straight and take the Burgers vectors nearly 80% to be b=<100>,<101> and <001>. The dislocation formation depends closely on the loosed packing of the B—O ring and Li, and on the high movability of a pair of Li atoms in the structural channel along the c-axis from the structural viewpoint (Q. L. Zhao, et al, Acta Phys. Sin., 1992, 41, 272—275). The grown-in dislocations emerged simultaneously on the entrance and exit surfaces on X-ray projection topographs shows a similarity with the stacking fault appearing equal thickness fringes (A. Authier, Phys. Sol. Stat., 1968, 27, 77—93), a set of the interference fringes along a dislocation appear with the number equal to the Pendellösung fringes at the specimen edges. Inclusions are formed via absorbing gas in sphere, trapping flux in the orthorhombic shape believed to be due to the negative crystal growth, and adhering the crystalite in random orientations. With similarity to BBO (Q. L. Zhao, et al, J. Synth. Crys., 1992, 21, 156—160), the inclusion severely induces the dislocation occured either in a dislocation network parallel to the plane of (010) or in the strained layer normal to the b-axis through the same mechanism as the grown-in dislocation. The result indicates that only overcoming the inclusion formation in the growth process will much greatly increase the crystal perfection. Finaly, two experimental evidences, one on measuring the lattice constants shows that the lattice expansion takes place in the a- and b-axis and the contraction only in the c-axis when raising the temperature from 170° to 790℃ and the other on testing the microscopic hardness of (100), (010) and (001) faces shows the smallest hardness only on the (001), strongly prove that such a pair of Lithium atoms in the structure behave high movability along the c-axis possibly due to the largest interatomic spacing between Li if compared with that in other structures. The following growth phenomenon, say the crystalite is used to be adhered seriously on (100), only a few on (010) and never on (001), also provides the supplemental evidence to illustrate the fact that the higher the free bonding density on the face, the greater the possibility on absorbing the crystalite.