11.1-6 XDT-OBSERVATION OF SILICON SINGLE CRYSTALS IRRADIATED WITH ENERGETIC HEAVY IONS, By H. Tomimitsu, Department of Physics, Japan Atomic Energy Research Institute, Japan.

Lattice imperfections in Si single crystals irradiated with different kinds of energetic ions under several specified conditions with the dose of 10^{13}-$10^{15}/cm^2$, have been examined by conventional X-ray diffraction topography (XDT)---Lang's method. The present article summarizes the results of the XDT-observation on those heavy-ion-irradiated Si wafers, in addition to the preliminary results in the case of 150MeV Ni^{9+}- and Cl^{9+}-irradiation (H. Tomimitsu, Jpn. J. Appl. Phys., 1983, 22, L674-L676).

1. Two different types of irradiation effects have been revealed: The very faint, black-and-white contrasts, indicating the concentration of the lattice strains, were observed at the boundaries of the irradiated- and non-irradiated regions, in the case of light ions (66MeV B^{4+}, 70MeV B^{3+}; 100MeV C^{5+}). Besides this characteristic image with much higher contrasts, on the other hand, systematic fringes were observed within the irradiated area and the macroscopic deformation of the specimen crystal were found on the bombardment with heavier ions (120MeV O^{7+}; 120MeV F^{6+}; 150MeV Si^{8+}, 165MeV Si^{8+}; 50MeV S^{7+}, 100MeV S^{8+}, 165MeV S^{10+}, 150MeVCl^{9+} and Cl^{10+}; 165MeV Ni^{9+}; 90MeV Br^{6+}; 169MeV Au^{13+}).

2. The systematic fringes could not be observed in the case of homogeneous irradiation, but were realized by beam-scanning with application of an alternating electric or magnetic field. Thus, the origin of the systematic fringes can be attributed to the inhomogeneity of the ion beam (U. Bonse, M. Hart and G.H. Schwuttke, Phys. Stat. Solidii, 1969, 33, 361-374). Furthermore, the occurrence of systematic fringes seems to be affected by the ion-energy, because the fringes were not observed in the case of 120MeV F^{7+} ions, while they were clearly seen in the case of 60MeV F^{6+} ions.

11.1-7 LATTICE DEFORMATION OF PROTON IMPLANTED BOUNDARY IN SILICON. By K. Biskupska, P. Naumowicz and K. Wieteska, Department of Solid State Physics, Institute of Atomic Energy, 05-400 Swierk, Poland.

Two regions of a silicon crystal were implanted by an inhomogeneous beam of protons with energy 1.0 MeV and 1.6 MeV, respectively. The average dose was 1.10^{17} cm^2. Reflection topographs were taken for various diffraction vectors using a double crystal X-ray spectrometer. Sets of fringes due to the interferences between the beams diffracted by the implanted and non implanted volumes were observed on the implanted areas. Because of the lattice parameter increase in the implanted layer, there are stresses and a tilt at the boundary between the implanted and non-implanted zones. In our case, the X-ray contrast of this boundary had a complicated structure. Series of topographs taken at different points on the rocking curve in the $/3_1$-3/ setting for CuKα radiation were taken. The contrast under observation depended on the angular position on the rocking curve as well as on the rocking curve as well as on the sign of the $\bar{n}_n\bar{n}_t$ product, where $\bar{n}_h,\bar{n}_t$ are unit vectors parallel to the spectrometer axis and the axis of the lattice tilt, respectively. In order to apply a step-like model similar to that proposed by Alter et al., (Czech. J. Phys. B35, 158, (1985)), the lattice spacing changes in the implanted parts of the crystal were measured. The rocking curves were taken by simultaneous diffraction from both implanted areas and a perfect part of the crystal.

11.1-8 INVESTIGATION OF HELIMAGNETIC DOMAINS IN ZnCr2Se4 USING NEUTRON AND SYNCHROTRON RADIATION TOPOGRAPHY. J.A. Cooper (1), J. Baruchel (2,3), M. Schlenker (3), and S.B. Palmer (1)

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(Work partly performed at LURE, 91405 Orsay, France)

Neutron diffraction topography is a very direct method for imaging inhomogeneities in the magnetic structure of single crystals, i.e. magnetic domains of all kinds as well as coexistence of phases with different magnetic order, because the local reflectivity for a magnetic or mixed (nuclear + magnetic) reflection involves the local magnetic structure. In fact, it is often the only method available for their observation: this is the case for chirality domains, distinguished by the left- or right - handedness of the helical magnetic structure in the case of MnP and terbium, and 180° (or time-reversed) domains in MnF2 (for a review, see Schlenker, M. and Baruchel, J., Physica, (1986), 137B, 309).

On the other hand, the resolution is much better in X-ray topography, and the two approaches are complementary, specially in those situations where a distortion is associated with at least some of the domains and can therefore give rise to contrast using X-rays.

ZnCr2Se4, a spinel in the paramagnetic phase, takes on, below the first-order transition at the Néel temperature of 20 K, a helical arrangement of magnetic moments around <100> directions. Thus domains are expected, and indeed found, at two different levels: q-domains corresponding to the three possible directions of the propagation vector, and, within each q-domain, chirality domains.

The major incentive for investigating this material is that it was shown, using standard (non-topographic) polarized neutron scattering, that the chirality can be controlled by applying simultaneously an electric and a magnetic field [K. Siratori, J. Akimitsu, E. Kita, M. Nishi, J. Phys. Soc. Jap. (1980), 48, 1111]. This may open the way to a better understanding of the physics of chirality domains, which are observed in other materials (Tb, Ho, MnP) and have very intriguing properties, in particular memory effects, but cannot be steered.

Both types of domains can be directly imaged by neutron topography, and are then immediately characterized, using the satellite reflections: thus for example a 0 0 4-q satellite only shows the domains with propagation vector along [001]. Chirality domains become visible when polarized neutrons with incident polarization along the scattering vector are used.

The q domains correspond to a tetragonal lattice distortion and are thus expected to be visible on X-ray topographs too, but through an indirect imaging process.

Our experiments have shown, at room temperature, the crystal defects, dislocations and growth striations. On going through the para-helimagnetic transition, the phase coexistence was recorded, using white-beam synchrotron radiation topography, both on video tape using the LURE television display system and on snapshot topographs taken with a simple device based on a modified slide projector. The q-domains obtained in the absence of a magnetic field are, in the simpler cases, stripes roughly .3 mm wide, with (110)-type boundaries as expected from elasticity conditions; strong memory effects are observed on successive temperature cycles. With a magnetic field applied during the transition, single q-domain situations are obtained. The chirality domains have been observed using polarized neutron topography, and an experiment involving E and B to control them is scheduled.