Precise orientation of semiconductor surfaces by the back-reflection Laue technique

Using a Polaroid camera, we have found that the back-reflection Laue technique allows the determination of crystallographic axes with the precision of 0.1° needed by semiconductor surface preparation.

It has been recently reported (Fewster, 1984) that computer indexing of Laue spots allows the definition of physical surface orientation in the range of 0.1°. The essential difficulty lies in the correct definition of the center of the diagram, which by reference to the distance to the crystallographic axis intersection will give the misorientation angle of the nearest crystallographic plane with the surface.

In III-V semiconductor compounds, this orientation should be as near as possible to a crystallographic plane such as (001) or (111) for liquid-phase epitaxial growth.

The back-reflection Laue technique was widely used since the application of Polaroid emulsion and a fluorescent screen. Looking for a better precision of the observed diagrams, we found that the increase in the distance of the crystal to the film was severely limited by the increase of exposure times, proportional to the square of the distance, and by the overexposure of the central part of the diagram, even when there is a hole in the conversion screen.

Using a fine point focus 0.4 x 8 mm sealed W tube, it is possible to achieve an optimization of the X-ray camera: better mechanical stability of the sample holder (the weight of which in some cases reaches 5 kg), good definition of reference planes and of the direction of incident beam, low 3° emergence angle, well defined 0.4 mm collimators. With these modifications, we get transmitted spots of the incident beam between 2 to 3 mm in diameter; this allows the definition of the beam center within 0.1 to 0.2 mm. A crystal rotation by 180° was used to check and correct these parameters. In the case of a film/crystal distance of 50 mm, the precision of measurement will lie below the 0.1° needed in general by crystal growers.

As a comparison, the diagram of a (111) surface of GaAs is given in Fig. 1 with the 0.75 mm collimator as delivered with the Polaroid XR7 camera.

The modified results appear in Fig. 2: at this level, the original films can be studied using a stereomicroscope with a 10 to 20 magnification to increase the precision in the definition of the center of the incident beam and of the crystallographic axis defined by the intersection of the (110) and (112) zone axes.

A good precision is now possible even for 30 mm distance where exposure times of 60 s are frequent for GaAs or InP surfaces.

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Reference


Crystallographers


This section is intended to be a series of short paragraphs dealing with the activities of crystallographers, such as their changes of position, promotions, assumption of significant new duties, honours, etc. Items for inclusion, subject to the approval of the Editorial Board, should be sent to the Executive Secretary of the International Union of Crystallography (J. N. King, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England).

Dr Masaaki Korekawa died on 14 January 1985 in Tokyo, Japan, at the age of 57. Professor R. Sadanaga writes that he began his crystallographic studies at Kyoto University in 1950 and was appointed in 1955 research instructor in the Mineralogical Institute, University of Tokyo. In 1959 he started his research in the Institute for Silicate Research in Würzburg, Germany, on a scholarship of the Alexander-von-Humboldt Foundation and was awarded in 1969 the degree of Doctor of Science from the University of Tokyo. From 1964 he was research assistant at the Crystallographic Institute, University of Munich, and worked in collaboration with Professor H. Jagodzinski. He was appointed in 1972 Professor and Director of the Institute of Crystallography and Mineralogy and in 1979 Dean of the Department of Earth Sciences, University of Frankfurt. He returned to Japan in 1980 for medical treatment and was unable to go back to Germany. Dr Korekawa achieved an international reputation for his work on modulated structures, especially of plagioclase feldspars.

Professor Alfred Niggli held the post of Professor of Crystallography at the Federal School of Technology and at Zürich University. He had to give up his work a few months before his death because of ill health. It was with his thesis advisor and namesake Paul Niggli that he first became interested in crystalline and molecular symmetry. He gained first prize from the science faculty of Zürich University for his thesis on the role of symmetry in molecular spectroscopy. During the time he spent in Sweden (University of Uppsala) and in America (Pennsylvania State University) he improved his knowledge on structural analysis by diffraction. He was one of the pioneers for the use of electronic computers to apply multidimensional Fourier synthesis with devices which at that time had not gained the title of...