Laboratory Notes


A simple automatic cassette for X-ray synchrotron topography

Use of synchrotron radiation for X-ray topography has led to an enormous reduction in exposure times and the possibility of rapid step by step experiments to study such phenomena as dislocation dynamics or magnetic domain wall motion. The rapidly expanding field has been reviewed recently by Tanner (1977). However, even though the exposure time may be as little as a few seconds (and with the advent of X-rays from storage rings this will be reduced even further), the time required to change manually the X-ray plate, clear the experimental area of personnel and open the shutter is typically two minutes. In short, experiments are severely limited if plate changing is not automated.

To promote rapid insertion and withdrawal of the Ilford L4 25 μm nuclear emulsion plates into and out of the diffracted beam a slide projector has been used in reverse as follows. The focusing lens was removed and a hollow brass cylinder was inserted in its place to eliminate X-ray damage to the plastic casing. Each X-ray plate (2 x 2") was mounted in an aluminium frame and placed consecutively in one of the 80 slide slots of a horizontally mounted circular slide magazine. The aluminium frame was necessary to prevent the thin plates from jamming. The loaded projector was then encased in a light-tight black plastic bag and positioned in the experimental area so that an X-ray plate would receive a particular X-ray reflexion when moved into the normal slide projection position. The quartz halogen projection lamp was removed and a lead screen was placed in front of the projector to cover all but the brass tube to avoid fogging of the stacked plates.

The experiment could then be completely automated and controlled remotely from outside the experimental area. Multiple exposures were affected simply by advancing the slide magazine by one. The latter operation took approximately 1½ s, meaning that the exposure time and the plate changing time were of the same order of magnitude. Also, the overall experimental time was greatly reduced as in, for example, a study of magnetic domain wall motion while the magnetic field was increased stepwise. 22 plates were exposed in 15 min, whereas under normal conditions this would have taken approximately 90 min. In this experiment, the time limitation was in the exposure time for the plate.

Because of chemical reaction between the aluminium, nuclear emulsion and developer the plates needed to be removed from the frames prior to development. In future, plastic frames will be used, and the plates developed in their frames.

The device has been used on the synchrotron radiation facility at Daresbury Laboratory and the SRC are thanked for provision of this facility.

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(Received 1 June 1977; accepted 1 June 1977)

Reference


Crystal orientation where the calculated adjustment exceeds the allowed movement on one arc

During the process of crystal alignment, when the calculated adjustment required exceeds the allowed movement on one arc, correction may still be made by rotating about the mounting axis of the goniometer head. A method is described of calculating the adjustments required.

Nomenclature and sign convention are as shown in Fig. 1. The unit vector, u, lies along the crystal axis and its coordinates are described by its projection on the xy plane. Consider u coincident with the z axis when the arcs are at their calculated angles (φ_r and φ_B) for alignment. Rotation of the top arc to φ_r=+17°(L) and φ_B=+2°(R) is shown by the dashed line. The forbidden region is shaded in Fig. 2. Adjustment is possible if and only if the circle described by the rotation of u enters the allowed region. The points of maximum adjustment are the points in the allowed region most distant from the origin, i.e. x_o=±sin φ_r=±15°. The vector u is constrained under a rotation ω about the z axis to a circle in the xy plane. If φ_r max =φ_r=+17°(L) and φ_B max =φ_B=+2°(R) is shown by the dashed line. Correction can be achieved by rotating the vector u about the z axis to a circle in the xy plane.

Fig. 1. The coordinate system used to describe a unit vector along the crystal axis. The sign convention used is 'left is positive' on the top arc while 'right is positive' on the bottom arc since these rotations will move the vector toward the positive axes. (Adapted from an arc diagram supplied by Stoe & Co.)

Fig. 2. The permitted region (x horizontal, y vertical) corresponding to φ_r max =φ_r=+17° and φ_B max =φ_B=+2°(R) is shown by the dashed line. The vector for φ_r=+17°(L) and φ_B=+2°(R) is shown by the dashed line. Correction can be achieved by rotation to the position of any of the four solid arrows, the nearest requiring a movement of 37.5° (anticlockwise) and arc settings of φ_r=+12° and φ_B=+12°.