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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 indexation 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.

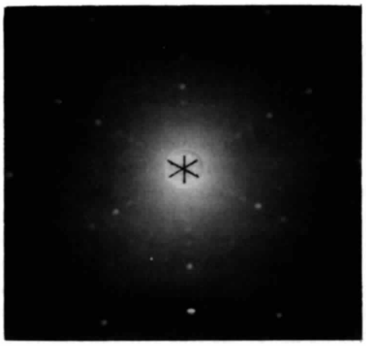

Fig. 1. (111) surface of GaAs. 50 mm crystal–film distance. 0·75 mm collimator.

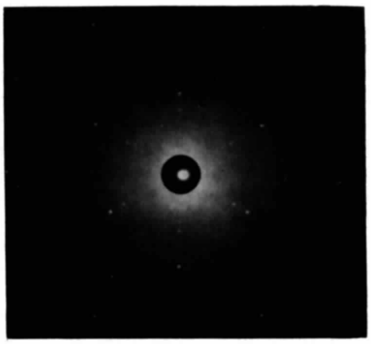

Fig. 2. Same conditions as Fig. 1 except for 0·40 mm collimator.

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 × 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

Fewster, P. F. (1984). *J. Appl. Cryst.* **17**, 265–268.

Crystallographers

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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 1960 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** died on 15 January 1985, aged 63 years. Professor G. Chapuis writes that Niggli was an outstanding personality in the sphere of crystallography and he will be greatly missed.

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 calculators applied to multidimensional Fourier synthesis with devices which at that time had not gained the title of

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computers. It was towards the end of the fiftes and at the beginning of the sixties that Alfred Niggli published with Hans Wondratschek a remarkable work on the generalization of symmetry groups or cryptosymmetry to quote them precisely. Their published works were at the source of a new domain in the field of mathematical crystallography. One can fully gauge their influence as these concepts are frequently used by present day researchers. V. A. Koptsik, author of many fundamental works on symmetry, took me in to his confidence and admitted that he considered Alfred Niggli as his master. An appreciation of this sort on the part of such an emminent author says very much for the significance of Alfred Niggli's work.

Niggli's knowledge of mathematical crystallography led him to close participation in the long elaboration of the new *International Tables for Crystallography* of which the first volume came out hardly a year ago. It must also be said that a good number of his works have remained unpublished, no doubt due to his own modesty. An example of this is a study on partially periodic space groups as well as a generalization of Hermann–Mauguin symbols applied to them.

I came to know and appreciate this generous personality as a PhD student in Alfred Niggli's research group. He was not just a crystallographer but also someone whose vast culture surpassed the title scientist. His knowledge of the classics led to him being called upon not only to appraise the Cantonal examinations in physics and chemistry but also in Latin. His knowledge of modern languages was equally impressive. What a surprise for Swedish guests on an official visit to Zürich to hear Alfred Niggli, then Rector of the University, addressing them in their own language.

Niggli often approached scientific problems with several well chosen words drawn from experiences during his journeys at home or abroad as well as from his activities in service for his country. He was also a music lover endowed with perfect pitch. He never forgot a theme and it is without doubt that this ability enabled him to take apart and analyse musical compositions. He discovered, particularly in Mozart's work, laws of symmetry similar to those one finds in one-dimensional freizes and borders. Some time ago he sent me a document showing some laws of symmetry in the *Jupiter* Symphony. It is today that I am able to estimate the significance of this last message from him. It is above all the radiance of his personality, his affability and his contributions to science that will leave the image of Alfred Niggli engraved in our memories.

New Commercial Products

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IBM-PC-based Multichannel Digital Oscilloscope and Waveform Digitizer

LeCroy has recently introduced **Waveform-Catalyst**, a multichannel digital oscilloscope software package with powerful capabilities for acquisition, display, archiving, and analysis of high-speed waveforms. It is an integrated system consisting of LeCroy's series of modular waveform digitizers, any of the IBM personal computers (PC, Portable, XT or AT) and system software. Characteristics include:

Wideband Performance – Digitizer plug-ins offer bandwidths to 100 MHz and maximum sampling rates of 200 MHz or 5 nsec between points.

High Resolution Recording – The expandable waveform memory of up to 512 K points simplifies capturing signals with uncertain triggers, records signals of long duration, and provides the capability to zoom in on regions of particular interest.

Multichannel, Multi-timebase Operation – Up to 100 digitizers may be housed in benchtop or rackmounted mainframes, each with independent trigger, memory, and time/sample characteristics.

Modular Flexibility – The plug-in architecture permits selection of instrument characteristics, supports future upgrades, and protects against obsolescence.

Friendly, Easy to Use – Catalyst operates like an instrument, not a computer. Single keystroke operating commands and familiar scope terminology make knowledge of computers or programming language unnecessary.

Powerful Display – The high resolution graphics permit simultaneous viewing of up to four "live" or previously stored traces, each with its own timebase and grid. Dual cursors control zoom, positioning, and the absolute differential measurement of time and voltage, while on-screen markers identify the trigger point, zero baseline, off-scale conditions, *etc.*

Programmable Control, Archiving and Analysis – Any graph, instrument setup, or operations sequence can be stored and recalled from disk, or output to a graphics printer. And of course, there is the full power of the PC available for analysis, networking, or other computer operations.

Components for configuring an **IBM-PC-based waveform digitizing system** are described in a new 10 page, colour brochure from LeCroy. LeCroy waveform digitizers consist of a family of mainframe housings into which plug-in digitizers, memories, signal conditioners and controllers are inserted to create an instrument that will meet general or application-specific signal measurement/analysis needs. A choice of three benchtop or rackmountable mainframes is offered, along with a family of high performance waveform digitizing modules. LeCroy's system components are described and illustrated with photos and selection charts for a variety of applications including waveform acquisition, storage, analysis, and display.

LeCroy Research Systems Ltd, Elms Court, Botley, Oxford OX2 9LP, England

Computer-Controlled Guinier Diffractometer System

Huber Diffraktionstechnik GmbH has introduced a new line of **computer-controlled Guinier-type diffractometers.** Three different kinds of samples may be investigated: Flat powder specimens (Model 642), single capillary encapsulated powders or liquids (Model 644), and thin films or anodized layers on solid bulk materials (Model 653). The detector is either a Na(I) scintillation counter tube with a variable entrance slit or a straight position sensitive detector of 50 mm length. Both are positioned by a 500 steps/turn stepper motor. The resolution may be as low as $0.02^{\circ}(\theta)$, depending on sample conditions. There is evidently no distortion due to $K\alpha_2$ or $K\beta$ radiation because of the focusing Johansson-type monochromator crystal. Together with a stepper motor control and a desktop computer, its graphically supported software is well suited for fast profile and phase analysis or intensity measurements for structure determination.

Models 644 and 653 may be equipped with a heater device for temperatures up to 1200 K. For the thin-film instrument 653, an additional rotation around the surface normal provides for the determination of preferred crystallite orientations or textures.

The software makes full use of CRT or matrix-printer graphics, featuring automatic search for diffraction peaks, precise refinement of angle position by a fitting procedure, smoothing of noisy scans, optimization of integration times and three-dimensional plots of diffrac-