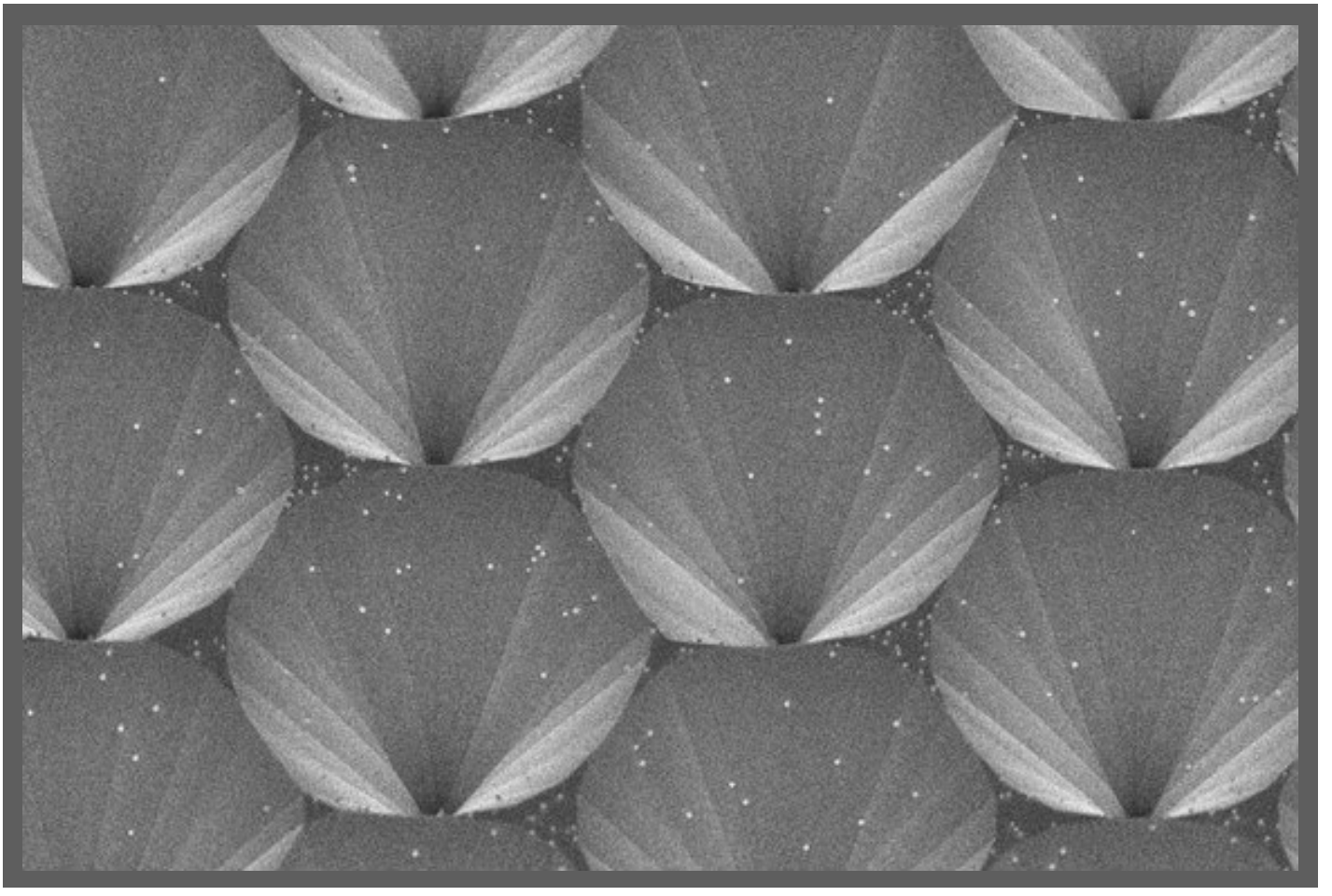
aacg

American Association for Crystal Growth

Volume 2, Issue 1, Spring 2024



President's Corner

You can't grow crystals in a vacuum.

Well, technically you *can* grow crystals in a vacuum, and many if not most of us *do* grow crystals in a vacuum.

But here when I use the term vacuum, I'm not referring to sub-atmospheric pressures but to isolation. Crystal growth, like many other specialties within materials science, is profoundly interdisciplinary. It requires interaction and collaboration with fellow scientists and engineers, end- users and raw material suppliers, equipment designers, substrate vendors, modelers and managers. Wherever you fall on the crystal growth continuum, in academia or industry, research or manufacturing, ultimately you can't succeed independently. Alone. In a vacuum.

It was this realization that inspired the "nucleation" of the American Association of Crystal Growth 60 years ago, a community where researchers in an exotic but "growing" field could gather to collaborate or compete, cheer or challenge, applaud or argue, but all in the name of advancing science and technology while sharing in the frustrations, failures, and infrequent euphoria of growing crystals. Many longtime members like myself have enjoyed decades of friendship and camaraderie with like-minded souls struggling to advance this field at often painfully slow rates of progress due to the many uncontrolled and unmeasurable variables and often very extended process times.

These friendships are undoubtedly the most joyful benefit of the AACG experience, and consequently are also the greatest source of loss when these friends pass away. Many of the founding fathers of crystal growth, who did seminal work in the 60's and 70's, have passed away in recent years. Regrettably and inevitably this process continues, and this issue of the Newsletter features several memorials to some of the most memorable and impactful colleagues in our field, including George Gilmer, Bill Tiller, Nick Holonyak, Holger Juergensen, Kelvin Lynn, Kanai Shah, and Glen Slack, along with extended tributes to Ken Jackson and Dennis Elwell. These brief remembrances cannot begin to express our appreciation for them both as crystal growers and as human beings. It was a great privilege to know them, and their presence will be sorely missed.

Reflecting on the past inspires the AACG's continued mission to organize and host annual scientific meetings where researchers from academia, industry, and government laboratories can present their latest results, network with colleagues, and interface with suppliers, students, and prospective employees at vendor exhibits, poster sessions, excursions and special events. Our national conference (~350 attendees) meets every 2 years in odd years (the next, ACCGE-24/OMVPE-22 will be held at the breath-taking Skamania Lodge in Stevenson,

---

On the Cover & featured on the AACG Website:

First Place (Natural Untouched Photograph/Micrograph)
from ACCGE-23/OMVPE-21 2023 Photo Contest.
Title: Faceted Calla Lilies by James Loveless (NCSU)

Washington, July 13-18, 2025). We also hold smaller crystal growth workshops (~75 attendees) that meet in the even years at Stanford's Sierra Camp, Fallen Leaf Lake, CA (the next, AACG-West-28, will convene June 9-12, 2024). Attendance at one of these meetings includes membership in the AACG, and for the last decade or more that has primarily defined our membership roster. The appearance of COVID-19, which disrupted our 2021 conference and shifted the International conference (ICCGE-20) into near direct conflict with ACCGE-23 last year, affected the membership status of many who have long been actively involved in our community.

If you are reading this Newsletter, I trust you are a current and active member of the American Association of Crystal Growth. However, your actual AACG membership may have lapsed due to some of the disruptions described above. If that is the case, I encourage you to renew your AACG membership today (by clicking on the membership link at http://www.crystalgrowth.org/ or contacting Shoshana Nash directly at 888.506.1271or aacg@comcast.net) since future Newsletters will only go out to current members. An important focus of our newly-elected Executive Committee and officers will be to revisit our membership process, perhaps moving from an MRS model of conference attendance including membership to a more traditional model of annual membership renewals offering discounted registration fees.

Last year's AACG election process was more spirited than usual: for the first time ever ended in a tie for president, between John Frank and myself. Rather than get the Supreme Court involved, the online voting process was simply extended by two weeks and the increased voter turnout broke the tie. Controversy averted. John has some great ideas about clarifying the AACG mission statement that we will continue to explore together.

I am excited to begin a second term as AACG president (the last from 2011-2015), and to work closely with Shoshana Nash (our amazing AACG administrator) and the newly elected (and re-elected) slate of officers and executive committee members. We are eager to find ways to expand our membership and offer more tangible member benefits. One of those benefits is this ACCG Newsletter, which keeps members informed about what's happening in the community. Many thanks to Kevin Schulte from the National Renewable Energy Laboratory (NREL) in Golden, Colorado for stepping up to serve as our new Editor. If you would like to contribute any content for upcoming issues of the newletter - such as advertisements, job listings, or feature articles – please send them to Kevin at kevin.schulte@nrel.gov. We also hope to provide our members access to the AACG Member Directory, since it has been a few years since we sent out an updated membership roster with valuable contact information. If you have any other ideas about how the AACG can better serve the broader crystal growth community please submit them in our new "Suggestion Box" feature on the AACG website (here's the link:) or email them to me directly at schunemann@alum.mit.edu.

I'm looking forward to a great 2024, and wish you all the best of luck in all your endeavors in the coming year! (Since crystal growers really need good luck!)

In your service,

Pete Schunemann, D. Eng,
Sr. Director of Crystal Growth, Onsemi
AACG President

AACG Newsletter Editor

AACG Executive Committee Member:

Kevin Schulte (NREL), kevin.schulte@nrel.gov

ACCGE-23
OMVPE-21
Conference Recap

Authors: Siddha Pimpuktar,
Balaji Raghothamachar, and Kevin Schulte

With the first in-person conference for AACGE since COVID, ACCGE-23 was a significant success as demonstrated by the almost 200 contributions at the event. It sent a clear and strong message, that the crystal growth community values the in-person experience to see each other and socialize in ways not possible via online experiences.

ACCGE-23 was held over 5 days in Tucson, Arizona (8/14/23 through 8/18/23). During this time, four parallel tracks were held in which 183 talks were presented across 20 symposia and 15 posters during the poster session. During this cycle, there was a strong showing by the community in core topic areas (including bulk crystal growth and fundamentals of crystal growth), along with more material-oriented symposia, such as the 6th symposium on 2D and low dimensional materials, biological and biomimetic materials, the 4thsymposium on ferroelectric crystals & textured ceramics, and (ultra-)wide bandgap semiconductor materials (III-N, SiC, Ga_2O_3).

Four plenary sessions were held to promote exciting ongoing work in the field. Presenters included Zlatko Sitar (“Unlocking the AlN-based technology through crystal growth and epitaxy”), Jung Han (“Frontiers in Selective Area Growth, Etching, and Doping of GaN by OMVPE”), Aleksander Ostrogorsky (“Bridgman Crystal Growth on Earth and in Microgravity”), and Leo Schowalter (“The development of ultrawide bandgap, pseudomorphic AlGaN semiconductor on native AlN substrates and its potential for opto-electronic and power devices (dedicated to Crystal IS co- founder Glen Slack)”). These were in addition to Partha Dutta’s AACG Award talk on bulk crystal growth of ternary III-V compound semiconductors – 30 years of personal journey.

During the conference, two special events were held. The first event was in honor of the late Ken Jackson and a memorial session was held in conjunction with the Fundamentals of Crystal Growth session which was attend by family, former students and a larger number of colleagues and friends. The second event was a special plenary talk held by astronaut Greg Olsen discussing his career trajectory “From Crystal Growth, to Entrepreneur, to Space Flyer”. Greg gave an inspiring talk about his career in crystal growth, which enabled him to become one of the few civilians to experience the magic of space flight.

The conference also featured the 21st Workshop on Organometallic Vapor Phase Epitaxy (OMVPE-21). Pulling from the general pool of conference submissions, the workshop features talks pertaining to advances in OMVPE growth or in devices grown by OMVPE that are organized in special evening sessions. Despite a later than usual start, (8 PM) attendance was strong and, as always, people enjoyed the accompanying refreshments. Organized by Andrew Allerman, there were two OMVPE sessions grouped by materials system. Night one featured talks on growth fundamentals and devices using III-V materials, while night two featured the latest advancements in the growth of III-nitride materials and devices.

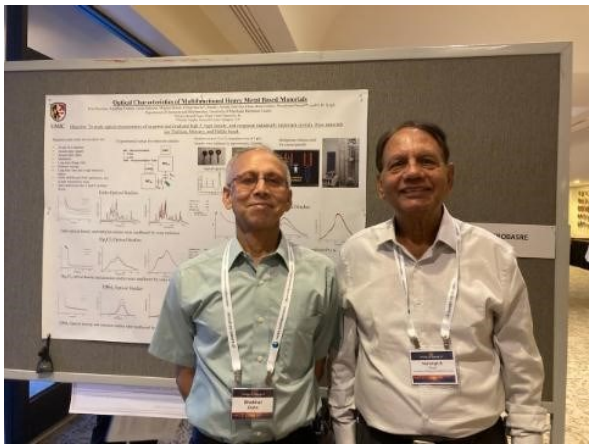
To allow for discussions and socializing opportunities, conference attendees were welcome to explore the wilderness of Tucson during the excursion. Tucson is surrounded by five mountain ranges in the Sonoran desert, offering easy access to Saguaro National Park as well as numerous hiking opportunities. Self-organized groups found each other and explored the desert in the early morning hours to experience the beauty of the desert as the sun rose over the horizon. The less-than-early birds were able to experience a task of the heat and discover the unique fauna and animals by hiking through national parks or driving out to the Biosphere 2.

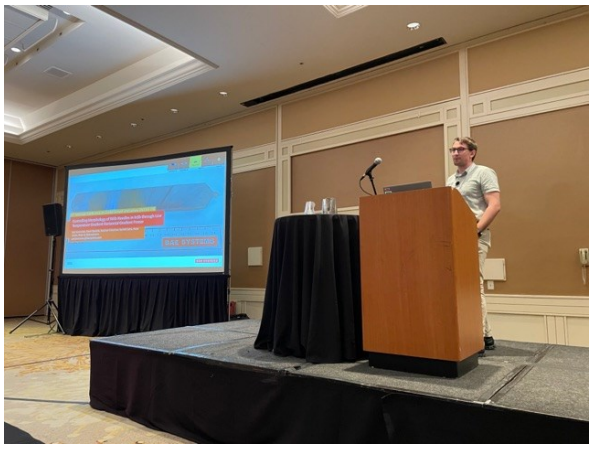
The always enjoyable conference banquet held onsite was another venue for everyone to socialize and catch up. The banquet featured the awards presentation, an in memoriam presented by Vince Fratello, and the announcement of the new set of AACG officers.

This conference featured new student programming to promote student attendance and enhance the student experience. The key event was the first Student Career Panel, which brought together established professionals from academia, industry, and the national laboratories to share their experiences about how they ended up on their respective career paths. This was followed by an open question and answer session with the students, who asked excellent questions about how to prepare for their desired career in crystal growth. Attendance was strong, as the students were eager to learn and have their questions answered, although the promise of free pizza certainly helped!

The next ACCGE/OMVPE will be in Skamania, Washington in 2025, and we hope to see you there, especially if you were not able to make it to Tucson!

Photos from ACCGE-23/OMVPE-21







Ken Jackson Symposium

Ken Jackson passed away January 7, 2022, at his home in Prescott Arizona. Ken was one of the founders of the American Association for Crystal Growth and a long-time member of the crystal growth community in his time at the University of Toronto, Harvard University, Bell Labs, and the University of Arizona. Ken contributed many outstanding discoveries that have affected the entire area of crystal growth, including contributions to the theory of constitutional supercooling, which laid the foundation for the field of shape stability of crystals during growth, understanding of the surface roughening transition introducing the Jackson alpha factor, defect formation in crystals, studies of alloy crystallization, using transparent analogues to visual crystal growth processes, computer simulation studies of atomic scale processes during crystal growth and semiconductor packaging. Ken rationalized the crystallization behavior of inorganic and organic compounds in terms of the dimensionless entropy of melting, $\Delta S_m/R$, which is used as a scale for the ease of crystallization.

In Ken's honor, a symposium on Crystal Growth Fundamentals was held at the ACCGE-23/OMVPE-21 conference this summer in Tucson. It was wonderful to see many of you there to honor our friend Ken's memory along with family and former students. Vince regrets that he forgot to wear a Hawaiian shirt in Ken's honor. The session was kicked off by remarks from Ken's daughter Stacy who presented some great reminiscences. Then Vince Fratello gave a review of Ken's life and work as summarized above.

Eric Chason of Brown spoke on "Relating Stress in Thin Films to the Processes of Crystal Growth" The Brown group has developed a kinetic model implemented as a user-friendly program that relates the stress to the underlying fundamental kinetic processes that control film growth including deposition, surface diffusion, and grain boundary formation and can be used by the thin film growth community to analyze their stress measurements. Gregory Brian Stephenson of Argonne National Laboratory and his co-authors contributed a talk on BCF Analysis of Azimuth Dependence of Step Dynamics for step, kink, and adatom dynamics on vicinal (0001) surfaces of GaN and compared their predictions with in-situ surface X-ray scattering measurements to determine fundamental kinetic parameters for adatom attachment and diffusion. Narsingh Singh of the University of Maryland Baltimore County gave a presentation that harkened back Ken's early collaborations with John Hunt at Bell Labs discussing the validation of the Jackson-Hunt model in organics and evolution to inorganic compounds such as Al-Si dendrites and the pathway for developing materials for electronic and optical applications. Finally, the session was closed out by Dan Bentz, a former student of Ken's at the University of Arizona, speaking on modeling the growth of irregular eutectic systems using an analog, two component, lattice gas system of a regular solution solid in contact with an ideal liquid showing a sharp transition in the kinetic behavior of the interface as a function of Jackson's alpha factor.

ACCGE-23 // OMVPE-21 Photo Contest Results

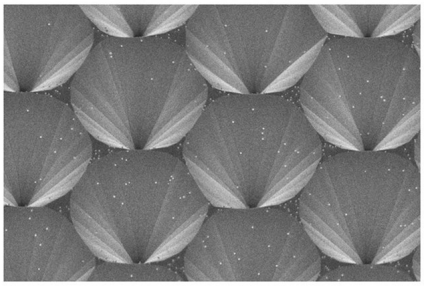
Chair: Yannick Ouloide Goue

Title: Faceted Calla Lilies

N1

Name(s) & Affiliation(s)

James Loveless, NCSU



Caption

Multifaceted GaN growth on 2D patterned GaN substrates, FE-SEM micrograph. The image is 15 µm wide, where each "lily" is only 4 µm in diameter.

Student Entry

ACCGE-23/OMVPE-21 Photo Contest

Natural

2023 Photo Contest

First Place

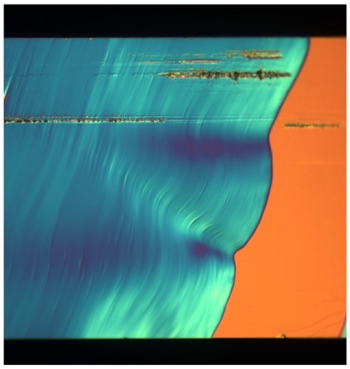
Natural Untouched Photograph / Micrograph

James Loveless
North Carolina State University

Mini Golden Beach

N2

Qianyu Cheng
Stony Brook University



Fancy a summer vacation with velvety gilded sand and crystal-clear water? Even stuck inside the lab, there is still your private beach to enjoy when peep into the microscope — the top edge of an axial sliced 4H-SiC with numerous growth steps and large terrace. Ready to surf that grain boundary wave?

Student Entry

ACCGE-23/OMVPE-21 Photo Contest

Natural

2023 Photo Contest

Second Place

Natural Untouched Photograph / Micrograph

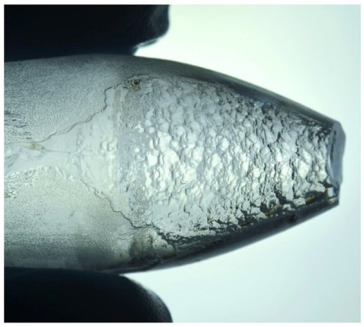
Presented August 16, 2023, to

Qianyu Cheng
Stony Brook University

"Scales" on a Halide Crystal

N8

Daniel Rutstrom, University of Tennessee



Bridgman-grown 22 mm diameter Cs_2ZnCl_4 single crystal with textured surface resembling fish scales that formed during the growth process.

Student Entry

ACCGE-23/OMVPE-21 Photo Contest

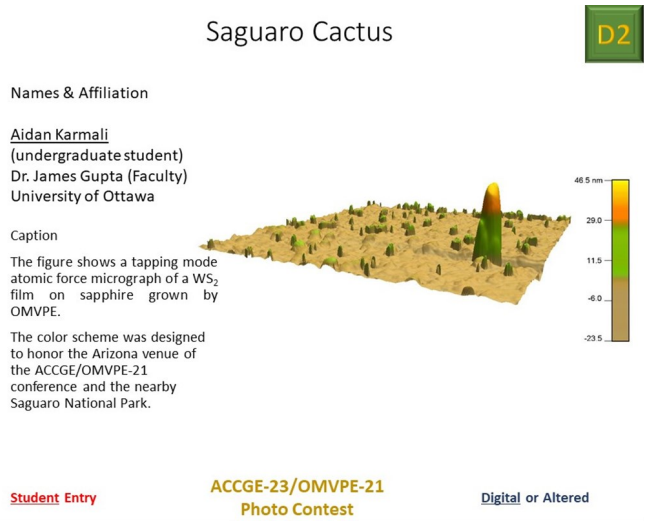
Natural

2023 Photo Contest

Best Student Photo

Presented August 16, 2023, to

Daniel Rutstrom
University of Tennessee



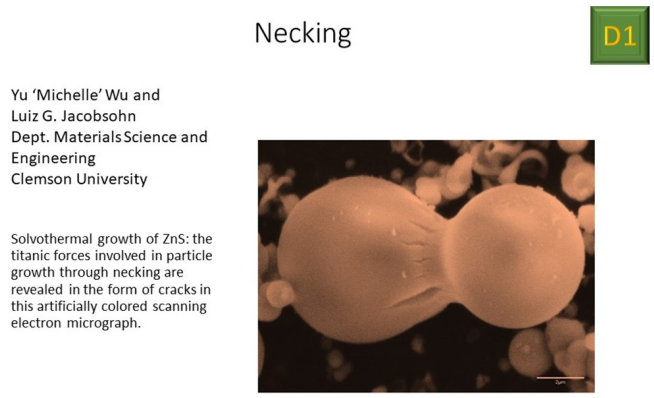
2023 Photo Contest

First Place

Digital / Altered Micrographs/Photographs and Computational Simulations

Presented August 16, 2023, to

Aidan Karmali
University of Ottawa



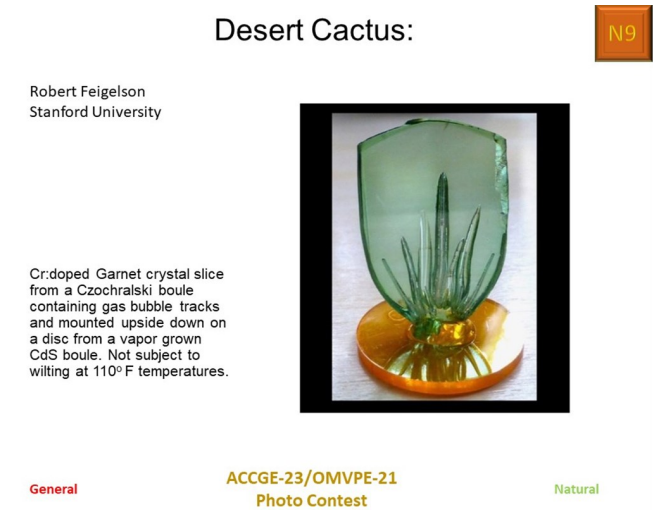
2023 Photo Contest

Second Place

Digital / Altered Micrographs/Photographs and Computational Simulations

Presented August 16, 2023, to

Yu "Michelle" Wu
Clemson University



2023 Photo Contest

Best General Non-Students

Presented August 16, 2023, to

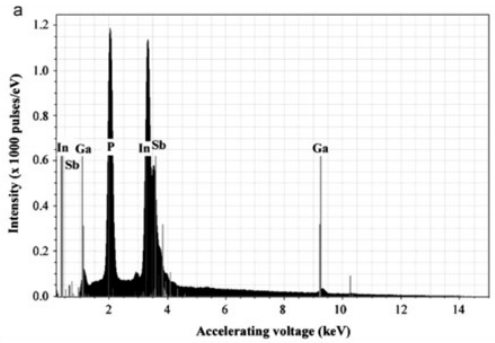
Robert S. Feigelson
Stanford University

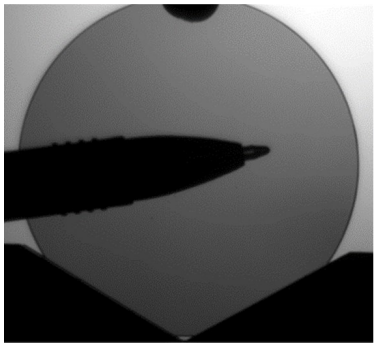
AACG Photo Contests coincide with ACCGE/OMVPE conferences. Submissions are voted on by attendees. Winners are announced at the conference and the images are prominently displayed on the website and in marketing material. Questions can be directed to Balaji Raghothamachar at balaji.raghothamachar@stonybrook.edu or Yannick Ouloide Goue at ogoue@xula.edu.

2023 AACG Award Recipient

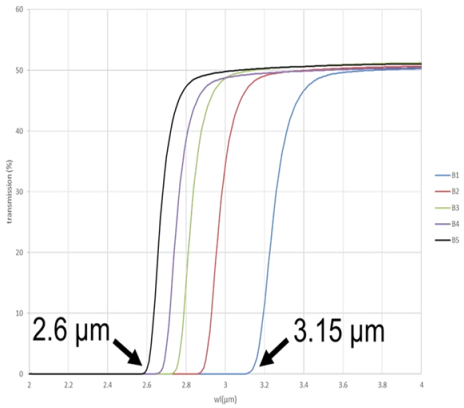
Partha Dutta

United Semiconductors LLC





Award Citation: For fundamental and experimental studies leading to the development of methods for growing large bulk crystals of complex ternary semiconductor compounds.



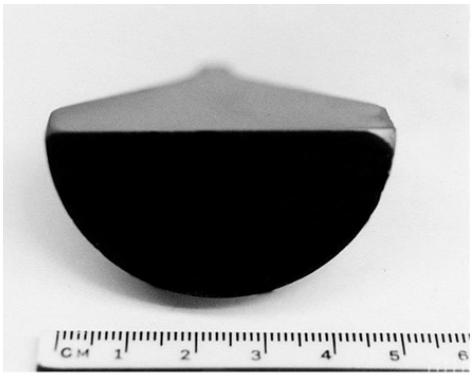


Fig. 1. Quasi-binary crystal of $(GaSb)_{0.97}(InAs)_{0.03}$.

AACG Membership

Membership in the AACG is open to everyone with a professional interest in crystals, thin films, crystal growth, epitaxy, and characterization.

Our membership includes **engineers, scientists, educators, technologists, marketing representatives, and students**. All share a strong interest in one or more facets in the field of crystal growth and epitaxy.

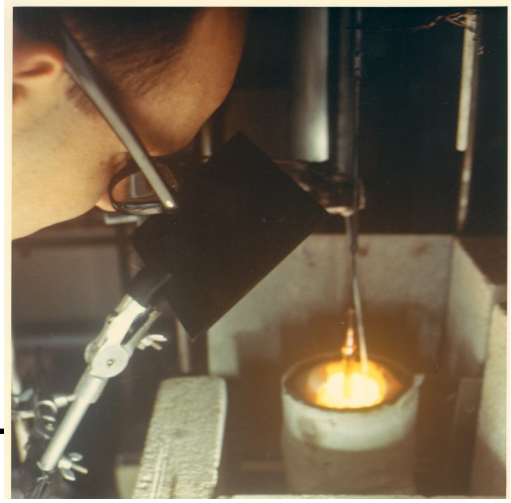
Annual membership benefits include discounted conference registration, annual newsletters, important career and conference announcements, and **connection** to the global crystal growth community.

Visit the AACG website:

www.crystalgrowth.org

Interview with Gabe Loiacono

by David Bliss



Gabe Loiacono is a pioneer in the growth of numerous crystals with commercially significant applications, including lithium niobate, KTP, and KDP. He co-founded Crystal Associates, which was later acquired by Coherent, and is currently a consultant to Coherent's Advanced Crystal Group. He spoke with David Bliss about his career and experience starting a successful business.

DB: How did you get your start in crystal growth?

GL: I was being trained as an analytical chemist at RCA in Princeton in the 1950s where we were using Na^{22} radiotracer methods to study semiconductor impurities. I was there for about two years when the head engineer left and went to Bell Labs. About six months later, I received a phone call asking me if I would like to work at Bell Labs. So in 1961 I interviewed at the semiconductor group at Bell. Ironically, the position disappeared, so instead I applied for another position with Kurt Nassau. We hit it off and the first crystal I grew with Kurt was $CaWO_4$ both pure and doped. Several years later Bob Laudise, our director suggested we work on $LiNbO_3$. Al Ballman had recently grown $LiNbO_3$ and $LiTaO_3$. Together with Ballman, Hy Levinstein, and Kurt, we discovered that $LiNbO_3$ was ferroelectric, and learned how to control the domains. From that point on we supplied crystals to the laser scientists, including Stu Kurtz and Gary Boyd.

DB: Did that give you a broader perspective on crystal growth?

GL: Let's put it this way. I came out of what many considered to be one hell of a university at Bell Labs. I had the good fortune to be mentored by, and know people like Kurt Nassau, Al Ballman, Joe Remeika, Bill Bonner, L.G. van Uitert, Bill Bonner, Bob Laudise, Howard Guggenheim and Hy Levinstein; all great teachers. When asked what I do for a living I tell people, I'm a Farmer. I plant a seed and grow a work of art (sometimes)!

DB: It was a unique time in our history.

GL: Yes, but after a few years I was offered a position at a small company, Isomet, run by Warren Ruderman. The job was in Palisades Park, much closer to my home than Bell Labs. About two days after I started I met John Zola, another new employee. This was the start of a long friendship and relationship. At Isomet I set up a $LiNbO_3$ growth operation and took charge of their crystal growth group. I stayed with Isomet for about another nine years. Well, during those years I had diversified the group's efforts to include other crystals; KD*P, TeO_2, $PbMoO_4$, CaF_2, other materials for laser, nonlinear optical, and pyroelectric detector applications.

DB: What method did you use to grow these crystals?

GL: Aqueous solution was used for the KD*P, and Czochralski growth for calcium tungstate, lead molybdate, calcium molybdate, calcium fluoride crystals. After about 2 years Isomet moved to Oakland, New Jersey and the president was removed and a

new manager came in. Then one day the new president came to me and said, "We've made a decision. We are moving the company to Springfield, Virginia." I had just relocated my home to be closer to Isomet, so this did not work for me.

DB: So what was your answer?

GL: I agreed to consider moving. Meanwhile, one of my contacts from Bell Labs, Stu Kurtz, had become the director of R&D at Phillips Lab in Briarcliff. He invited me to join Phillips in order to start up a crystal growth operation. So in 1975 I became a program leader at the R&D division that reported to NV Phillips in Eindhoven Holland. Phillips had a large program in ferroelectric detector materials. I had grown triglycine sulfate (TGS) and deuterated tri-glycine fluoroberyllate (D*TGFB), all infrared detector materials.

DB: Did Isomet have a problem with you taking the technology with you?

GL: Quite the opposite. The new president of Isomet asked me if I would write a manual for KDP growth and transfer the technology to Phillips. This was a lot of extra work, so I asked for something in return. At the time we were growing x-ray analyzer crystals like rubidium acid phthalate (RAP). I asked for the customer base and some of the equipment as my fee. He agreed, and then I made an agreement with Don King, the president of Phillips Labs, so that I could do this crystal growth on the side. He agreed, as long as it would not interfere with my regular hours nor present any conflicts of interest.

DB: Were you going to do this work by yourself?

GL: Well, soon after I came to Phillips I reconnected with John Zola, whom I had known since 1966, and we hired him at Phillips to set up and lead a crystal fabrication group. We worked well together. He helped me on the weekends to grow and polish crystals in my basement. Unfortunately, our president, Don King, suddenly died and his replacement took a dim view of our activities and gave us an ultimatum: "Either give up the outside business or both of you hand in your resignations." We both had a problem.

DB: Pretty risky to lose all that?

GL: Maybe. Although this goes back to my membership in AACG. I distinctly remembered that during the AACG conference in Boston I met Bill McBride from the Naval Weapons lab at China Lake. He had asked me about nickel sulfate. I had the book Alan Holden had written on solution growth which had a recipe for nickel sulfate growth, and I was confident that we could grow it easily. After the conference, I didn't hear any more about it until I got a call from Honeywell in Lexington MA, asking if we could supply them with nickel sulfate crystals. It turns out they had a government contract for a missile warning system to detect missiles aimed at helicopters. Nickel sulfate was the solar-blind filter for the system. Within a few days, after the "ultimatum", I received a call and they asked us to come and visit the Honeywell plant in Lexington.

DB: Did you even have a company name at that point?

GL: No. But we had moved out of my basement to John's basement which was bigger. At Honeywell we were asked: "How much money would it take to build a facility to produce 120 elements per month?" John and I came up with a number of $800,000. The manager turned to the financial officer, and said:"They do not leave here today without a contract."

DB: That was a relief.

GL: Oh Yes. The day we came back to Phillips Lab we turned in our notices. That was in 1989. Then we signed a three-year lease on a 2000 ft^2 garage space to start the company. From John's design we built 100 liter crystallizers for growth and we gave our company the name Crystal Associates. Fortunately, we had backing from Honeywell to guarantee our purchases from suppliers. In the first year we built 20 crystallizers and by the end of the year we needed more space. Then we took a 9000 ft^2 place in Waldwick NJ. Our final move was to a 30,000ft^2 facility in East Hanover, NJ. Our manu-

facturing operations and R&D facilities included over 30 high temperature and 40 low temperature crystal growth stations; precision x-ray orientation equipment; state-of-the art crystal fabrication equipment for cutting, grinding, and diamond turning; and precision optical polishing capabilities. For quality control, R&D, and materials characterization and evaluation, we had equipment and various apparatus for optical, laser, electrical, thermal and mechanical measurements.

DB: A lesson in how to build a successful business!

GL: Well there were other things. We also bid on a number of government-supported SBIR programs. The work that we did was of a sufficient quality that government contracts acted as a fundamental building block to our success in business. It gave us the capability to have ongoing programs and to hire new staff. It was very enjoyable, and at times very terrifying.

The main reason for our success, was that both John and I had complimentary talents and personalities.

We then hired our sons Dominic and John Jr to join us, along with an excellent group of people. I am especially proud of my son Dominic, who is now General Manager of the facility and a Vice President at Coherent.

DB: How did you get into KTP growth?

GL: Back at Phillips Lab in the early 1980s, Stu Kurtz asked if we could grow KTiOPO4 (KTP) by the hydrothermal technique published by John Bierlein at DuPont. I told him we did not have the equipment, but I believed it could also be grown from a suitable flux. I looked at potassium phosphate and phosphoric acid as possible fluxes to grow KTP, and developed $K_6P_4O_{13}$. We were the first to grow KTP by flux method, and everything else is history.

After that discovery I went up to MIT to give a lecture to Gus Witt's group hoping to find some new interns for Phillips Lab. There I met a young grad student named Peter Bordui who seemed interested.

He came down to work for me for a summer, and we discussed a topic for his master's thesis. He was to develop a real-time method to measure supersaturation during growth. Peter came up with the idea of measuring the conductivity of the solution, related to concentration and temperature. And it worked. The measurement system allowed us to grow KDP at rates that were unheard of. Later on, Peter came to Phillips in Briarcliff to do his PhD on KTP by flux growth. As a result of that effort we filed a joint patent on KTP growth using a heat pipe while he was employed at Phillips. Later on, Peter moved to California and became an R&D director at Crystal Technology in Palo Alto.

DB: You mentioned the European Labs owned by Phillips. Did you interact with these labs?

GL: NV Phillips had research labs in England, France, Germany, and of course Holland. At that time NV Philips had the largest crystal growth effort in Europe. So my colleagues were people like John Brice, John Wilkes, John Robinson, and Wolfgang Tolksdorf . For about 13 years, I was the American representative to the Phillips crystal growth committee. There were a great many members who held their meetings in Europe, so I traveled to England, France, Germany or Holland every year for discussions. I interacted with university types- Pieter Bennema (Katholieke Univ. Nijmegen), and Hans Ahrens (ETH ,Zurich) for example.

John Brice and John Wilkes were in England. Our charter was to be aware and stay aware of any developments in crystal growth world-wide. Also we formulated a prescription for what materials would be needed in the future.

DB: Do you have any advice for leaders in crystal growth?

GL: I have a message especially for senior managers at major component companies, including Coherent. Crystal growth of any material is a constantly improving process. It's very simple; we have a crystal today that works to a certain degree, but tomorrow we want 25% higher performance. All of a sudden, we have problems with the crystals, and they don't work. I am always amazed at how little the engineers who use these crystals really understand the need for improvement.

DB: With the acquisition of Crystal Associates by Coherent in 2000, did you find a better link with those engineers?

GL: We were a key element in their supply chain. They had deep pockets. We had direct inputs on industry needs and requirements in terms of desired crystal properties. We were able to focus our resources on specific crystal applications and potential problems, and we did not have to satisfy multiple customers and produce multiple crystalline materials. The main problem has always been when a customer says "crystal doesn't work", is it really the crystal or the customer? Working with Coherent, we were able to have crystals tested and problems resolved rapidly. We gained the ability to increase staff, and acquire additional capital equipment.

DB: You have worked at big systems houses, then at

a small business, and now at a component manufacturer. Is there a preferred business model for maintaining good career opportunities in crystal growth?

GL: This is a difficult question to answer. I had the good fortune to work at Bell Labs, then a small company Isomet Corp., then Philips Research Laboratories, and later my own small business that was finally acquired by Coherent. I do not believe the same conditions or opportunities exist in today's world. There are not that many small crystal growth companies; not many large corporations with crystal growth labs; and only a few Universities that have crystal growth programs. Furthermore, government funding is limited. At present I am a consultant to Coherent's Advanced Crystal Group, and I am fortunate to be associated with an excellent staff.

I believe to achieve a career opportunity in crystal growth, one needs two basic principles:

1. Stay current in your field

2. Engage with others through networking

DB: What do you think the future looks like for crystal growth as an occupation?

GL: It is a strange environment today. Our company has had trouble finding employees who are willing to learn crystal growth from the ground up. Coherent's crystal growth group is planning to expand to a new larger facility in 2019, and are going to need additional crystal growth people. Where are we going to get them? Many young chemical engineers are looking for laboratory jobs in biotechnology, and as you know, there are not many university level programs to train people in crystal growth. I believe the only answer is to start an internship program. We can take undergraduates with chemistry, physics, or ceramics backgrounds, and expose them to the processes and methods of crystal growth. Then when they graduate, they will be ready to continue as employees. This is similar to the way Bell Labs trained so many of us when we started in crystal growth.

Save the date!

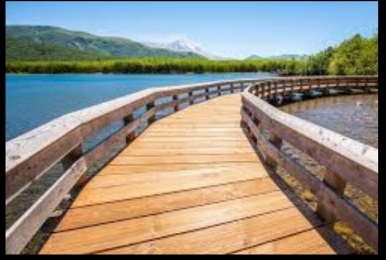
ACCGE-24
OMVPE-22

Stevenson, Washington, USA

July 13-18, 2025

About Skamania Lodge: Skamania is an unrivaled, quintessential Pacific Northwest experience that inspires. Positioned against one of the most dramatic landscapes on earth, nestled amongst lush towering timbers, travelers embrace all senses. It is uniquely defined as a place where you see the world a bit differently at the intersection of nature and the great outdoors, adventure, holistic wellness, relaxation and retreat, all in one iconic destination.

www.crystalgrowth.org



Elections Summary

The AACG Nominating and Elections Committee
Vince Fratello vjfratello@gmail.com
Kevin Zawilski kevin.zawilski@baesystems.com
Michael Brennan michael.brennan@iiviad.com

The American Association for Crystal Growth holds elections every two years in conjunction with our bi-annual conferences. The AACG Executive Committee nominally consists of 24 elected members with four-year terms, half of which are elected every two years. This year an election was held to fill twelve slots for the term 2023-2027 in addition to the twelve continuing members whose terms are 2021-2025.

There are additional lifetime members and former officers who get a four-year extension past their term of office. Presidents of the active local sections (not indicated here) are also members of the Executive Committee. We are pleased to announce that, following the election process, the following volunteers have been elected for four-year terms. We want to thank all those who volunteered to run. As a volunteer organization, the AACG is driven by the willingness of many members who step up to a variety of tasks large and small. It is one of the truly wonderful things about this Association.

The Executive Committee for 2023-2025 is as follows with the newly elected/re-elected individuals indicated with a star. This cycle we also elected new officers to four-year terms and those are indicated in parentheses.

Al Balushi, Zakaria
Dabkowski, Antoni
*Derby, Jeffrey
DeYoreo, James
Dhanaraj, Govindhan
*Dutta, Partha
*Ehrentraut, Dirk
Feigelson, Robert (life)
*France, Ryan
*Frank, John
Fratello, Vincent (life)
*Hite, Jennifer
*Kisailus, David
Koschan, Merry
Mawst, Luke
*Melcher, Chuck
Mnushkina, Irina
Paskova, Tania
Pimputkar, Siddha
*Raghothamachar, Balaji
Redwing, Joan (Vice President)
Schulte, Kevin
Schunemann, Peter (President)
*Snure, Michael
*Vekilov, Peter
Wang, Christine
*Ye, Zuo-Guang
Zawilski, Kevin (Secretary)
Zepeda-Ruiz, Luis (Treasurer)
Zhuravleva, Mariya

We also owe our thanks to the outgoing Executive Committee members Bob Biefeld, Marty Glicksman, David Joyce, and Candace Lynch for their service this past four years (and some longer than that). The outgoing officers are President Mariya Zhuravleva and Secretary Merry Koschan who have done exceptional work for the Association. They will continue on the Executive Committee for a four-year extension to contribute to the institutional memory.

We also want to thank all of you as members who took the time to nominate and vote in this democratic process.

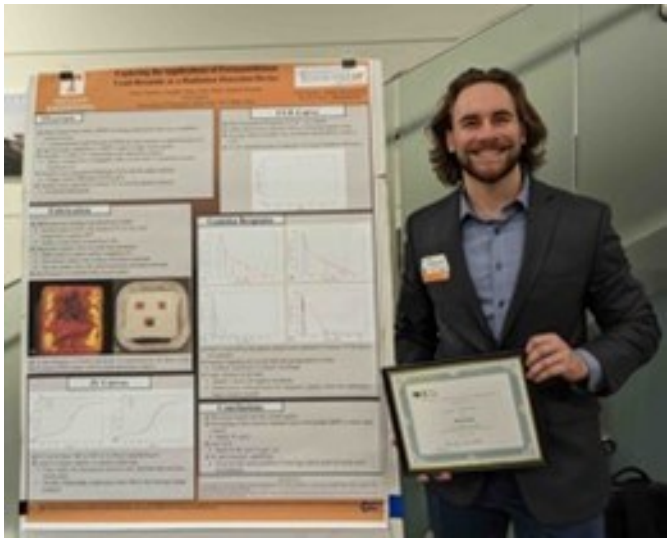
AACG-SE co-organized Student Poster Night

On February 16, 2023, the American Association for Crystal Growth, Southeast Section (AACG-SE) once again joined with the Oak Ridge Chapter of ASM and the University of Tennessee Center for Materials Processing in holding a student poster contest.

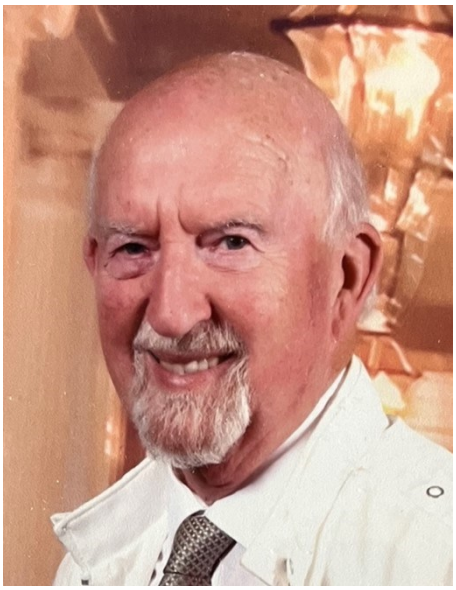
Each organization had a separate, independently judged competition. The AACG-SE had an additional two judges for evaluating posters that included crystal growth topics: Dr. Wei Tian, neutron scattering scientist, and Dr. Brenden Ortiz, Wigner Distinguished Staff Fellow, both at the Oak Ridge National Laboratory.

Posters were contributed by a total of 55 undergraduate students and graduate students from a variety of academic units including Chemistry, Materials Science and Engineering (MSE), Mechanical, Aerospace, and Biomedical Engineering (MABE), Civil and Environmental Engineering (CEE), Chemical and Biomolecular Engineering (CBE), and Nuclear Engineering (NE). The winner in the graduate competition was Bogdan Dryzhakov, MSE for his poster "Off-axis Ferroelectricity by 2D/3D Phase Mixing of Hybrid Perovskite Single Crystals". The winner in the undergraduate competition was Owen Johnson, NE for his poster "Exploring the Applications of Formamidinium Lead-bromide as a Radiation Detection Device". AACG-SE President Mariya Zhuravleva presented winners with award certificates.

BELOW: AACG-SE award winners with their posters: Bogdan Dryzhakov, graduate student, MSE (left) and Owen Jognson, undergraduate student, NE (right).



Obituary for Dennis Elwell (1935-2023)



We regret to report that on May 29, 2023, Dr. Dennis Elwell, one of the pioneers of the crystal growth community passed away at his home at Discovery Harbor, on the Island of Hawaii. He was 87 years old. In 1969, Dennis, with other notable British scientists and engineers, helped found and organize the British Association of Crystal Growth and was its first secretary. He received his B.Sc. in Physics with honors from Imperial College in London in 1957, and his Ph.D., also in Physics, from Sheffield University in 1960. He became a faculty member at the then Portsmouth Polytechnic (later to become the University of Portsmouth) starting in 1960 until 1975. His initial research interest at Portsmouth was the study of the physical properties of magnetic oxides notably ferrites such as $NiFe_2O_4$ and garnets such $Y_3Fe_5O_{12}$. This work led to his greater interest in crystal growth processes, particularly the flux growth method. He made significant contributions to the understanding of the growth mechanisms involved in making crystals from high temperature solutions and co-authored several papers with Hans Scheel, John Brice and other well-known scientists. Two of his Ph.D., students, Peter Capper and Kevin Roberts, became important members of the crystal growth field. Dennis was a prolific author, writing both scientific journal papers (~ 100) and books. In 1970 and 1972 he co-authored two books with Tony Pointon, "*Physics for Electrical Engineers*" and "*Classical Thermodynamics*" (Longman and Penguin press respectively) and in 1975, after many years of collaboration with Hans Scheel, their well-regarded book "*Crystal Growth from High Temperature Solutions* (Academic Press). In 1973, together with Tony Pointon, he started the Association of Polytechnic Teachers becoming its inaugural General Secretary where he worked hard to achieve parity between the then polytechnics and the rest of the university sector. A vison finally achieved in 1992. He spent several summers as a visiting scholar, first at the Israel Institute of Technology (1969), followed by The IBM Research Laboratories in Zurich Switzerland (1971) and then in my group at Stanford University (1974 and 1975).

In 1975 I persuaded Dennis to join my Crystal Science group full time. This was in the government funded Center for Materials Research at Stanford University. He left England in 1977 for the last time with his first wife Jean and their two daughters Kathy and Susanne and settled in California until his retirement. At Stanford he directed activities in the new area of semiconductor crystal and thin film growth and characterization using electrochemical deposition techniques. One of the unique techniques he developed was the electrorefining of Si from sand above its melting point using a high temperature flux solution. This resulted in one of 4 patents he was awarded during his lifetime. He also was instrumental in getting the Stanford Crystal Science Lab. involved in a NASA program on the growth of protein crystals, and helped found the conferences (on-going for over 30 years) devoted to this subject. He also worked on a novel technique for stirring melts during growth using low frequency vibrations, and studied the various mechanisms involved in the melt growth of crystals such as GaN and $CsCdCl_3$. In 1979 he independently published his popular book *Man-Made Gemstones* (Ellis Harwood Press). Dennis was also a consultant for NASA and the European Space Agency. During his time at Stanford

he became an active member of the American Association for Crystal Growth (AACG), and for many years we were co-editors of the association newsletter.

In 1984 he left Stanford to take a position as Manager of the Crystal Growth Group in the Semiconductor Materials Division of the J.C. Schumacher Co. in Oceanside CA where he worked on their new low cost, low temperature, thermal decomposition process for producing polycrystalline Si. After Schumacher, (~1986) he joined the Diamond Cubic Corp, also in Oceanside, as Director of Crystal Growth. There he worked on the controlled precipitation of oxygen and nitrogen in VLSI silicon devices. Several years later (late 1980's) he joined the Hughes Aircraft Co. in Newport Beach as Chief Scientist/Engineer and manager of the technology Department of the Microelectronic Circuits Division. There he worked on a number patent producing projects including Multichip modules (MCM's) for defense avionics applications (1993-1996) and the preparation of multiple ceramic magnetic tapes at high production rates (1992). He also received a patent for developing a heat absorbing material for limiting temperature through isothermal solid-solid transitions in electronic assemblies. As late as 1988 he jointly published a paper in *Progress in Crystal Growth and Characterization* with his second wife Marge (Simkins) Elwell on the growth of GaN. In the late 1990's Dennis joined the short-lived San Diego start-up Magnum Defense. The goal was to develop equipment to produce biodegradable plastics. While they were successful, they could not obtain investor funding and the company was dissolved shortly thereafter.

In 2001, Dennis and Marge left the mainland and retired to Hawaii. Dennis, who loved to write, whiled away his early retirement years writing about the local Hawaiian culture. These books, *Historic Na'alehu-Hawaii's Deep South (2005)*, *Ka'u District* (2015) and History of Kahuku Ranch (Elwell Associates), one of the largest cattle ranches in Hawaii, were co-authored with Marge who died in 2016.

Dennis is survived by his third wife, Carol Ann Elwell of Discovery Harbor, daughters, Kathy Elwell and Susanne Elwell of San Francisco and San Jose respectively, and a sister, Christine Lunn of England. Dennis was very active in two religious communities in Hawaii , a Methodist Church and a Buddhist Temple. In that regard, in 2007 Dennis wrote a book called *Looking for God* (Paragon Agency).

Some quotes from fellow colleagues from the mid-1970's.

"He is a man of great personal charm, an effective organizer, a sound teacher, a popular person and a loyal colleague", William Bardsley, RSRE Malvern.

"I am most impressed by the unusual combination of breadth and depth in his work. I consider him as one of the rare scientists in the area of crystal growth who combine a thorough and critical understanding of physico-chemical concepts with a good deal of intuition", Prof. Franz Rosenberger. Univ Utah.

"*His publications are usually substantial in content and his work is marked by originality. He has made a very real contribution to the science of crystal growth and is acknowledged internationally as a leading expert in his field",* J.W. Mullin, Univ College London.

"In spite (or perhaps because) of his quiet reserved manner, Dennis has the ability to get things done without giving offence to anyone. He has great managerial and technical ability….and to pick projects and people. …As a colleague he is reliable, efficient, hard-working and extremely stimulating.", John Brice, Mullard Research Laboratories.

Submitted by Robert Feigelson

In Memoriam

Ken Jackson (1930-2022)

Ken Jackson gave us contributions to the theory of constitutional supercooling, surface roughening, including the famous Jackson alpha factor, the use of transparent analogs to understand crystallization, computer modeling of crystal growth, metal castings and so much more. We, of course, remember him for being one of the founding co-presidents of the AACG and his tireless efforts to give our community an independent identity. Ken leaves a rich legacy in his scientific family tree as a teacher, colleague, mentor and friend. I think we will all remember sharing a glass of good wine with him.

Bill Tiller (1929-2022)

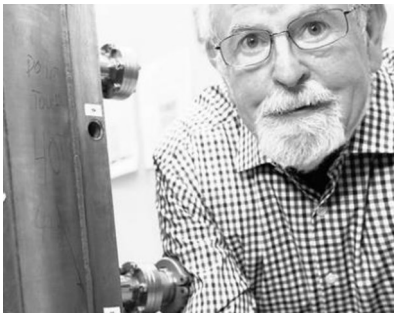
Bill Tiller and Ken Jackson will be forever linked by their seminal paper on the theory of constitutional superconducting and closely followed each other in passing last year. After graduating from the University of Toronto, he spent nine years at Westinghouse Laboratories before becoming became the first to be appointed (rather than promoted) to the rank of full professor in the Materials Science and Engineering Department at Stanford University. The Asaro-Tiller mechanism of morphology development in stress corrosion cracking became the foundation for a new line of theoretical work on shape evolution of strained epitaxial semiconductor films, including quantum nanostructures and quantum dots.

George Gilmer (1937-2022)

George Gilmer, a founder of the field of atomistic phenomena in materials through computer simulations and long time collaborator of Ken Jackson spent his career at Bell Labs, Lawrence Livermore Laboratories and the Colorado School of Mines doing what he loved best. George specialized in the field of crystal growth; modeling how crystals form at the molecular level. Physics, for George, was as much a hobby as a job. His coworkers remember him as a generous friend and mentor who significantly influenced others career paths with his enthusiasm. He taught many of his overseas postdocs to drive.

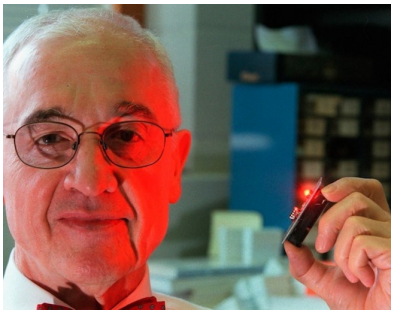
Glen Slack (1928-2019)

Glen Slack loved growing crystals so much he had a second act in retirement. He had a long career at GE Research and Development and RPI with substantial contributions in thermoelectric materials. Glen first demonstrated the possibility of bulk AlN crystal growth by the sublimation-recondensation method in the 1970s. Along with Leo Schowalter, he founded Crystal IS in 1997 to develop native Aluminum Nitride (AlN) substrate technology for more powerful and reliable semiconductor devicincluding processes for growing active crystal layers such as LEDs on the AlN substrates, while preserving the low defect densities of the AlN.



Kelvin Lynn (1948-2020)

Kelvin Lynn was the Boeing Chair of Advanced Materials Science at Washington State University. While working after hours in his high school chemistry lab he realized there were problems in science no one had the answers to—things you could do that no one else could.". He spent his early career at Brookhaven National Lab and earned a mention in Time magazine for his work disproving cold fusion and a spot on television's 20/20, as well as the ire of BNL management. He and his team built the first nuclear reactor-based positron beam only to prove that the particle they sought did not exist. He then built up the excellent WSU crystal growth facility, which survives his untimely death.



Nick Holonyak (1928-2022)

Nick Holonyak was known as the godfather of LED lighting and developed the first red LED in 1962. He once said "It's a good thing I was an engineer and not a chemist. When I went to show them my LED, all the chemists at G.E. said, 'You can't do that. If you were a chemist, you'd know that wouldn't work.' I said, 'Well, I just did it, and see, it works!'" He predicted that LED lighting would surpass other methods because, as he said "the current is the light!" Nick never took a sabbatical because, as he said I'm living in the playground where I go to play with an idea and see if I can make something." In spite of being the primary inventor, he was twice passed over for the Nobel Prize, but lives on in our memories.

Holger Juergensen (1957-2021)

Holger got his doctor degree at the Technical University Aachen in 1985 with a thesis on the growth of InP by HVPE. While working on his thesis he founded AIXTRON in 1983. He was the visionary who lead AIXTRON until 2002. He recognized early on the potential of III-V semiconductors for photonic applications and OMVPE as the method of choice for industrial production of film structures for devices. His vision made AXTRON one of the driving forces for the growth of the photonics industry enabling the mass production of Lasers, LEDs, solar cells, and VCSELs. Holger passed away unexpectedly in January 2021 after a short illeness at the age of 63.

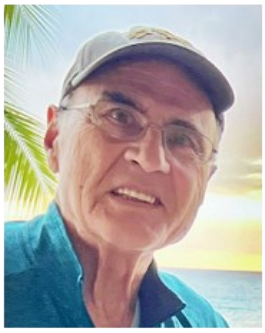
Kanai Shah (1961-2022)

Kanai Shah, President of Radiation Monitoring Devices, passed away early in 2022 at the age of 60. He was a dedicated materials scientist who worked for 35+ years on all varieties of crystals and devices for radiation detection. His contributions to the field included development of both semiconductor and scintillation crystals for radiation detection. He was proud of having developed new inorganic scintillators that were successfully brought into the commercial market by RMD. He authored over 230 technical papers and 35 patents.

In Memoriam

Bill Wilcox (1935-2021)

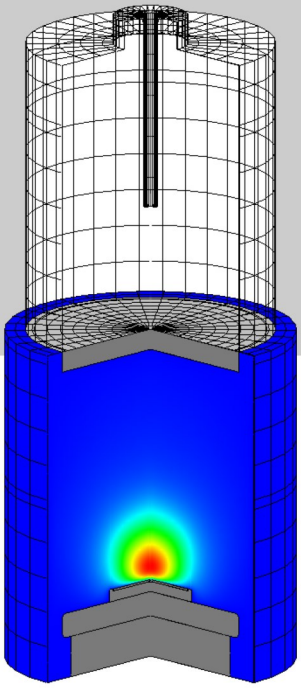
Bill Wilcox was an early member of the AACG and served as Vice President from 1984-1987. He was a beloved professor at Clarkson University after stints at TRW and USC. Bill had a 30-year association with NASA's microgravity materials research program. This included both ground-based research and experiments in Skylab, the Space Shuttle, and sounding rockets, as well as two sets of experiments performed by Wilcox himself on the notorious "vomit comet" low-gravity aircraft. A fond personal memory of Bill is when the slide projector for his talk blew a bulb and there was no replacement. He calmly went to the chalkboard and gave the whole talk without slides.



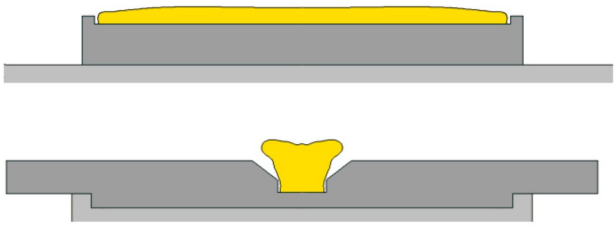
George Antypas (1940-2023)

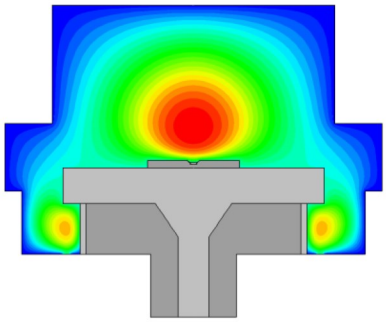
Born in Thessaloniki, Greece in 1940, George Antypas received a Fulbright Scholarship which enabled him to attend Anatolia College, an American high school in Thessaloniki. In 1959, he traveled to America pursue a college education at Washington State University where he earned a B.S., and M.S. in Electrical Engineering and a Ph.D. in Materials Science in 1962, 1963, and 1967 respectively. After graduating, he moved to Mountain View, where he met his future wife Jeannine, and began working at Varian Associates in Palo Alto. George pioneered the growth of indium phosphide crystals for semiconductor applications and in 1980 he founded CrystaComm Inc. to make indium phosphide wafers commercially available. George's contributions in early Silicon Valley include 60 published papers and nine patents, including patents for the photocathode used in 3rd generation night vision goggles. In 1992, George was elected a Fellow of the Institute for Electrical and Electronics Engineers (IEEE). George is remembered for his humility, generosity, quick wit and devotion to family.

DiaDeMo Software for MPCVD of Diamond

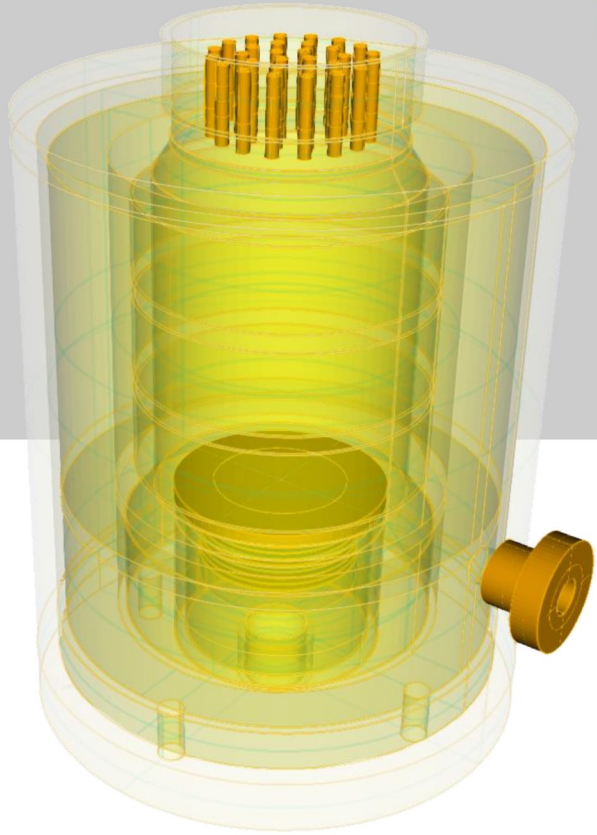


- Self-consistent distribution of electric field and plasma
- Gas and solid temperature
- Species concentration and flux
- Diamond growth rate and uniformity
- Parasitic deposition and soot formation

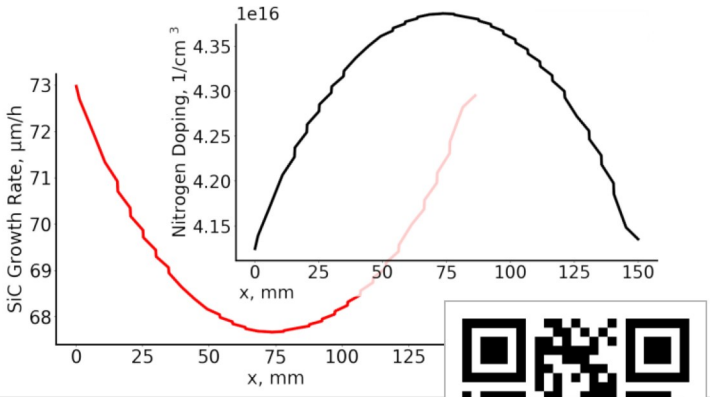




CVDSim3D Software for Modeling of Chemical Vapor Deposition Processes



- Gas flow
- Resistive, lamp, and RF heating
- Thickness and composition uniformity
- Doping and impurity incorporation
- Parasitic reactions and gas-phase nucleation



www.str-soft.com

Other STR products for simulation of bulk crystal growth and epitaxy include CGSim and Virtual Reactor.

CALL FOR PAPERS!

The 28th AACG Western Section Conference on Crystal Growth and Epitaxy

to be held from June 9 - 12, 2024 in beautiful Fallen Leaf Lake, California, USA

Keynote Speaker: Dr. Brent Constantz, Founder & CEO, Blue Planet Systems

Submission deadline: April 15, 2024

The 27th Western Section Conference aims to provide an interdisciplinary platform for researchers to discuss fundamental physics and chemistry across multiple scales that are central to the growth of crystals in technology, nature and the intersections between the two. Registration is all-inclusive and includes lodging, meals, all sessions, and recreational activities.

The conference focusses on current and emerging challenges in understanding, engineering, and design of crystal growth in nature and technology. We welcome contributions in areas such as crystallization of biological and biomimetic materials, synthesis of crystalline material systems for renewable energy, environment and sustainability, interplay between synthesis and performance of functional materials, and fundamental aspects of nucleation, growth and phase transformations in a wide range of crystalline material systems.

The final conference sessions will be determined based on submission interest. **As a guide, in the past the conference themes have included the following topics:**

Biological and Biomimetic Materials
crystallization of biological/biomimetic materials; mechanisms and dynamics of self-assembly, including supramolecular and/or hierarchical assembly of organic and biogenic materials (e.g., polysaccharides, proteins, peptides/peptoids, DNA and RNA, and synthesized polymers); nucleation, growth, morphology (e.g. chirality) and phase transformations of inorganic components in these systems; interplay between self-assembly and function; interactions at the inorganic-organic interface; machine learning/AI-based models for modeling biological/biomimetic crystallization; experimental, theoretical and computational approaches aimed at bridging fundamental principles and applications; challenges in biomimetic/bioinspired syntheses and scalable manufacturing.

Energy and Environmental Material Systems
nucleation, growth, and morphological evolution of material systems (e.g., metals, metal oxides, perovskites, and metal-organic frameworks) for energy harvesting, storage and conversion, catalysis, water treatment, environmental remediation, and climate change; interplay between crystallization and function in these material systems; crystallization at interfaces (electrode/solution, substrate/solution, membrane/solution, solution/solution), crystallization kinetics, morphology and structure-property relationships for in-device system performance and manufacturing; operando characterization methods and experimental techniques; theoretical, simulation and data-enabled machine learning approaches for understanding and engineered performance of these material systems; processing and manufacturing challenges.

Functional crystals and architectures
crystallization of functional materials (magnetic, optoelectronics, excitonic, photonics, plasmonic, phononic, thermoelectric, etc.); interplay between synthesis and functionality induced by chemistry and/or low-dimensionality (0D, 1D, 2D, thin films); thermodynamically dictated and/or seeded growth of band-gap engineered materials; surface/interfacial/domain wall engineering via controlled nucleation, growth and phase transformations; bottom-up self/directed assembly of architected and mesostructured materials; crystal growth based routes for synthesis of optical/mechanical metamaterials

Fundamentals of Crystallization
theoretical, experimental, and computational studies on nuclea-

tion, crystal growth, phase transformation; thermodynamics (crystal structure, shape, size) and kinetics (atomic-scale diffusion, reaction pathways) of bulk and low dimensional crystal growth; fundamentals of self- and directed-assembly; morphology, stress and interfacial microstructural evolution during crystal growth; inorganic and organic bulk crystallization from liquid-phase solutions and melts; crystal growth on surfaces, 2D interfaces or in confined spaces; near-/far from-equilibrium particulate assembly and fusion processes, including patchy particles; computational modeling techniques and data-enabled integrated genomic efforts understanding for crystal growth across scales; process modeling for scalable manufacturing of crystals.

Postdoctoral, graduate and undergraduate student participation is highly encouraged, with anticipated panel discussions for early-stage researchers for careers in academia, research laboratories and industry.

Sincerely,

Western Conference Chairs

Moneesh Upmanyu
Northeastern University

Peter Vekilov
University of Houston

Jong Seto
Arizona State University

David Kisailus
University of California at Irvine

Luis Zepeda-Ruiz
Lawrence Livermore National Laboratory

Registration and submission is open on the conference website:

https://www.aacgwest.org

Conference Sponsors

Blue Planet Systems®

AACG
AMERICAN ASSOCIATION FOR CRYSTAL GROWTH

Lawrence Livermore National Laboratory

Pacific Northwest
NATIONAL LABORATORY