low-up letters were sent to those who had not replied on March 23, and April 8, 1977 urging that the questionnaires be filled out and returned, or passed to someone in the department who was more active in teaching. At the end of June when returns essentially ceased, there were 236 replies, representing active groups with over 400 faculty and over 800 research students. While no such survey can ever be complete, this would seem to represent the major portions of the actual activities in this field in the universities and colleges in the USA.

The results are presented in Table 1, and an examination of this summary led to the following observations:

(1) The field is particularly weak in the physics community; there are very few groups, and the equipment is poor. Five schools had graduate courses but the laboratory component was minimal. Only two had breadth in their coverage. Crystallography as a discipline is no longer well represented in physics curricula, despite its past history and new horizons. Only eight of the schools contacted were teaching in the area and only three of the eight were adequately equipped. Staff will be required for the new facilities to develop the equipment and theory needed to optimize their use. There is still time for this community to respond to this need.

(2) The ACA might wish to involve the large activity in the materials community more directly.

(3) The broadest scope of education in the field appears to be available in geology and materials departments.

(4) In the biological and chemical fields, despite excellent available equipment in research groups, there is inadequate laboratory work associated with many courses, and the course content is involved primarily with only structure determination. Students need a broader training, especially since most will undoubtedly work in industrial and government laboratories, where they could be much more helpful if they knew about the vast range of possibilities for information from scattering, such as small-angle studies, particle size, powder work, the specific usefulness of electrons and neutrons, surface studies and the new spectroscopies. Certainly part of the training in structure determination could be carried out informally in each research group, while providing a broader scope for the much larger audience in the classroom. (Such broader courses might even increase the class sizes in these fields.) There are too few courses being offered in biology departments.

(5) There is some weakness in the fundamentals taught in the materials community, as the teaching centers around Bragg's law in scalar form, without reciprocal-space concepts. The training involves many applied topics, such as stress measurement, texture, and analysis, which do seem appropriate because many of the students terminate with a bachelor's degree and are employed in production situations. The more advanced courses are in need of updating, and are perhaps too closely tied to available texts.

(6) There is ample room for developing courses that would be broader in scope (and hence probably of greater interest) if university crystallographers would try to develop appropriate interdisciplinary sequences. Formal departments of crystallography are probably not needed, but the lack of interaction that now exists is surprising. Local interactions could result in joint courses or course sequences with a breadth that does more justice to our entire field. Without such activities we force our students into a narrow mold, which will only deepen the separation of the various aspects of our field in the future, as some of the current students move into the teaching profession.

The questionnaires also indicated that there was extensive training in classical crystallography in geology departments, and good coverage of the powder method and its practical uses, as well as elementary fluorescent analysis in geology and materials. There was some quite brief initial exposure to crystallography and diffraction in many courses in general chemistry and physical chemistry.

The author would like to thank Mrs Kay Jensen for her help in organizing this survey. He also wishes to express appreciation to the other members of the committee for advice and comments throughout this project, (Drs J. Bregman, S. Abrahams, M. Mueller, Q. Johnson, D. Dahm and Professor R. Young).

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(*Received* 3 *April* 1978; *accepted* 17 *May* 1978)

References

Blundell, T. L. & Johnson, L. N. (1976). *Protein Crystallography*, New York: Academic Press.

Cullity, B. D. (1978). *Elements of X-ray Diffraction*. Reading, Mass.: Addison Wesley.

Hirsch, P. B., Howie, A., Nicholson, R. B., Pashley, D. W. & Whelan, M. J. (1965). *Electron Microscopy of Thin Crystals*. London: Butterworth.

Stout, G. H. & Jensen, L. H. (1968). *X-ray Structure Determination, a Practical Guide*. New York: Macmillan.

Warren, B. E. (1969). *X-ray Diffraction*, Reading, Mass.: Addison Wesley.

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, 13 White Friars, Chester CH1 1NZ, England).

Dr **David R. Davies,** Laboratory of Molecular Biology, National Institutes of Health, Bethesda, Maryland, and Dr **Isabella L. Karle,** US Naval Research Laboratory, Washington,DC, have been elected to the USA National Academy of Sciences.

Professor **P. P. Ewald** received the Max-Planck Medal of the Deutsche Physikalische Gesellschaft on 3 July 1978.

Dr **Thomas Rundell Lomer,** Senior Lecturer and Departmental Tutor in the Department of Physics, University of Birmingham, died suddenly and prematurely on 21 July 1978. He is best known for his studies of metal soaps, but has published also on other aspects of crystallography and biophysics. He is survived by his widow and four children.

Book Review

Works intended for notice in this column should be sent direct to the Book-Review Editor (J. H. Robertson, School of Chemistry, University of Leeds, Leeds LS2 9JT, England). As far as practicable books will be reviewed in a country different from that of publication.

Crystal growth and materials. ECCG1, Zürich, 1976. Edited by *E. Kaldis* and *H. J. Scheel*. Vol. 2 of the series: **Current topics in materials science.** Edited by *E. Kaldis*. Pp. xvi + 916. Amsterdam: North-Holland, 1977. Price $122.50, Dfl. 300.00.

As the title suggests, this book performs two functions. On one hand, it is a collection of the sometimes extended versions of 28 invited papers which were presented

at the First European Conference on Crystal Growth, Zürich, 1976. On the other hand it is the second volume of a new series: *Current Topics in Materials Science*. (At the time of writing, the first volume has yet to appear.)

This reviewer freely admits to finding his task a difficult one. In part this is bebecause of the dual purposes intended for the book. The stated aim of the series is to provide 'authoratative reviews on important current developments in the fields of the chemistry and physics of crystalline and amorphous materials. The reviews are designed to cut across the boundaries of the various disciplines, and bridge the gap in time betweeen the original reports and the appearance several years later of extensive monographs'. Such ambitions are generally beyond those of review papers presented at conferences. One can also imagine that the use of this mechanism to produce a book puts constraints on those who attend the conference. While they want to attend, they do not necessarily also wish to subscribe to a book which is supposedly more than the proceedings of the conference. In fact, the majority of reviewers have either concentrated on their own work or produced a review whose scale is more appropriate to a conference.

The papers cover a wide range of subject matter, from, for example, *Theory of the Roughening Transition* by H. Muller-Kumbhaar to the very practical and specific paper, *New Developments in Flux Growth* by W. Tolksdorf. In order to convey, as well as possible, this range of material, a majority of the papers will be mentioned briefly.

A nice cohesion is formed by a group of papers concerned with interface kinetics. G. Gilmer and K. A. Jackson describe their computer simulations of the equilibrium and growth forms of low-index crystal faces. This is an extremely lucid and comprehensive account of their work. Real surfaces on cleaved crystals also have monatomic steps. These may be revealed by decoration techniques. The characteristics of some such surfaces are described and explained by M. Krohn and H. Aethge. The detailed structures of the growing faces of real crystals have been considered by J. B. Theeten *et al*. In this case, the process used was the chemical vapor deposition of GaAs. Stereochemical arguments are used to explain why absorbed complexes are responsible for growth-rate limitation on certain low-index faces. Molecular-beam epitaxy is a related process also used to grow III–V compounds. R. C. F. Farrow has described the techniques and principal features associated with this process. Both the latter two papers discuss some of the multitude of tools now available to the surface scientist. These tools are reviewed by J. A. Venables. In doing so, 31 different acronyms are used. The techniques are compared assuming a reasonable knowledge of them on the part of the reader. It would appear that one must be cognisant of the field to appreciate this work.

Another group of papers is concerned with the fundamentals of nucleation and growth from liquids. There is a very comprehensive review of many results for growth rate as a function of undercooling for a range of materials. These give support to the classical theories for growth mechanisms (I. Gutzow). There is a fresh consideration of nucleation theories and experiments (V. P. Skipov) and a discussion of nucleation and equilibrium forms for mixed crystals (R. Lacmann and P. Schmidt). A major paper in this section is concerned with the capture of inclusions during crystal growth. It is described by A. A. Chernov and T. E. Temkin. Theory and experiment are detailed which illustrate the critical conditions under which foreign particles in the melt may be included by the growing interface.

There is a second collection of papers on growth from the liquid phase. A comprehensive review of transport and kinetic effects in solution growth, with particular emphasis on large-scale industrial applications, is presented by J. Garside. The effects of hydrodynamic flow driven by thermal and solutal density gradients and thermal surface-tension gradients are reviewed succinctly by D. T. J. Hurle. There are also papers on: electrocrystallization (D. Elwell), the melt growth of laser-host-lattice crystals (B. Cockayne) and liquid-phase epitaxy (J. C. Brice). Defects in crystals grown from liquids are covered by two papers. A. Authier considers X-ray topographic techniques, while A. J. R. de Kock is concerned with semiconductor crystal quality. The latter paper concentrates on swirl defects in silicon. A very lucid account of the present evidence and theories on this subject is given. Also included in this section is a paper on the structure and growth of protein crystals (B. K. Vainshtein). The emphasis of this paper is on structure rather than growth.

The final section has the title *Recent Progress in Materials Research and Applications*. This title could obviously include those papers discussed so far, while only a few of the papers in this section would have been out of place at a conference on crystal growth alone. It may be that the section is a concession to the subject area of the series as a whole.

Two papers which do appear to be out of place are *Organic Crystals with Metallic Conductivity* (A. J. Berlinsky) and *Superionic Conductors* (H. U. Beyeler and P. Bruesch). They are otherwise excellent papers.

The new technology of metallic glasses is outlined by J. J. Gilman, while R. L. Parker reviews what we have learned from crystal growth experiments carried out in the microgravity conditions of space. Control of structure in semiconducting devices is discussed by C. H. L. Goodman. This is an area which deserves consideration in that, if the shape of a growing epitaxic interface can be controlled it offers interesting applications. Important at the moment is the production of large-area, low-cost silicon for solar cells. This is covered by both the last-mentioned paper and by J. J. Brisot. Because of the rate of development of this field, review papers are likely to 'date' rapidly.

In conclusion, the papers are generally of a high standard; the depths of their treatments are variable and this is probably due to confusion between the two purposes they were asked to serve; some will come to be regarded as important reviews. It is unfortunate that the price of the book makes it unlikely to be purchased for an individual's private library.

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