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## Editorial

# The origins of the International Crystal Growth Conferences, the International Organisation for Crystal Growth and the Journal of Crystal Growth

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### 1. Introduction

It all started 36 years ago with a conference in Boston, MA, USA. Ichiro Sunagawa recently wrote [1] that prior to this conference, (which was conceived by an enthusiastic young man working on magnetic materials at Harvard University), “The crystal growth community was totally fragmented and had remained as a peripheral field at the mercy of other organisations”. Scientists interested in the science and technology of crystal growth had only sporadic opportunities to report their results and that from only a subsidiary position at meetings of various societies whose principal focus was not on crystal growth.

That first truly international conference devoted exclusively to crystal growth marks the formation of a critical nucleus of a community of those concerned with the theory and practice of crystal growth embracing a vast range of materials from the semiconducting to the biological. It came about principally as the result of the vision and determination of one man—Michael Schieber. His personal account of how this was achieved and how it led on to the establishment of the International Organisation for Crystal Growth (IOCG) and the Journal of Crystal Growth were published in an American Association for Crystal

Growth (AACG) Newsletter [2]. I have drawn heavily on his paper in preparing this text.

Prior to 1966 there had been a few conferences devoted to crystal growth but mostly these were on a national scale. In Russia N.N. Sheftal had organised a series of conferences under the auspices of the Institute of Crystallography of the Soviet Academy of Sciences and these were published and were translated into English under the title “Growth of Crystals” Vols. 1–6 [3]. However attendance at these conferences was essentially confined to member states of the then Soviet Union.

In England a, now famous, Discussions of the Faraday Society took place in Bristol in 1949 at which F. Charles Frank presented a classic paper on the role of dislocations in crystal growth [4]. Under the auspices of the UK Royal Naval Scientific Service, W (Bill) Bardsley organised a series of conferences devoted principally to electronic materials but there were no conference Proceedings. Raymond Kern organised a Colloquium with foreign participation in Nancy in 1965. Amongst its attendees were F.C. Frank, I.N. Stranski, A.A. Chernov, G.M. Pound and I. Sunagawa. The Proceedings were published by CNRS [5].

The most significant conference with international representation to be held prior to the 1966 Boston meeting was the Cooperstown conference in 1958 the Proceedings of which are

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published in the book “Growth and Perfection of Crystals” [6].

Crystal growth was not perceived as a separate discipline. In the Soviet Union it was deemed to be a branch of crystallography. In Germany at that time *Kristallwachstum* (the study of mechanisms and kinetics of growth) was considered as an academic subject properly represented internationally by the International Union of Crystallography (IUCr). The practical side—the production of technically useful crystals (*Kristallzüchtung*)—was held in lower regard (In correspondence with Michael Schieber, Prof. Ewald referred to this coterie as “crystal farmers”). In the USA the division tended to be by class of material with the American Ceramic Society covering growth of refractory crystals and the Journal of the Electrochemical Society embracing the, then new, field of semiconductors.

So, perhaps not surprisingly, Michael Schieber met opposition from many quarters with their own vested interests when he sought to bring together all the disparate fields of *Kristallwachstum* and *Kristallzüchtung*. This opposition is detailed in his article [2]. Fortunately he had had the wisdom to enlist the support of several eminent figures in the field, including Charles Frank in England, David Turnbull, Harvey Brooks, Frederick Seitz and Bruce Chalmers in the USA and I Stranski in Germany. With their help opposition was overcome and compromise reached, notably with IUCr who held a meeting in Moscow just prior to the Boston meeting. Several of the organisers of the Boston meeting pledged themselves to attend the Moscow meeting and report its crystal growth content to the Boston meeting. Fig. 1 records that they kept their promise. Prior lobbying for an international meeting in the USA by Steffen Peiser of NBS (now NIST), though unsuccessful, had helped to provide a favourable climate within the USA. Other key figures in overcoming opposition were Ken Jackson and the late Bob Laudise in the USA, Bill Bardsley in England, Profs. Hausshuhl and Bethge in West and East Germany, respectively and Alex Chernov in the Soviet Union. Jackson and Laudise, both from Bell Laboratories, were also pivotally involved in the organisation of the Conference. Funding was obtained

by Chuck Sahagian of the USAF Cambridge Research Laboratories. (This was the period of the Cold War and much of the work on crystal growth was funded by the military). Additional support was obtained from several corporate and government laboratories on the East Coast.

The Boston meeting, subsequently designated ICCG1, was held on 20–24 June 1966 in a heat wave. It was a great success attracting some 625 delegates. (I still have the list of the names of those delegates). The conference Proceedings were edited by Steffen Peiser and published as a supplement to the Journal of Physics and Chemistry of Solids [7]. The Proceedings record the membership of the various committees.

Michael Schieber had anticipated that the Proceedings would be published as a regular issue of J. Phys. Chem. Solids and would therefore be abstracted and distributed to all subscribers to the Journal. However this did not happen; the Proceedings Supplement had to be ordered separately. Michael wrote [2] “I realized that without organising our own international and interdisciplinary Journal of Crystal Growth, our community, composed of both ‘scientists’ and ‘farmers’ would remain at the discretion of other disciplines for which crystal growth has a secondary importance”.

## 2. The launch of the Journal of Crystal Growth

Michael expressed his views on the need for a dedicated journal to Ken Button of the National Magnet Laboratory at MIT. Button, on a visit to the North-Holland Publishing Company (now Elsevier) in Amsterdam proposed the idea to their Physics Editor, Drs. W.H. Wimmers who agreed to publish such a journal with an Editorial Board comprised of Nicholas Cabrera, Bruce Chalmers and Michael Schieber as Principal Editor. The Journal was launched with commendable speed, Vol. 1, No. 1 appearing in January 1967. Its cover is shown in Fig. 2.

In their editorial the Editors wrote:

“It has become increasingly evident in the last few years that the scientific aspects of crystal



Fig. 1. Some delegates at the 7th International Union of Crystallography Congress, Moscow 1966. Standing, from left: Slava Osiko (Moscow), Michael Schieber (Israel, ICCG1 cttee), Joe Wenckus (USA, ICCG1 cttee), Yuri Voronkov (Moscow). Kneeling: George de Kruiff (Netherlands) and Bob Laudise (USA, ICCG1 cttee). (Photo courtesy of Joe Wenckus).

growth have attracted the attention of physicists, chemists, metallurgists, ceramists, materials scientists, mineralogists, geologists as well as a small but growing number of biologists, and that a substantial number of these people regard crystal growth as their special field of competence and interest. The dispersion of the literature on this subject among many journals

has been a source of great inconvenience, and no excuse is needed or offered for the appearance of yet another journal.

The new *Journal of Crystal Growth* is intended to be the medium for the publication of important papers on theoretical and experimental aspects of the growth of crystals from

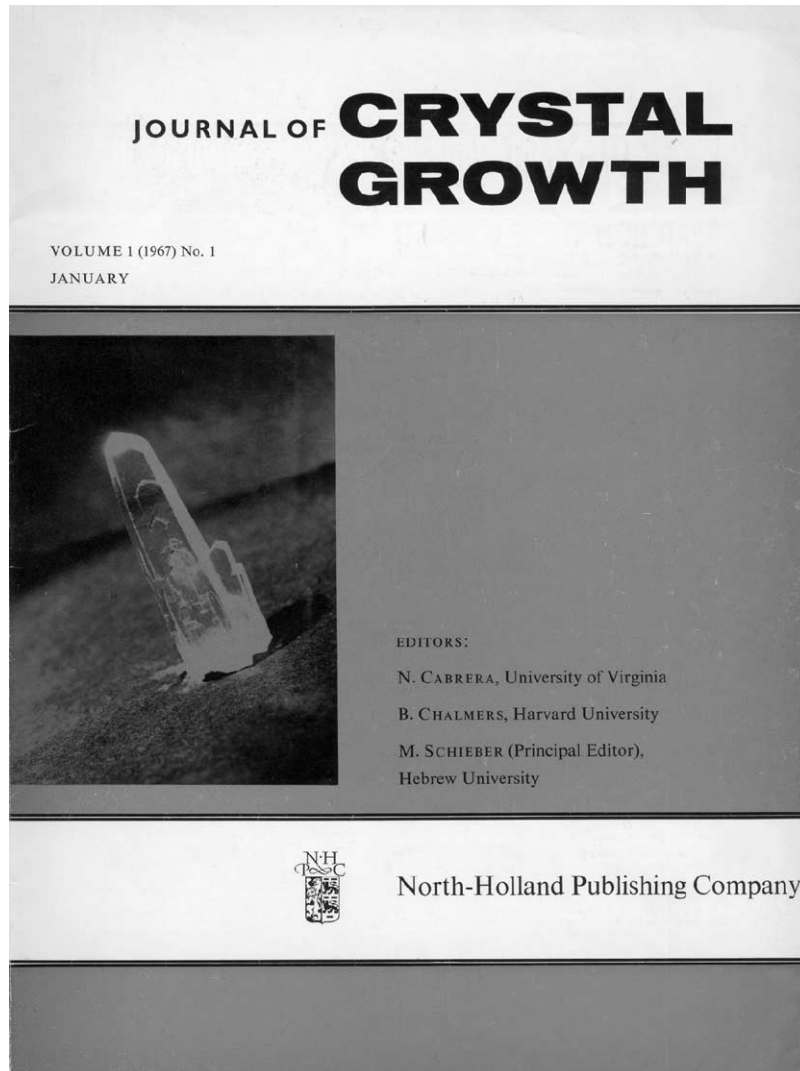


Fig. 2. The cover of Vol. 1, No. 1 of the Journal of Crystal Growth, January 1967.

vapor, liquid and solid phases. The Editors hope that the Journal will be international in terms of both contributions and readers; papers and short communications will be welcomed, and will be accepted or rejected on the basis of the Editors' judgement of the extent to which they contribute to our understanding of the process of crystal growth. It should be emphasised that a balance between experimental and theoretical studies is to be desired; but its

realization depends on the submission of suitable material".

The Journal rapidly grew in status to become the pre-eminent journal in the field; a position it still retains today. Papers were initially accepted in three languages: English, French and German. My personal vision of the Journal is that it can be represented as a wheel whose hub is the core science of the crystallisation processes the spokes

of which are the various classes of materials (such as metals, semiconductors, inorganic salts, refractory crystals, bio-materials etc) to which this science can be applied.

Bill Bardsley successfully persuaded Prof. Charles Frank to become involved with the Journal as an Editor. Also Steffen Peiser was appointed Principal Associate Editor, both of these names being added on the cover of Vol. 1, No. 3 which appeared in August 1967. Some 19 Associated Editors were also appointed to provide expert reviewing of this multi-disciplinary field. Additionally the publishers appointed Ms. F.Y. Verploegh-Chassé (née Cox) as Technical Editor, a position which she held until her retirement some 27 years later! Sadly the publishers have since abolished this role and it now falls to the Editors and Associate Editors to ensure that figures are up to standard, that acronyms are not used in the title, that the format of the references is correct, that Keywords and PACS codes are included etc, etc. It has to be admitted that the very high standards set by Mrs. Chassé are no longer attained.

Of the founding Editors Michael Schieber has remained to this day very actively involved in the Journal and remains on its Editorial Board as Founding Editor having handed over the reins, after no less than 31 years as Principal Editor, to Jerry Stringfellow in 1998. There can be few journals in the world that can beat that record.

### **3. How the future of this fledgling community of crystal growers was secured**

At the Boston conference there was a groundswell of opinion in favour of continuing such conferences on a regular basis rotating between participating countries. A significant factor in this was the frustration felt by those in the semiconductor field that they were not receiving due credit for their contributions to the rapid advances being made in the science and technology. Steffen Peiser in his Preface to the Boston Proceedings wrote:

“An early morning meeting surprisingly drew a crowd and heard a cautiously optimistic report

by the Executive Secretary Mr. Kenneth J. Button. At this meeting Dr. William Bardsley of the Royal Radar Establishment (RRE) in England was recognised by unanimous acclaim as chairman of an organising committee for subsequent crystal growth conferences”.

That early morning meeting secured the future of ICCG conferences but an international co-ordinating body able to liaise with the relevant International Unions such as IUCr, IUPAC and IUPAP was also needed. At the conference a meeting was convened with the members of the International Advisory Committee and some members of the Organising Committee. They took the decision to form an international committee, which was to be named the Comité International de Croissance Cristalline. Bill Bardsley was elected its President, Michael Schieber Secretary and Chuck Sahagian Treasurer. So all the key elements needed for the nurture of this new community were put in place in the 5 days of that pioneering conference.

### **4. The next few years**

On his return to England, Bill Bardsley joined forces with Prof. Alan McQuillan of the Metallurgy Department of Birmingham University and they agreed to co-chair ICCG2 at the University in July 1968. The profit made by ICCG1 was made over to the organisers of ICCG2, a tradition which was continued. There were 530 registrants. A detailed description of the conference can be found in the Preface to its Proceedings which was edited by Charles Frank, Brian Mullin and Steffen Peiser. It was published as a regular issue of the newly founded Journal of Crystal Growth [8] and therefore the individual papers became referenced in the relevant abstract journals. The Proceedings was distributed to all subscribers and attendees. The Journal has continued to publish the ICCG Proceedings ever since [9] without a break to the benefit of both the publisher and the crystal growth community. This has given members of the community a greater sense of commitment to the Journal than is enjoyed by most journals I

suspect. Certainly many, many eminent members of the community have served as Associate Editors over the years. Brian Mullin's involvement in editing the Proceedings set him on the road to editing the Proceedings of so many national and international IOCG approved conferences that he must surely hold the world record. At 72 years of age he is still doing it!

The Comité International de Croissance Cristalline (CICC) held an open business meeting at which Bill Bardsley stepped down from the Presidency to be replaced by Prof. Charles Frank. At the meeting it was decided that ICCGs should be held triennially. Prof. Raymond Kern was appointed as Chairman of an Organising Committee charged with holding ICCG3 in Marseille. It was agreed that a more permanent constitution was needed for CICC. A sub-committee, which included Raymond Kern, worked on this in the intervening 3 years and a Constitution together with a change of name to International Organisation for Crystal Growth (IOCG) was presented to the conference in Marseille and approved.

The Marseille meeting attracted about 650 delegates and revealed the wide range of disciplines in Europe which were interested in crystal growth. A major innovation, which was the result of an initiative by Raymond Kern, was the holding of an International Summer School on Crystal Growth (ISSCG) immediately before the Conference. This was held in Noordwijk in the Netherlands and was organised by Piet Hartman. The Proceedings, edited by Prof. Hartman, were published in book form by North-Holland/Elsevier [10]. The holding of a summer school in conjunction with the ICCG has continued uninterrupted since, which is why the ISSCG number is two less than that of the accompanying ICCG.

## 5. The formation of national crystal growth associations

Michael Schieber recognised [2] that without the support of national organisations, the International Organisation would be too weak to have influence with the International Unions. The British Association for Crystal Growth was

formed in 1969 in the wake of the Birmingham conference with Prof. Alan McQuillan as its first Chairman. Around the same time the American Association for Crystal Growth (AACG) was formed with Bob Laudise and Ken Jackson as co-chairmen and the French Association was formed by Raymond Kern and Boyan Mutaftschiev.

Michael encouraged other countries to form their own national associations, forming an Israeli Association co-chaired by Prof. BenDor and himself. Swiss, German and Dutch Associations were also formed around this time. A Japanese Association was formed in 1974 at the time of ICCG4 which was held in Tokyo. Over the years the number of affiliated countries has grown to about 20 all of which send Councillors to IOCG.

IOCG has an ex-officio representation on the IUCr's Commission on Crystal Growth and also appoints representatives to IUPAP and IUPAC.

## 6. Some reflections

The academic study of crystal growth mechanisms had its origins many, many years before 1966. Indeed many (most?) of the seminal papers in this field predate the publication of the Journal of Crystal Growth. This is evident from the North-Holland publication in 1992 (to celebrate the 25th anniversary of the launch of the Journal) of "A Perspective on Crystal Growth" which reprinted 27 classic papers [11].

The commercial growth of single crystals also has earlier origins in, for example, Verneuil's growth of synthetic ruby. However 1966 does correspond in time with the rapid growth in the commercial production and exploitation of single crystals, particularly in the electronics field following the birth of the transistor, the integrated circuit and the laser.

Over those intervening 35 years the ICCGs have reflected the growth and diversification of the field both in its fundamental and applied aspects. It has seen the community expand to the point that at the most recent conference (ICCG-13 held in Kyoto), well over 1000 delegates attended.

How significant has this bringing together of a community with its own regular international conferences and dedicated journal been? Had this not happened, how different would the research record and the scale of commercial developments have been? These are not easy questions to answer. Let us first observe that crystal growth is at the node of several disciplines from which it feeds. These are notably, thermodynamics, fluid mechanics, crystallography, condensed matter physics, crystal chemistry, metallurgy and, more recently, biochemistry.

The understanding and control of melt growth processes and their commercial scale-up have benefited enormously from the inputs from fluid dynamics and particularly from supercomputing CFD. This success has required input from the crystal grower of the essential physics and chemistry for the different classes of crystallisable material. The interaction between growers of widely differing classes of materials, which has been nurtured by the ICCGs and by the Journal, has made this effective.

Again, in epitaxial growth processes which now dominate the electronics and opto-electronics scene, supercomputer simulation of the nucleation and step-flow processes which occur below the roughening transition have furnished understanding which is advancing device design and nanotechnology. The achievement of this has involved the familiarisation of the device engineer with the classic academic studies of step formation and flow of Volmer, Stranski, Frank and others. The ICCGs and the Journal can be seen to have played important roles here too.

But perhaps the most important contribution of IOCG and its conferences is the confidence it brings to those in the field that crystal growth is a

valid discipline in its own right and not simply the poor relation of a number of more major and disparate disciplines. That defines the debt of gratitude which the community owes to Michael Schieber for his vision and tenacity in overseeing the putting in place of this infrastructure. That debt extends also to those who, in the early days, shared his vision and collaborated with him to achieve and sustain it.

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