

Report

18th International Conference on Crystal Growth and Epitaxy (ICCGE-18)

With our Japanese colleagues, we started a discussion on a proposal to host the 18th International Conference on Crystal Growth and Epitaxy (ICCGE-18) in 2008 in Japan. We sent a letter to Professor Chernov, who was the chairperson of the International Organization for Crystal Growth (IOCG), to put forward our proposal for ICCGE-18, which was held in Japan in 2016. We also sent an official proposal to IOCG to host ICCGE-18 in March, 2010. The IOCG then selected Japan as a host country of ICCGE-18 during the general assembly of ICCGE-16 in Beijing (2010).

The Japanese working group created an organizing committee for the 18th International Conference on Crystal Growth and Epitaxy (ICCGE-18) within the Japanese Association for Crystal Growth (JACG). The co-organizations (the Japanese Society of Applied Physics, JSAP, and the JACG) and the Japanese Council of Science were established in 2014 and 2015, respectively. After discussions within the working group, we selected the city of Nagoya as the conference site, because it is home to numerous researchers who work on crystal growth.

To promote our crystal-growth community, we proposed to the Science Council of Japan to serve as one of the organizers. We had two interviews with the Science Council of Japan, in which we faced severe competition from various scientific disciplines, including medical and pharmaceutical sciences, before gaining confirmation as organizer in 2014. Fortunately for our cause, Professor Akasaki, Professor Amano, and Professor Nakamura won the 2014 Nobel Prize in Physics for their work on blue light-emitting diodes, which supported our effort to gain confirmation from the Science Council of Japan as one of the organizers. With this support, we were honored to have the opportunity to invite the Crown Prince to the opening ceremony and plenary lecture given by Professor Akasaki. The invitation of the Crown Prince provided cause for a one hour lecture to the Crown Prince at the Crown Prince's Palace on July 12, 2016.

After this success, we gained support from the Japan Ministry of Education, the International Union for Crystallography (IUCr), and others. Consequently, the four main co-organizers of ICCGE-18th were the Japanese Association for Crystal Growth, the International Organization for Crystal growth, the Japanese Society of Applied Physics, and the Science Council of Japan. The conference was sponsored and supported by many universities, institutions, companies, and individuals.

The origin of ICCGE can be traced back to the conference held during a heat wave in Boston in June, 1966. Since then, these conferences have encouraged communication and discussion on crystal growth throughout the world. Under the leadership of International Organization for Crystal Growth, the ICCGE has been held during the summertime every three years. In 1974, 1989,

and 2001, the 4th, 9th, and 13th, ICCGE were held in Tokyo, Sendai, and Kyoto

Due to the long worldwide economic recession, we were concerned we would not receive many abstracts from around the world. Thus, with support from the IOCG, we sent many e-mails, including the first call for papers, to members of the worldwide crystal-growth community. We sincerely appreciate the efforts of the IOCG, which paid off with 1030 submissions. Since we received many cancelations after finalizing the program, we sent further e-mails to confirm attendance at the conference. The final number of accepted paper was 1020.

The theme of this conference was “Innovation Platform for Crystal Growth based on Fundamentals.” The spirit of the theme was to create an innovative platform for crystal growth through a collaboration between basic science and engineering. To realize this idea, ICCGE-18 provided sessions with presentations and discussion of the recent research and development activities in all aspects of crystal growth. The conference consisted of the plenary, topical, and general sessions as follows: (<http://www.iccge18.jp/>)

Plenary Sessions

Plenary 1: Isamu Akasaki (Meijo University, Japan *2014 Nobel Prize Laureate): Invention of GaN p-n junction blue LEDs.

Plenary 2: Zbigniew Galazka (IKZ Berlin, Germany) Advances in bulk crystal growth of transparent semiconducting oxides.

Plenary 3: Daan Frenkel (University of Cambridge, UK) The role of nucleation in complex self-assembly.

Plenary 4: Zhanggui Hu and Chuangtian Chen (Chinese Academy of Sciences, China) Research progress and prospect of UV nonlinear optical crystals.

Plenary 5: Hiroshi Amano (Nagoya University, Japan *2014 Nobel Prize Laureate) Growth of nitride crystals to solve global issues.

Plenary 6: Frances Ross (IBM Yorktown Heights, USA) A dynamic view of nanostructure growth.

Plenary 7: Thomas Kuech (University of Wisconsin, USA) MOVPE Chemistry and process modeling: Where are we and what can we do?

■ General Session (Fundamentals & Growth Technologies)

G01: Fundamentals of Nucleation and Crystal Growth: Theory, modeling, and experiments designed to learn the fundamental aspects of nucleation and crystal growth. Thermodynamics of interfaces.

G02: Surfaces and Interfaces: Surface and interface science including the structure of solid-liquid interfaces, surface defects, and surfactants. Stress evolution during growth. Morphological stability.

- G03: Nanomaterials and Low-Dimensional Structures: Synthesis of nanoparticles, quantum dots, nanowires, nanotubes, and other low-dimensional structures. Materials for additive manufacturing. Precise fabrication of nanometer-scale structures by lithography, self-assembly, chemical synthesis, etc. Applications in areas of energy conversion, storage, magnetics, optoelectronics, quantum computation, nanoelectromechanical systems, and semiconductor electronics.
- G04: Thin Films and Epitaxial Growth: Physical, chemical, and technological aspects of epitaxial growth.
- G05: Organic and Biological Crystallization: Current advancements in biomineralization, macromolecular crystallization, protein-crystal growth, and bio-inspired materials synthesis. Biomimetics, learning from nature to grow organic and biomacromolecular crystals.
- G06: Bulk Crystal Growth: Bulk crystal growth including crystallization mechanisms and morphological instabilities. Development of new methods and approaches for bulk growth. Novel materials and structures.
- G07: Defect Formation: Studies of the mechanisms of defect formation in crystals. Investigations of crystal chemistry, crystalline structure, and physical properties.
- G08: Advanced Growth Technologies: Growth of advanced multidisciplinary inorganic materials. Investigations of crystal chemistry, crystalline structure, and physical properties.
- G09: In situ Observation and Characterization: Recent advancements in in situ monitoring methods. Microscopy, spectroscopy, topography, scattering, and other characterization techniques.
- G10: External Fields, Microgravity: Nucleation and crystal growth under external fields, including reduced gravity, magnetic, and electric fields.
- G11: Industrial Crystallization: Innovations made over the last decade in the area of industrial crystallization. Equipment for industrial crystal growth. Crystal preparation such as cutting, polishing, and structuring. Food, cosmetics, and pharmaceutical crystallization.

■ Topical Session (Materials & Applications)

- T01: III-V Semiconductors: Bulk and epitaxial growth of III-V semiconductors.
- T02: Group IV Semiconductors: The latest progress in growth of group IV semiconductors such as Si, Ge, and SiGe.
- T03: 2D Materials: Growth and application of graphene and other two-dimensional materials.
- T04: II-VI and Oxide Materials: Growth of HgCdTe, ZnSe, ZnO, and CdTe, as well as other II-VI and oxide materials.
- T05: Materials for Spintronics: Growth of spintronic materials including diluted magnetic semiconductors, oxides, and metals.

T06: Materials for Optical Devices: Crystal growth and characterization of materials for optical devices such as lasers, nonlinear optics, solar cells, and magneto-optic materials.

T07: Materials for Electron Devices: Preparation and characterization of advanced materials for electron devices.

T08: Materials for Organic Devices and Bio Applications: Functional materials and devices for organic electronics and bio applications. Thin film growth, self-assembly, and self-organization.

T09: Nitride Semiconductors: Recent progress and outlining future directions in the field of bulk substrates and thin film growth of III-Nitrides.

T10: Silicon Carbide: Scientific and technological advances in the field of SiC and related materials such as diamond.

■ Joint Session

J01: Growth Simulation and Practice

The technical program included both oral and poster sessions, as well as plenary and invited talks to provide a complete picture of the latest developments in the fields.

The IOCG Frank Prize at ICCGE-18 was awarded to Professor Stringfellow (University of Utah, USA) for his pioneering work in the development of the foundations of organometallic vapor phase epitaxial growth of compound semiconductors. His contributions include the delta-lattice-parameter model for the calculation of the enthalpy of mixing, the roles of strain and surfactants in the growth of semiconductor compounds, the development of a model to accurately predict the composition of semiconductor alloys, and the development of new alloys. These compounds have found widespread applications in, for example, LEDs, transistors for cell phones, and high-efficiency solar cells.

The ICCGE-18 Laudise Prize was awarded to Professor Chung-Wen Lan (National Taiwan University) for his development of crystal-growth technology for high-performance multicrystalline silicon for the solar cell industry. The growth of low-cost, high-quality crystalline material underlies the increasing impact of silicon solar cells. Controlling defects and grain size are critical for this, and Professor Lan proposed in 2011 a novel method in which silicon ingots are grown starting from small uniform grains formed either from small seeds or from nucleation agents. This method gives material of excellent quality with high yield and results in high-efficiency solar cells.

The ICCGE-18 Schieber Prize was awarded to Dr. Van Driessche (IS Terre, CNRS, University Grenoble Alpes, France). After graduating from CSIC-University of Granada, Spain, in 2007, Dr. Van Driessche made significant contributions to several of the central fields of crystal

growth. His thesis work focused on the nucleation of protein crystals and involved in situ observation of the growth dynamics of these crystals. Since that initial work, he has focused on the nucleation and growth of crystals ranging from the study of nano-crystallites to the giant gypsum crystals in the Naica mine in Mexico.

The reception was held on Sunday, August 7, 2016 and counted about 500 participants from all over the world, despite the 28 °C temperatures in Nagoya at the time. We met old friends and started many fruitful discussions on crystal growth.

The opening ceremony was held on Monday, August 8. The ceremony started in the presence of the Crown Prince, the president of the Japanese Council of Science, the Governor of Aichi Prefecture, and the Mayor of Nagoya. All the greetings were in English to facilitate communication between participants from around the world. After the ceremony, the first plenary talk was given by Professor Akasaki on the history of blue light-emitting diodes. The Crown Prince attended the plenary talk.

The conference excursion was held on Wednesday, August 10 in the afternoon. We enjoyed several courses: Ise grand shrine, Nagoya Brewery, and Atsuta shrine, Toyota automobile museum and Railway museum. Even if the temperature in Nagoya exceeded 37 °C, we really relaxed and enjoyed the excursion. We are grateful to the members of the local organizing committee for their enthusiastic arrangement of the excursion.

A general assembly was held August 11 in the afternoon. The assembly included the next ICCGE, which is The 19 th International Conference on Crystal Growth and Epitaxy (ICCGE-19). The ICCGE-19 will be held in Keystone, CO, USA in August 2019. The Conference Co-Chairs are Prof. Jeff Derby and Dr. Vince Fratello; Program Committee Co-Chairs: Prof. Chris Wang and Dr. Peter Schunemann. The Summer School ISSCG-16 will be co-organized by Prof. Thomas Kuech and Prof. Joan Redwing.

The bid was presented by representatives of the Italian Crystal Growth Section to hold ICCGE-20 in Naples (7-12 August 2020) and ISSCG-18 in Parma (1-6 August 2020) which was accepted by the Executive Committee and therefore submitted to Council and General Assembly for final approval. Conference Co-Chairs are Dr. Andrea Zappettini and Dr. Antonio Vecchione. The Summer School will be co-organized by Prof. Roberto Fornari and Dr. Edmondo Gilioli.

After a general assembly at the conference site, the banquet was held on Thursday, August 11 in the evening at the Marriott Hotel near Nagoya Station. More than 450 attendees enjoyed the banquet including the “Ninja” Play and elegant dance music played by “Maikos-Geikos” who were invited from Kyoto. The banquet included the IOCG prize ceremony, and award plates and a Japanese watch were distributed, both of which were provided by the IOCG president, Professor Fornari, and the co-vice presidents Professor Vlieg and Professor Kuech, and Ms. Wetering. At the end of the banquet, our American colleagues announced ICCGE-19 in Colorado in 2020.

The conference contained both scientific and commercial exhibits. A total of 73 companies and organizations presented their activities during the conference. In addition to the exhibits, several companies such as Japanese-Sake and candy makers provided the participants with a seemingly endless quantity of spirits and sweets, which greatly boosted our enjoyment of the exhibition time. We really appreciate their kind support. A photo contest was also organized during the conference: 25 attractive photos were nominated, and the winner was selected by a vote of the participants. Five nominators shared the prize.

The closing ceremony was held in the afternoon of Friday, August 12. The statistics of the conference are as follows: The total number of participants was 1189, which includes accompanying persons. We received 300 manuscripts; such a large number of participants and submitted abstracts required intense efforts from our executive members and program-session chair persons. At the end of the closing remarks, the chairperson expressed sincere gratitude for all their efforts.

Preparations for this conference took nearly six years, starting with our proposal. Many persons were involved during this period for the preparation. Professor Mori spent a huge amount of time on this preparation, especially to solicit financial support from many companies. We could not have enjoyed the conference without his enthusiastic contribution. The co-chair also expresses sincerely gratitude to all those who helped with the organization: all of the members of the ICCGE-18 Organizing Committee, the Japanese Advisory board, the International Advisory committee, the Executive Committee, the Program Committee, the Publication Committee, the Local Committee, the Exhibition Committee, and the Fund Raising Committee. We also express sincere gratitude to Polaris Secretaries and Keitis Corp. for their enthusiastic support, including for the conference sequence and for the invitation for the Crown Prince to attend the beginning of the conference. We would also like to express our sincere gratitude to JTB for arranging excursion and hotel reservations. Finally, we would like to express our thanks to the Nagoya Congress Center for the use of their numerous, excellent rooms and halls during the conference.

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Poland 110
China 74
Germany 73
Russian Federation 59
United States 31
Ukraine 17
Korea, South 17
Taiwan 17
United Kingdom 16
France 15
India 15
Spain 9
Romania 9
Italy 8
Belgium 7
Latvia 7

Netherlands 6
Canada 5
Switzerland 5
Czech Republic 4
Australia 4
Algeria 4
Slovakia 3
Saudi Arabia 3
Austria 3
Brazil 2
Norway 2
Singapore 2
Denmark 2
Finland 2
Israel 2
Thailand 2
South Africa 2
Turkey 1
Hungary 1
Armenia 1
Kazakhstan 1
Mexico 1
Sweden 1
Belarus 1
Estonia 1
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