

## Report

### 20<sup>th</sup> International Conference on Crystal Growth and Epitaxy (ICCGE-20)

#### History and Contest

At the beginning of 2016 we started discussing with some colleagues from the Italian community involved in crystal growth and epitaxy the possibility of hosting the International Conference on Crystal Growth and Epitaxy (ICCGE-20) in Italy in 2022. This conference had never been organized in Italy and the Italian materials scientists, engineers, physicists and chemists were ready for this event. After having verified the feasibility of the conference in various Italian cities, the choice fell on Naples for several reasons: i) Naples is a beautiful ancient town, ii) it is easy to reach with a good International airport, iii) the historic University of Naples 'Federico II' had immediately made itself available to make its facilities accessible for the event in the heart of the city, iv) Naples has a wide choice of hotels for all budgets. Furthermore, among the universities and research centers between Naples and Salerno area there were many colleagues who had made themselves available to join other colleagues from other Italian research institutions to be part of the local organizing committee of the conference.

The bid to hold ICCGE-20 in Naples (in August 2020) and ISSCG-18 in Parma (in July 2020) was presented in Nagoya, Japan (2016) by representatives of the Italian Crystal Growth Section of the Italian Association of Crystallography and was accepted by the International Organization of Crystal Growth (IOCG) Executive Committee and therefore submitted to IOCG Council and IOCG General Assembly for final approval. The proposed Conference Co-Chairs were Dr. Andrea Zappettini and Dr. Antonio Vecchione. Prof. Roberto Fornari and Dr. Edmondo Gilioli were proposed as Co-Chairs of the Summer School.

The Italian working group created an organizing committee involving the Italian Association of Crystallography, the CNR-SPIN and CNR-IMEM Institutes.

In the meanwhile, it was obtained institutional support from Consorzio Interuniversitario Nazionale per la Scienza e Tecnologia dei Materiali, European Crystallographic Association, Department of Chemistry and Biology-University of Salerno, International Union of Crystallography, Department of Physics-University of Naples and the patronage of the municipality of Naples. ICCGE-20 was organized based upon work supported by the Air Force Office of Scientific Research under award number FA8655-23-1-7014. The conference contained both scientific and commercial exhibits. A total of 10 companies and organizations presented their activities during the conference.

Under the leadership of IOCG, the ICCGE has been held during the summertime every three years. The last two editions before the one in Naples were held in Nagoya in 2016 and in Keystone in Colorado (USA) in 2019. The edition in Naples was scheduled for 2022 but due to the well-known events connected with the COVID-19 pandemic it was decided by the IOCG Executive Committee to postpone the edition organized in Italy to 2023. Unfortunately, other factors intervened that greatly influenced participation in the ICCGE-20 such as the post-pandemic, the world-wide economic recession and the war in Europe. All these factors, combined with the concomitance of two other important conferences related to crystal growth such as ACCGE-23 held in Tucson, Arizona, USA and the Congress and General Assembly of the International Union of Crystallography held in Melbourne, Australia have reduced the number of participants expected for the conference and, consequently, also the number of abstracts submitted.

## **ICCGE-20**

The 20<sup>th</sup> International Conference on Crystal Growth and Epitaxy (ICCGE-20) took place from July 30<sup>th</sup> and August 4<sup>th</sup> 2023 at University of Naples 'Federico II' Campus in San Giovanni a Teduccio. All details of the Conference are available at the Conference Web Pages (<https://www.iccge20.org/>). The Conference was chaired by Antonio Vecchione (Italy) and Andrea Zappettini (Italy). The secretarial work for the Conference was carried out by Scientific Communications s.r.l. (<https://www.jeangilder.it/>).

## **Scientific program**

### *Presentations*

ICCGE-20 provided sessions with presentations and discussion of the recent research and development activities in all aspects of crystal growth and epitaxy. The conference consisted of 5 plenary speakers, 292 invited and oral contributions and 211 poster contributors distributed in seven parallel sessions.

The detail of the plenary talks are as follows:

Plenary 1: Peter Vekilov (University of Houston, USA) - Molecular mechanisms to control crystal nucleation.

Plenary 2: Boaz Pokroy, Technion (Israel Institute of Technology, Israel) - From unravelling crystal growth strategies in nature to their implementation in synthetic systems.

Plenary 3: Chung-Wen Lan (National Taiwan University, Taiwan) - 20 years crystal growth of solar silicon: my serendipity journey.

Plenary 4: Anna Fontcuberta I Morral (EPFL Lausanne, Switzerland) - Selective area epitaxy for next generation quantum computing and photovoltaics.

Plenary 5: Andrea Caviglia (Université de Genève, Switzerland) - Oxide interfaces: a versatile platform for material design and ultrafast light control.

### *Topics*

The topics of the scientific sessions are reported below:

#### 2D Materials

Advances in observation and characterization methods

Bulk crystal growth

Composite and hybrid crystals

Crystalline solids for drugs and pharmaceuticals

Crystallization of organic and biological systems

Crystals for photovoltaics and green energy

Functional crystals

Fundamentals of nucleation and crystal growth

Growth at the nanoscale: nanocrystals, nanowires, nanomaterials

Industrial crystal growth technology and equipment

Modelling and artificial intelligence of crystal growth processes

New methods and techniques for crystal growth

Optical crystals

Semiconductors

Structural defects and impurities in crystalline materials

Surfaces and Interfaces

Thin films and epitaxial growth

Topological quantum materials

### *Prices*

The IOCG Frank Prize was awarded to Peter Vekilov, University of Houston (USA) and Juan Garcia-Ruiz, Instituto Andaluz de Ciencias de la Tierra (Spain) for fundamental advances in understanding

crystallization from solutions through discoveries of two step-nucleation, the role of surface diffusion, sources of step instabilities, and the emergence of life-like morphologies, mineral patterning, and giant single crystals, in complex and natural chemical environments.

The IOCG Laudise Prize was awarded to Peter Rudolph, Crystal Technology Consulting (Germany) for for unmatched deep understanding of crystal growth fundamentals combined with a skill of technological practice in the field of various semiconductors (II-IV, III-V and silicon), these important results on liquid clustering, point defects, dislocation networks and the use of magnetic fields having been successfully incorporated into industrial crystal production.

The Journal of Crystal Growth Schieber Prize was awarded to Bharat Jalan, University of Minnesota (USA) as young author for innovative work and scientific leadership in the field of crystalline oxide film and hetero-structure synthesis and properties, particularly the development a powerful method known as hybrid molecular beam epitaxy (h-MBE), an important and impactful epitaxial growth technique with extraordinary capabilities and diverse applications.

The Scientific Council of the Institute of Physical Chemistry at Bulgarian Academy of Sciences in association with the ICCGE20 Conference Chairs awarded the “Rostislav Kaishev” Prize for best oral presentation given by a young scientist. The award, given on the occasion of the 115th anniversary of Rostislav Kaishev’s birth, was conferred to Isha Bade, Imperial College London (UK) and to Artur Tuktamyshev, University of Milano Bicocca (Italy).

A photo contest sponsored by Elsevier was also organized during the conference: 37 attractive photos were nominated, and the winner was selected by a vote of the participants. The winners were Arnab Kar, Indian Institute of Science Bangalore (Natural photograph section); Alexandru Moldovan, Cambridge Crystallographic Data Center (Digital photography section); Uta Michibata, Osaka University (Student section).

### *Social events*

The welcome reception was held on Sunday, July 30th, 2023 at the Santa Maria la Nova convent and church in Naples and counted 330 participants from all over the world. The Registration Desk was open from 17:30 to 20:00. At 17:30 and 18:00 guided tours of the Convent and Church was offered to the participants.

The opening ceremony was held on Monday, July 31<sup>st</sup> at University of Naples ‘Federico II’ Campus in San Giovanni a Teduccio. The ceremony started in the presence of the Prof. Angela Altomare (president of Italian Association of Crystallography), Prof. Salvatore Amoruso (on behalf of the Rector of University of Naples), Prof. Koichi Kakimoto (president of IOCG). After the opening ceremony, the scientific program started. The conference excursion was held on Wednesday, August 2<sup>nd</sup> in the afternoon. The participants enjoyed the ruins of Pompeii and Herculaneum. The social dinner was



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held on Thursday, August 3rd at 19:30 at National Railway Museum of Pietrarsa. More than 340 attendees enjoyed the banquet. The closing ceremony was held in the afternoon of Friday, August 4<sup>th</sup>.

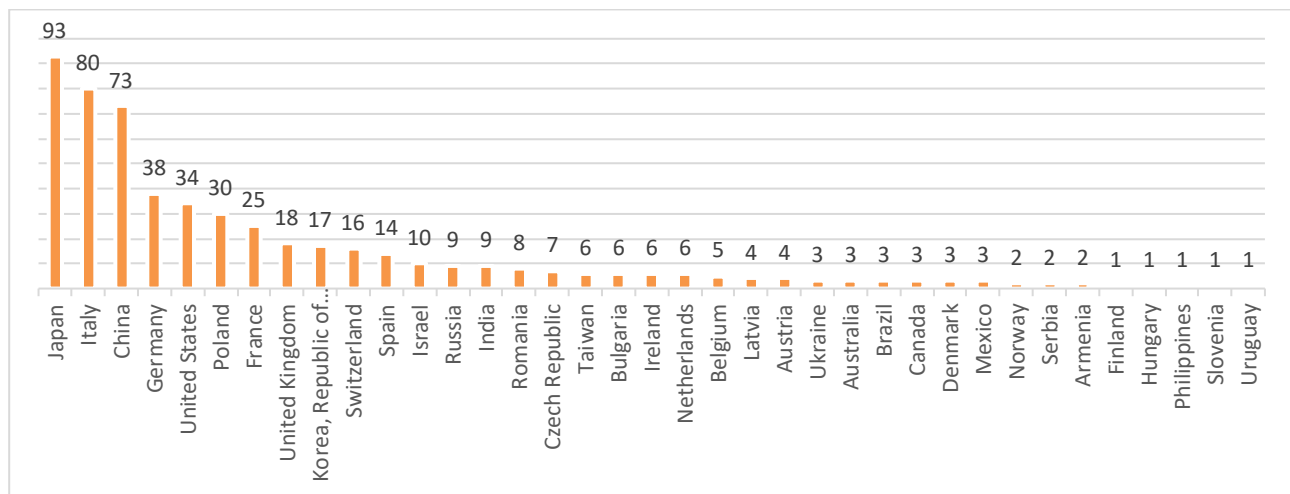
#### *IOCG activities*

The IOCG Executive Committee Meeting was held on Monday, July 31<sup>st</sup>, the IOCG Council Meeting was held on Tuesday, August 1<sup>st</sup> while the IOCG general assembly was held August 3<sup>rd</sup> in the afternoon. The assembly included the next ICCGE, which is the 22 International Conference on Crystal Growth and Epitaxy (ICCGE-21). The ICCGE-22 will be held in Grenoble, France in August 2028.

## ICCGE-20 Statistics

The statistics of the conference are as follows:

The total number of participants was 547. The country of origin of the participants is report in the following figure:



We received 605 abstracts; 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.

### Conference Proceedings

The conference proceedings are published on a Special Issue of Journal Crystal Growth. 73 manuscripts are in the publication process.

### The ICCGE-20 Committees

#### Conference Chairs

Antonio Vecchione, SPIN-CNR, Salerno, Italy

Andrea Zappettini, IMEM-CNR, Parma, Italy

#### Conference Program Chairs

Geetha Balakrishnan, University of Warwick, United Kingdom

Giuseppe Falini, University of Bologna, Italy



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Journal of Crystal Growth Proceedings

Geetha Balakrishnan, University of Warwick, United Kingdom

Rosalba Fittipaldi, SPIN-CNR, Salerno, Italy

Luca Seravalli, IMEM-CNR, Parma, Italy

Local Organizing Committee

Salvatore Amoruso, University of Naples Federico II, Naples, and INFN, Naples, Italy

Raja Arumugam, SPIN-CNR, Salerno, Italy

Matteo Bosi, IMEM-CNR, Parma, Italy

Marco Cannavacciuolo, University of Salerno, Salerno, and INFN, Naples, Italy

Davide Calestani, IMEM-CNR, Parma, Italy

Rosalba Fittipaldi, SPIN-CNR, Salerno, and INFN, Naples, Italy

Anita Guarino, SPIN-CNR, Salerno, Italy

Annalisa Guerri, University of Florence, Florence, Italy

Mariateresa Lettieri, SPIN-CNR, Salerno, Italy

Antonella Secondulfo, IMEM-CNR, Parma, Italy

International Advisory Committee

Lynda Amirouche, Université des Sciences et de la technologie Houari Boumediène, USTHB, Algérie

Monika Budayova-Spano, Université Grenoble Alpes, UMR 5075 CEA/CNRS/UGA, France

Andrea Caviglia, Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands

Naomi Chayen, Imperial College London, United Kingdom

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James De Yoreo, Pacific Northwest National Laboratory, USA

Jeffrey J. Derby, University of Minnesota, USA

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Pavel P. Fedorov, Russian Academy of Sciences, Russia

Roberto Fornari, University of Parma, Italy

Laura Fornaro, Universidad de la República, Uruguay

Christiane Frank-Rotsch, Leibniz Institute for Crystal Growth, Germany

Vincent Fratello, Quest Integrated- LLC, USA

Jochen Friedrich, Fraunhofer Institute for Integrated Systems and Device Technology, Germany

Yoshinori Furukawa, Institute of Low Temperature Science, Hokkaido University, Japan

Enrico Giannini, University of Geneva, Switzerland

Brian Glennon, University College Dublin, Ireland

**Organizing Secretariat: Scientific Communication srl**

Via G. Palermo 45, 80131, Naples - email: [info@iccge20.org](mailto:info@iccge20.org)

Conference website: [www.iccge20.org](http://www.iccge20.org)



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László Gránásy, Wigner Research Centre for Physics, Hungary  
Franca Jones, Curtin University, Australia  
Koichi Kakimoto, Research Institute for Applied Mechanics, Kyushu University, Japan  
Dobrosława Kasprowicz, Poznań University of Technology, Poland  
Zdenek Kozicek, Institute of Physics of the Czech Academy of Sciences, Czech Republic  
Stanislaw Krukowski, Polish Academy of Sciences, Poland  
Chung-Wen Lan, National Taiwan University, Taiwan  
Hans Eric Lundager Madsen, University of Copenhagen, Denmark  
Dominique Maes, Vrije Universiteit Brussel, Belgium  
Tariq Mahmud, University of Leeds, United Kingdom  
Wolfram Miller, Leibniz-Institut für Kristallzüchtung, Germany  
Abel Moreno, Universidad Nacional Autónoma de México, Mexico  
Dorota A. Pawlak, Institute of Electronic Materials Technology, Poland  
José Luis Plaza, Universidad Autónoma de Madrid, Spain  
Boaz Pokroy, Technion – Israel Institute of Technology, Israel  
Igor Pritula, Institute for Single Crystals of NASU, Ukraine  
Andrey Prokofiev, Technische Universität Wien, Austria  
Perumal Ramasamy, SSN College of Engineering, India  
Bogdan Ranguelov, Institute of Physical Chemistry – Bulgarian Academy of Sciences, Bulgaria  
Joan M. Redwing, 2D Crystal Consortium – NSF Materials Innovation Platform (2DCC-MIP), Pennsylvania State University, USA  
Michael Roth, The Hebrew University of Jerusalem, Israel  
Joop H. Ter Horst, University of Strathclyde, United Kingdom  
Satoshi Uda, Tohoku University, Japan  
Matias Velazquez, French National Centre for Scientific Research (CNRS-SIMaP), France  
Daniel Vizman, West University of Timisoara, Romania  
Elias Vlieg, Science Radboud University, The Netherlands  
Alexey Voloshin, Shubnikov Institute of Crystallography – Russian Academy of Sciences for Physics  
Jiyang Y. Wang, Shandong University, China  
Evgeny Zharikov, Russian Academy of Sciences, Russia

*Conference Session Chairs*

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2D Materials:

Silvia Milita, IMM-CNR, Italy -

Joan M. Redwing, PennState College of Earth and Mineral Sciences, USA

Advances in observation and characterization methods:

Alessandro Bombardi, DIAMOND Light Source, UK

Cinzia Giannini, CNR-Istituto di Cristallografia, Italy

Luke Rhodes, University of St Andrews, United Kingdom

Bulk crystal growth:

Rosalba Fittipaldi, SPIN-CNR, INFN, Italy

Sabine Wurmehl, IFW Dresden, Germany

Composite and hybrid crystals:

Abel Moreno, Universidad Nacional Autónoma de México, Mexico

Dritan Siliqi, CNR, Italy

Stéphane Veessler, CNRS, France

Crystalline solids for drugs and pharmaceuticals:

Lucia Maini, University of Bologna, Italy

Tariq Mahmud, University of Leeds, United Kingdom

Crystallization of organic and biological systems:

Simona Fermani, University of Bologna, Italy

Consiglia Tedesco, University of Salerno, Italy

Crystals for photovoltaics and green energy:

Jochen Friedrich, Fraunhofer Institute for Integrated Systems and Device Technology, Germany

Stefano Rampino, IMEM-CNR, Italy

Functional crystals:

Alberta Bonanni, Johannes Kepler University, Austria

Adele Sassella, University of Milano-Bicocca, Italy

Fundamentals of nucleation and crystal growth:

Linda Pastoro, University of Torino, Italy

Silvia Rizzato, University of Milan, Italy

Elias Vlieg, Science Radboud University, The Netherlands



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Growth at the nanoscale: nanocrystals, nanowires, nanomaterials:

Florinda Costa, University of Aveiro, Portugal  
Richard Noetzel, South China Normal University, China  
Stefano Sanguinetti, University of Milano-Bicocca, Italy

Industrial crystal growth technology and equipment:

Alison Lewis, University of Cape Town, South Africa  
Jaime Gómez Morales, CSIC-UGR, Spain  
José Luis Plaza, University Autónoma of Madrid, Spain

Modelling and artificial intelligence of crystal growth processes:

Natasha Dropka, IKZ Institute, Germany  
Toru Ujihara, Nagoya University, Japan

New methods and techniques for crystal growth:

Christo Guguschev, IKZ Institute, Germany  
Jan Pehchal, Institute of Physics, Czech Academy of Sciences, Czech Republic

Optical crystals:

Carlo Altucci, University of Naples Federico II, Italy  
Dobrosława Kasporowicz, Poznań University of Technology, Poland

Semiconductors:

Matthias Bickermann, IKZ Institute, Germany  
Roberto Fornari, University of Parma, Italy

Structural defects and impurities in crystalline materials:

Claudio Ferrari, IMEM-CNR, Italy  
Jean-Pierre Landesman, University Rennes, France  
Oscar Martínez Sacristán, Universidad de Valladolid, Spain

Surfaces and Interfaces:

Raffaella Calarco, IMM-CNR, Italy  
Letizia Savio, IMEM-CNR, Italy

Thin films and epitaxial growth:

Fabio Miletto-Granozio, SPIN-CNR, Italy  
Lucia Sorba, NANO-CNR, Italy

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Topological quantum materials:

Anna Isaeva, University of Amsterdam, The Netherlands

Gang Cao, University of Colorado at Boulder, USA

Mario Cuoco, SPIN-CNR, Italy

### **Final remarks**

Preparations for this conference took nearly six years, starting with our proposal. Many persons were involved during this period for the preparation.

The program chairs Geetha Balakrishnan and Giuseppe Falini were the pillars of the scientific program. We could not have enjoyed the conference without their enthusiastic contribution. The co-chairs also express sincerely gratitude to all those who helped with the organization: all of the members of the ICCGE-20 Organizing Committee, the International Advisory committee, the Session Chairs, the Exhibitors.

We also express sincere gratitude to Scientific Communications staff for their enthusiastic support. Finally, we would like to express our thanks to the University of Naples for the use of their numerous, excellent room and halls during the conference.

Antonio Vecchione ICCGE-20 Co-chair  
Andrea Zappettini ICCGE-20 Co-Chair