16.2-3 A MULTI-PURPOSE γ-RAY DIFFRACTOMETER.

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The design as well as the scientific areas of application of a newly constructed γ-diffraction instrument are presented. The diffraction instrument is designed as a multi-purpose instrument and it is equipped with an Ir-192 source with a half-life of 74 days. The maximum activity of the source is 450 Curie. γ-rays with energies 315.5, 468.1 and 604.4 keV are available for diffraction experiments. The diffraction instrument is suited for the development of monochromator crystals for the neutron spectrometers at the Studsvik Reactor. A hydrolic press for plastic deformation of large single crystals can be mounted on the diffraction instrument. It is in this way possible to perform on-line studies of mosaic distribution functions during plastic deformation. The press can be used to apply a force of 2000 N at temperatures up to 800°C and it is therefore suited for plastic deformation of e.g. Cu and Ge crystals. γ-rays interact only weakly with condensed matter, diffraction experiments are therefore easily performed in pressure cells, furnaces and cryostats. γ-diffraction is therefore a convenient technique for studies of phase transitions in which strain is an order parameter. Furthermore γ-diffraction can also be used for accurate charge density studies because structure factors are measured on an absolute scale and extinction is low compared to X-ray diffraction. Preliminary results showing the diffraction instrument performance will be presented.

16.2-4 HIGH SPEED HIGH ACCURACY BRAGG-SPACING MEASUREMENTS. By M. Hart, Department of Physics, University of Manchester, UK and D. Häusermann, Wheatstone Laboratory, King’s College, London, UK.

A method of measuring differences in the lattice parameter of silicon to an accuracy of 1 part in 10⁶ in two minutes has been developed. The technique uses three symmetric Bragg reflections from two parallel crystals but requires only one standard diffractometer axis, two detectors and one X-ray source. Mechanical stability is achieved by combining monolithic design and elastic axes. These axes are double leaf springs machined out of silicon which are made to flex using a combination of permanent magnets and small dc coils. They are used to control the fine rotation of the sample and third reflecting surface with a reproducible accuracy of one millisecond of arc. Short term thermal stability is ensured by the speed of the measurements and a very simple temperature control. The technique does not require a specialised operator as the measurements are entirely under microcomputer control. Changing the sample is straightforward and only takes a few seconds as the latter is simply held by gravity on a silicon spring. A single key stroke initiates a 30 minutes measuring cycle during which the sample tilt is optimised, measurements are repeated six times and all the data is analysed.

The technique consists of measuring the differences between the angles at which the third reflection occurs for various samples. Three beams of copper Kα radiation are produced from a single source using pinholes and reflected from the 333 planes of the first crystal at the appropriate Bragg angle. When the angular position of the sample is such that its 333 planes satisfy their own Bragg condition, all three beams are reflected a second time towards the third surface, which is cut out of the first crystal. The central beam (T) undergoes a third reflection towards a detector when the angular position of this part of the crystal again satisfies the Bragg condition of the first crystal, whilst the outer beams (D) travel through the windows towards a second detector. The D-beams are used to optimise the sample tilt [Ando, Bailey and Hart. Acta Cryst. A34, 1978. 484-489] and provide a reproducible angular reference during all measurements. When the sample is changed the second axis is reset to the mean centroid of the two narrow non-dispersive double reflection rocking curves and a new angular position of the triple reflection rocking curve is obtained on the third axis. The difference between the Bragg spacings of the two samples is thus uniquely determined by the change in the latter.