

COORDINATING TECHNICAL COMMITTEE ANNUAL REPORT 2018

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1. Executive Summary

A business meeting took place on 23rd September, 2018 in Yokohama, Japan, during the annual ICG meeting. In addition to this meeting, telephone conferences amongst the CTC members were organized bimonthly.

The meetings focused on a summary of activities, presented by the cluster coordinators. The Steering Committee decided to provide financial support to stimulate the development of new actions in the TCs. Several special events, such as expert workshops and schools, were organized. The CTC followed and evaluated the outcome of such events.

The CTC monitored the activity of the TCs and took care of the necessary adaptations of the TC structure.

1.1 Cooperative actions of the technical committees

The main actions performed by TCs are Round Robin tests and organization of conferences and symposia. A complete description of these cooperative actions is given in the following sections. The Summer and Winter Schools are written up as press releases for advertising purposes. Abridged versions of these press releases are presented below.

1.2 ICG Schools & Workshops

This year marked the 10th Anniversary of the ICG Summer Schools in Montpellier, France. A few though arrived late for the school because of transport upheavals the previous day in Paris following strike action; sadly they were delayed for a second time by the building work in Montpellier!

The first day was run as a single session for both the basic science stream and for those who had come to learn about bio and pharma glasses. 40 students were present, of whom a quarter were primarily registered for the bio stream. The temperatures outside were high, around 33°C for most of the week, but powerful air conditioning inside the lecture rooms kept everyone awake. In the afternoon the students were each allocated a 3 minute slot to introduce themselves and explain their research interests. They showed admirable time-keeping skills and we were able to start the last lecture of the day on time. This talk given by Prof Delia Brauer gave everyone the opportunity to learn of the latest research in biomaterials.

Over the next three days the class divided into two groups following the traditional Glass Science courses used for the previous 9 years and a stream on biomaterials that included the use of glasses to repair body parts, such as teeth and bones and was followed by an in-depth discussion of the design of glass containers for specialist products in the pharmaceutical industry. The chemical durability of glasses formed an important theme carried over from the first day into these specialist lectures.

Projects were allocated on the second afternoon to the students in groups of five, with the deliberate aim of mixing people with different backgrounds and expertise. For one hour on each of Wednesday and Thursday afternoons small group tutorials were held to explore topics introduced earlier in greater depth and more interactively. The tutorials proved particularly popular this year and there was significant demand for more such interactive sessions and slightly fewer formal lectures.

On the final morning everyone came together again for topics that introduced the applications of science in an industrial context. These helped to indicate the kinds of career paths that might be available. Unfortunately one speaker had been taken ill overnight but this provided an opportunity to distribute copies of the text book created over the previous 8 months in celebration of our 10th

Anniversary. Each participant was given one and there was considerable enthusiasm from the students to collect the signatures of the authors present.

In the afternoon the students took the floor to present the conclusions of their project work. Eight groups spoke on topics that covered a wide range of subjects. The winning group, consisting of Petr Chrast, Susanta Sengupta, Julia Weißhuhn, Bulat Sydykov and Marcela Arango Ospina; their topic was: 'Is it accurate to describe the silica rich exoskeleton of certain deep sea creatures as glassy? Can an understanding of the way biological processes naturally produce complex structures based on glassy materials help us to develop new materials?' Before the awards were announced the party atmosphere to celebrate our 10th Anniversary began. Profs Conradt and Parker played two piano duets as part of the entertainment and one of the students had brought with him a banjo which he used to lead some community singing.

During this session we were joined by a group from Wuhan University who wanted to see how the Montpellier Schools compared with the more recently developed Winter Schools in Wuhan. A representative of Prof Peng Shou, Prof Pan also gave a talk on the Chinese Glass Industry to conclude the morning session. Next year's summer school will be from 8-12th July again in Montpellier and before that we have a Winter School in Wuhan (5-9th November 2018).

Finally we wish to thank our speakers all of whom give their time without payment; the course could not run without their contribution. The speakers on the Basic Science course were in order of presentation: J Parker, R Conradt, D Brauer, R Vacher, P Florian, H Inoue, J Deubener, J C Sangleboeuf, A Takada, B Hehlen, M Choudhary, R Hand, Prof Pan, and on the Biomaterials options: R Hill, L Hupa, A Boccaccini, M Guglielmi and D Zuccato.

4th ICG Winter School in Wuhan

The fourth ICG Winter School at the Wuhan University of Technology in China began on Sunday 4th November 2018 with registration in the ornate and spacious entrance lobby of the Vienna International Hotel.

The Opening Ceremony started at 8am on Monday and needed a large lecture theatre at the Conference Centre on the Mafangshan Campus of the University. We were warmly welcomed by Prof Zuyuan Liu, the vice president of the University. These words of welcome were echoed by the ICG president Prof Alicia Durán and immediate past president Prof Manoj Choudhary who together warmly welcomed the 57 or so student participants in the audience along with the 16 international lecturers giving the course. Prof Shou Peng, a past ICG president who has strongly supported the creation of the ICG schools in China was unfortunately unable to attend and sent his apologies. Prof Parker outlined the activities that ICG undertakes for the glass community and introduced the students to the school's format, explaining the importance of getting involved to maximise the benefits available, using a quiz to illustrate the need to process and analyse the information provided.

Finally those students who had received grants to travel from beyond Asia to the event, 6 in total all from Europe, were presented with their awards. After a group photograph, everyone was straight down to work with three lectures before lunch, two on basic glass science, given by Profs Alicia Durán and John Parker, and a third presented by Prof Russell Hand introduced this year's conference theme on 'Glass for Nuclear Waste Immobilisation'. It was the students turn to speak in the afternoon, each giving a 10 minute presentation explaining their backgrounds and interests. This information was used

in assigning project work and served to initiate networking. The afternoon session was closed by Prof Manoj Choudhary who talked on heat transfer in glass making.

For the next two days the school had two parallel sessions on 1) Glass formation, structure and properties and 2) Glasses for nuclear waste immobilisation. 22 students had registered for the first option and 16 for the second, but numbers for the nuclear option were boosted by 15 or so attendees from industry. Lecturers on the first stream were: Prof Reinhard Conradt, Prof Yuanzheng Yue, Prof John Parker, Prof Rene Vacher, Prof Bernard Hehlen, Prof Jinjun Ren, Prof Tars Kavetsky, Prof Akira Takada, Prof Manoj Choudhary and Prof Michael Ojovan. The teaching on nuclear waste immobilisation was based on members of ICG's technical committee TC05 on Waste Vitrification (Prof Michael Ojovan, Dr Oliver Pinet, Dr Kevin Fox, Dr Hong Li, Prof Russell Hand, Mr Kevin Selkregg, Dr Mr Wei Zhang, Dr Mingzhou Chen and Dr Richard Pokorny). The two streams recombined for the last two days of the school which concentrated on thermodynamic calculations and Raman spectroscopy together with the presentations by the students of their project work.

The main activity though was the project work. Altogether the students were split into 8 groups with 4 or 5 in each team. The projects were very open ended to give them flexibility in creating a solution. Presentations were made on the last day, each group then had to answer searching questions posed by those present. Once all the presentations had been given the staff left the room to judge and rank what they had heard. Meanwhile the students themselves had to fill in a questionnaire on the course itself and they also formally received their certificates of attendance. Prof Reinhard Conradt as the chair of the group of teachers firstly congratulated everyone on an excellent set of presentations. Then he announced the outcome of the panel's deliberations. Third prize went to a group from the Nuclear theme. Second and first prizes went to groups from the Basic Science thread. The winning team consisting of: Baochen Ma, Linfeng Ding, Zheng Zhang and Congyun Li and worked on the programme 'Select the 3 best ways in which glass can help to reduce the CO₂ levels in the atmosphere. Indicate the magnitude of the reductions that are possible.' It also was announced that the 5th fifth ICG winter school will be held on Oct. 20th – 26th, 2019, at Wuhan University of Technology.

1.3 Activities of other TCs

There were several other schools and workshops organized by TCs.

TC02: Workshop on chemical durability testing in November 2018 in Paris, France.

TC03: School on the Thermodynamics of Glass. Sunday 12th of May in Erlangen at the Universität Erlangen-Nürnberg, Department of Material Sciences and Engineering, Martensstr. Organizing Committee: Reinhard Conradt, Natalia Vedishsheva, Daniel R. Neuville, Dominique de Ligny.

TC09 supported organization of a specialized meeting arranged by Glasstrend on 18-19th April at Schneider Electric office in Markt Heidenfeld Germany.

TC17: Dr. Alok Kumar Kanungo organized and an international Conference cum Workshop on the History, Science and technology of Ancient India Glass, at the Indian Institute of Technology, Ghandinagar, India. January 21-25th, 2019.

TC23: 2nd Glass Technology Course by CeRTEV, São Carlos, Brazil, August, 20-25th, 2018

TC23 has organized the second Glass Technology Course, for glass industry personnel and engineers. For six days, 33 lectures were presented by ten professors, academics, consultants and glassware

specialists, who approached, in addition to themes including basic notions of glass structure and properties, also the glass processing, shaping as well as glass transformation.

The course also included two technical visits: the first one to a sand deposit that also deals with sand treatment, and the second one to a glass industry, an automatic processing plant for glass packaging production. At LaMaV, there was an experimental demonstration of a laboratory glass melting, manual fiber pulling, the production of Prince Rupert drop, glass crystallization, visual (under polarized light) thermal stress evaluation before and after glass annealing. All those practical lessons illustrated several subjects discussed during the lectures

The course was joined by twelve attendants, most of them engineering from seven different glass industries and transformer, as well as two attendants from academy. According to the attendant's evaluation, the course was successful, provided very rich discussions including real problems experienced by the students in their respective companies

Youth Outreach committee:

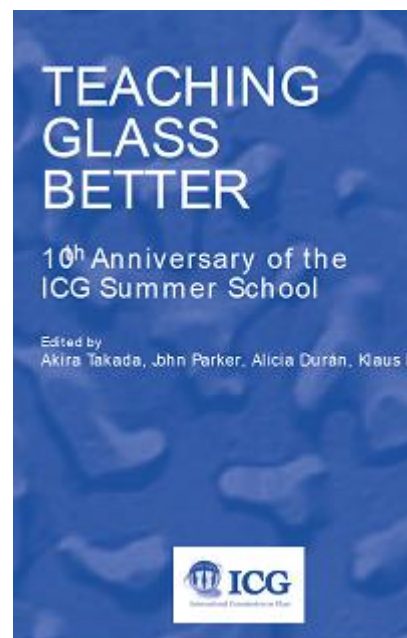
With over 200 participants over 3 days, the second Youth Outreach event organized at the ICG seminar in Yokohama, Japan, was a great success. Organized during lunchtime during the 3 days of the conference, the event was tailored to allow students and young professionals to network with glass academics and industrials. The 1st day was focused on academia, with mentors coming mainly from universities, while during Day 2 the mentors were mainly from industry. The 3rd day was a mix of academic and industrial mentors.

1.4 Publications

TEACHING GLASS BETTER

..... *Book launch at the 10th Anniversary ICG Summer School in Montpellier*

The ICG, a platform for global cooperation in the world of glass, has as part of its mission the promotion and stimulation of understanding and interaction between glass experts in science and technology, art, history and education. To revitalize the role that education plays a committee was created, using a European Grant, to support and develop teaching programs on glass fundamentals in 2005. The target audience was those new to the subject, whether in industry or academia, groups perceived as the lifeblood of research and development and the key to the ongoing success of the material in the marketplace. Based on this background, the first ICG summer school took place in Montpellier in 2009. It has been repeated annually ever since and at the 2017 school everyone agreed that 2018 should be a celebratory event. One aim was to prepare a book which summarized the course content but which also captured the historical development and the philosophy of the schools, explaining the lessons learned and offering a framework for others wishing to follow.



Preparation and publication was completed to coincide with the 10th School in July 2018 and to a high standard using full colour. The early chapters review the history and the evolutionary processes involved in creating the school's present structure. The major part of the book presents the core of the course – spanning glass science lectures on: structural analysis using the latest analytical techniques and atomistic simulation; optical, chemical and mechanical properties; thermodynamics and transport phenomena; and phase separation, glass ceramics and glass surfaces. Over the last five years technical streams on: glass melting technology; glass production; glass surfaces and thin films; and numerical modeling, have run alongside the more fundamental courses. The chapters are written in a tutorial style by the lecturers – all recognized glass scientists and technologists. The appendices include more personal and less formal descriptions of each event, an example of questionnaire responses from the students, biographies of the contributors and last, but not least an index.

The book provides an invaluable introduction to those starting a career in glass. It offers a starting point for the next generation of glass experts who will in turn be able to influence the health of academic glass research and stimulate an efficient and productive glass industry in the face of global concerns such as sustainability, global warming, health issues, energy shortages and population growth. A key feature of the courses is to encourage networking, links that can and do continue well beyond the close of each school. While a book such as this encapsulates what is taught, the only way to experience the value of the contacts made between all the participants, whether teachers or students, is to participate. The dates of future schools and how to join can be found on the ICG web site (icglass.org).

Teaching Glass Better: 10th Anniversary of the ICG Summer School

Edited by: Akira Takada, John Parker, Alicia Durán, Klaus Bange

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Order from: The Deutsche Glastechnische Gesellschaft, The Society of Glass Technology, the Japanese Ceramic Society.

- 1) Wolfram Höland and new TC04 member Markus Rampf have submitted a book chapter "Glass-ceramics for dental restorations" to be included in: K. Pawelec (ed.), "Bone repair biomaterials: Regeneration and clinical aspects" (2nd ed.), Elsevier (anticipated date of publication: January 2019).
- 2) Chengtie Wu has edited a special issue on Tissue Therapy & Regeneration in Applied Materials Today, which has just been completed in late 2018.
- 3) A special issue "Bioactive Glasses 2017" has been published in the journal Materials. All articles are free to download. The issue was edited by Aldo R. Boccaccini and co-edited by Enrica Vernè.
- 4) A special issue in honour of the great Prof. Larry L. Hench has been published in the Journal of Materials Science 2017. Aldo Boccaccini, Julian Jones, Mohammed Rahaman and Enrica Vernè were guest editors, many TC04 members contributed as authors.
- 5) A special issue gathering six articles that build on the Hench legacy and which were presented at the Larry L. Hench Memorial Symposium in Madison, Wisconsin, during the Glass & Optical Materials Division (ACerS GOMD) meeting in 2016 is available online. All papers are free to download.

6) The book *Bioactive Glasses: Fundamentals, Technology and Applications* edited by Aldo R. Boccaccini, Delia S. Brauer and Leena Hupa and published by the Royal Society of Chemistry in December 2016 is available online and in print. (See image of the book cover on the right.)

7) An open access e-book on *Inorganic Biomaterials* was published in *Frontiers* in 2016; it was co-edited by Prof. W. Höland and Prof. Aldo R. Boccaccini. (An ICG grant to TC04 supporting this publication is gratefully acknowledged.)

8) A scientific open access journal *Biomedical Glasses* (editor-in-chief: Aldo Boccaccini; TC04 members Julian Jones, Delia Brauer, Chengtie Wu and Mohamed Rahaman are associate editors and several others are on the editorial board).

9) TC07 members published jointly their research activities. They show upcoming and finalized special issues on crystallisation in glasses and glass-ceramics listed on their web site.

10) TC20 published the following:

a) L. Petit and D. Dorosz were guest editors, together with Wilfried Blanc (TC28), of a special issue of *Applied Sciences* on “Rare-Earth Doping for Optical Applications”. The issue contains 8 research articles.

b) G. C. Righini was guest editor, together with N. Righini, of a special issue of *Micromachines* on “Glassy Materials Based Microdevices”. The issue so far contains 5 reviews and 13 research articles.

c) S. Jiang and S. Taccheo were guest editors, together with B. Boulanger, S. Mirov, J. Nilsson, A. Petersen, F. Rotermund and T. Taira, of a feature joint issue of *Optics Express* and *Optical Materials Express* on “Advanced Solid-State Lasers 2017”, collecting 30 articles.

11) TC27 are working on the following book project:

12) TC Chair Jincheng Du was invited to write a book chapter on “*Molecular Dynamics Simulations of Oxide Glasses*” for a new *Handbook of Glasses* to be published by Springer.

1.5 The Annual ICG Conference 2018

The 2018 ICG annual conference was held during the 4 days (23-26th September) in Yokohama, Japan. The ICG Conference was run in conjunction with the 59th Meeting on Glass and Photonic Materials together with the 14th Symposium of the Glass Industry Conference of Japan. Its President was Kazuyuki Hirao, an ex-Chair of ICG’s TC20 and President of the Ceramic Society of Japan, while the Meeting Chair was Professor Hiroyuki Inoue, of the University of Tokyo and the Chair of the ICG Coordinating Technical Committee. The overall theme was ‘Innovations in Glass and Glass Technologies: Contributions to a Sustainable Society’ and was taken up by two Plenary talks on the first morning. Prof Akio Makishima spoke on the subject ‘Scientifically really important or Technologically really important?’ while Takuya Shimamura of AGC Inc., Japan spoke on ‘The Past, Present and Future of Japan’s Glass Industry – Its contribution to our Sustainable Society.’ The Opening Session was concluded by talks from the winners of last year’s Gottardi Awards, Dr Ashutosh Goel, Rutgers University.

The conference theme defined during the opening ceremony was further developed by 4 keynote speakers. For the main programme 60 invited speakers, selected on the basis of recommendations by for example ICG Technical Committee Chairs, spoke on one of six sub-themes: Glass Production Technology; Radioactive Waste; Glasses for Photonic Technologies; Electric and Magnetic Functions;

Crystallisation and Glass Ceramics and Atomistic Views of Glass. They were followed in turn by some 200 oral and 100 poster presentations.

A feature of the Conference was its focus on Young People. Every lunch time a room was set aside for a talk and to link students to available mentors. The short talk by a different younger glass technologist each day gave a feel for available career paths and how to approach job hunting. Students then gathered in groups around an allocated table to discuss their thoughts and questions at a more personal level with an allocated mentor.

Stevanato again provided a prize for the best Poster while the local organising committee selected the best 10 students on the basis of their poster presentations, their success being acknowledged as part of the closing ceremony. A tradition at the closing ceremony is to provide the delegates with the final statistics for the conference. All together there had been 588 delegates, a very large number, and 29 different countries were represented. Of the attendees 88 were students and 12 were retired, giving 488 regular delegates. 376 of the attendees were from Japan with 29 from China; Germany and the USA were close behind with 24 delegates each. A further 95 came from 17 different European countries (in number order: France, UK, Belgium, Czech Republic, Italy, Netherlands, Slovakia, Denmark, Spain, Finland, Liechtenstein, Slovenia, Turkey, Bulgaria, Croatia, Portugal, Sweden) and 30 from other Asian countries (South Korea, Thailand, Singapore, Taiwan, India and Malaysia). 6 came from Russia and 4 from Brazil.

After acknowledging the staff, contributors and many sponsors who helped to make Yokohama such a successful conference, the final act was for the representatives of the American Ceramic Society to issue an invitation to all those present to participate in the 25th triennial ICG Congress in Boston, USA, from 9-14th June 2019.

1.6 Turner Award

The Turner Award was given to Dr. James Marra. He was chair of TC05 through 2016. He has participated in numerous collaborative activities with large global participation of TC members, including joint meetings/workshops and conferences at numerous ICG meetings. Furthermore, he has supported initiatives in the field of waste vitrification that have strengthened the community such as the “2nd International Summer School on Nuclear Glass Wasteform: Structure, Properties and Long-Term Behavior Wasteform” in France.

1.7 The Best TC Websites

The best TC websites as judged by the CTC were TC07: Crystallisation & GCs, and TC20: Optoelectronics and TC23: Education. The proposed prize consisted of a 700 Euro (max) contribution to a dinner for the winning TC members.

1.8 ICG fund for 2017

CTC offered financial support up to 12450 Euro to its TCs. The amount exceeding the budget of 2019 was taken from the expenditure from 2020. The members of the CTC evaluated the applications of five TCs which were selected using an agreed procedure. The TCs and the actual amounts of support are shown in the table. A report of the use made of the funding was required for the annual report. The committees not receiving support were encouraged to resubmit at a later date.

Results of the amount of the support

Technical Committee			Amount of Support (Euro)
TC03	Glass Structure	a School on Thermodynamics of Glass	3000
TC09	Furnace Efficiency	a harmonization of the definition of KPI, efficiencies, unit measures and other conventions	2450
TC17	Archaeometry	a Conference on History, Science & Technology of Ancient Indian Glass	2000
TC20	Optoelectronics	2019 Summer School on Photonic Materials & PRE'19	3000
TC23	Education	Diffusion of basic glass science through Comics	2000

1.9 Annual Reports

CTC again asked TC chairs to place their annual reports directly onto the ICG web site. The web site will be an up-to-date summary and review of overall ICG activities.

1.10 Plans for 2019

The Congress on ICG will be held in Boston, USA on 9-14th June 2019. Almost technical committees will meet in the Congress in Boston. A CTC Business Meeting is planned in Boston, USA, on 10th June 2019.

The 1st North American Summer school on Photonic Materials will be held in Quebec, Canada on 16 - 21st June 2019.

The 11th Montpellier Student Workshop will be held on 8 - 12th July, 2019.

The 5th ICG Winter School will be held in Wuhan, China, from 20 - 26th, October, 2019.

2 Summary of R&D Activity Fields & TC Activities

2.1 BASIC GLASS SCIENCE – Coordinator: B Hehlen

In 2018, TCs met at conferences, sometimes in the form of joint-TC meetings, highlighting the strong dynamics in the groups and within the cluster. TC27 co-chaired the organization of a GOMD meeting during MS&T2018 in Columbus. The activity was also marked by the publication of TC works in peer-review journals, as well as by a significant contribution of every TCs to the ICG-book ‘Teaching Glass Better’.

TC meetings at conferences

- Joint TC03 and TC26 Meeting at PCNS in St Malo-France, July 2018.
- TC26 met at the ICG conference in Yokohama, sept. 2018.
- TC27 met at the ICG conference in Yokohama , set. 2018.
- TC03 met at the ICG conference in Yokohama-Japan, sept 2018. D. Neuville presented a new version of the Thermodynamic School that will be organized in May 2019 just before the DGG-USTV meeting in Erlangen. The school is supported by the ICG (3000 €) and the USTV (1000 €).

time	Speaker	Description
9:15	Dominique de Ligny <i>Universität Erlangen-Nürnberg</i>	Welcome and practical questions
9:20	Pierre Benigni <i>CNRS - Aix-Marseille Université</i>	Experimental technique and thermodynamical functions
10:05	Daniel R. Neuville <i>IPG-Paris, CNRS, U. Paris</i>	Entropy and viscosity
10:50		Coffee Break
11:10	Reinhard Conradt <i>DGG and UniglassAC GmbH</i>	Thermodynamical functions in common glass systems
11:55	Natalia Vedishcheva <i>Russian Academy of Sciences, St. Petersburg</i>	Thermodynamics of the vitreous state: a tool for establishing structure–property relationships.
12:40		Lunch
14:00	Alexander Pisch <i>CNRS- SIMaP- Grenoble</i>	A global approach of the liquid Gibbs energy, Calphad modeling.
14:45	Jürgen Horbach <i>University of Duesseldorf</i>	MD and “ab initio” a future for thermodynamic
15:30		Coffee break
15:50	Roberto Moretti Volcano Observatory Guadeloupe, IPGP	Thermodynamic of volatile in silicate liquids
16:35	Leena Hupa <i>Åbo Akademi University</i>	Thermodynamic and environment
17:20	Daniel R. Neuville	Conclusion
19:00		Possibility to join a together diner in the center of Erlangen

Organization of conferences and session-chair at conferences

- TC27 organized the Modeling and simulation session of Glass and Optical Materials Division Meeting (GOMD) in San Antonio, Texas.

- TC27 co-chaired the Glass and Optical Materials Symposium during MS&T 2018 in Columbus, OH, USA. (Oct. 2018).

Other activities

- TC03: round robin focused on the structure of phosphate glasses.
- TC07: published the article “Updated definition of glass ceramics” in *J. Non-Cryst. Solids* **501**, 3(2018).
- TC27: published a special issue on “Molecular Dynamics Simulations of Glasses: Current Status and Challenges” in *Journal of Non-Crystalline Solids* as selected papers for the 3rd Challenge Workshop on Molecular Dynamics Simulations of Glass and Amorphous Materials at San Carlos, Brazil in July 2017.
- Contribution to chapters in the ICG-Book ‘Teaching glass better’:
 TC03 (R. Conradt): “Thermodynamics of Glasses” & “Chemical Durability of Glasses”
 TC07 (J. Deubener): “Controlled crystallization of glasses – from transf. to glass-ceramics”
 TC26 (B. Hehlen): “Light scattering by atomic vibrations”
 TC03 and TC26 (L. Cormier): “Diffraction and X-ray absorption spectroscopy”
 TC27 (A. Takada): “Atomistic simulation”
- TC26 engaged in the project of creating an open source database for Raman and IR spectra.
- TC27 Continue to work on a book project with Wiley on “Computer Simulations of Glasses: Methodologies and Applications” co-edited by Jincheng Du and Alastair Cormack.

2.2 GLASS PRODUCTION – Coordinator: Hande Sesigur

There are six technical committees (TC) in the Glass Production cluster. All these committees continued their activities according to the needs of the glass industry with the coordination of “Coordinating Technical Committee” of ICG.

TC09: Energy Efficiency

Technical Committee on Energy Efficiency TC09, mainly focus on glass melting since this contributes on average about 60-65 % to the total energy consumption in glass production. The aim of this committee is to identify the major process steps with energy efficiency improvement potentials, to select suitable technologies, to test or develop tools that supports energy efficiency investigations such as energy balance models, protocols for energy management, energy audits and finally to define research activities for developing energy saving glass production methods.

In 2018, the committee gathered in three meetings, firstly at Schneider Electric office in Markt Heidenfeld Germany during Glasstrend Seminar which was at 18-19 April, secondly at Schott in Mainz on 28 August and finally met during the ICG Annual meeting at Yokohoma.

TC09 will develop recommended Best Practices for defining energy use and efficiency so that manufacturers. The results of this project will be used to explain the energy balances of glass furnaces and to evaluate the methodology of applied energy balance models, measuring techniques and benchmark data. In this connection 6 float furnaces investigated with the aim to define a uniform approach to define energy efficiency or specific energy use within or across the various glass industry sectors. A draft publication is in progress.

TC09 started a round robin comparison of calculating the Thermodynamic Energy Requirement for glass melting for some selected glasses. There is not a clear standard for what is the actual minimum amount of enthalpy (thermodynamic energy requirement) that is needed to melt a certain soda lime (Container) glass batch. Several batches were defined and the minimum melting energy was calculated by using thermodynamic models.

Besides these studies, TC09 exchanged information on running projects and new initiatives to reduce energy consumption in the glass production process. Many companies apply energy benchmark studies as a starting point of energy reduction programs. To reduce the CO₂ footprint and energy consumption some companies switched from air-fuel to oxy-fuel, while others increased the fraction of electric boosting. New initiatives in the glass industry are for example the application of Organic Rankine Cycle (ORC), Hot-Ox systems to preheat fuel and oxygen, the application of the 'Optimelt' TCR system and the use of smart batches which melt more easily.

TC11: Materials for Furnaces

Technical committee working on refractory materials and its interaction with the glass melt, TC11, aims to discuss the material related problems in glass melting furnaces and the defects generated by these materials like blisters, stones, knots and cords. TC11 tries to find out solutions and experimental testing methods by exchanging the knowledge and experiences between the members and participants from refractory industry, glass industry and academia.

In 2018 the committee initiated three new activity at which the first one is to evaluate different test methods for blistering potential of refractory materials, and they aim to prepare an official publication on recommended test methods. Secondly they initiated a round robin test on different test methods for corrosion of silica bricks and finally they will investigate the non-destructive measurements of refractory materials such as radar, ultrasonic methods.

TC13: Environment

The main mission of environmental committee, TC13, is to achieve best practices by exchange of information concerning current and developing techniques for reducing the environmental impact of glass during its production, use and disposal. This also includes the comparison of the results of different control techniques and the determination of best practice for measuring pollutants (primarily total particulate, NO_x, SO_x, HCl, HF & heavy metals) by means of parallel measurements, material balances, and round robin tests. With emission limits becoming tighter and more expansive there is a critical need for better and more reliable measurements methods. TC13 will focus on providing the glass industry with adapted and affordable standard protocols, and it will help the industry benefit from new monitoring and emission control technologies.

In 2018, the committee met two times; firstly at the offices of Arc, in Arques, France and secondly at SSV, in Murano, Italy. TC Chair Mr. Piranda had left the glass industry. Mr. Battaglia the vice-chair was elected as chairman and Mr. Orhan was elected as the vice-chair.

The topics of REACH and the Carcinogens and Mutagens Directive were covered during the meetings. This included a presentation of the results of boron leaching tests on a range of different glasses, a technical review of boron leaching, workplace exposure measurements of RCF and an update on the draft TC13 RCS paper. The committee then addressed measurement of emissions from glass furnaces. This included discussion of the results from the round robin exercise on volume flow

rate calculation, abatement of boron emissions, parallel measurements to compare the results of FTIR against other test methods and factors affecting the formation of SO₃ in SCRs. It was agreed to that TC13 should develop papers on the topics of waste gas volume flow rate and the conversion of SO₂ to SO₃ in SCRs.

The group finally discussed items relating to REACH and CMD regulations. It was confirmed that the TC13 work on respirable crystalline silica in sand would be published in early 2019 and there was a comprehensive presentation on new testing strategies for measuring compliance with workplace exposure limits.

TC14: Gases in Glass

Technical Committee working on gasses in glass TC14, promotes activities to better understand evolution mechanisms of gases in glass and bubble formations. It supports cooperation with other Technical Committees in order to fulfill its mission. Most of its recent activities have been carried out jointly with TC11 and TC18 regarding the influences of glass contact materials and melting process on bubble formation.

The committee organized its 2018 meeting in Saint Malo during the ESG Conference. They recalled previous studies and discussed ongoing projects.

They considered that some previous topics can be still extended and/or repeated with the new approaches/methods. Interrupted dynamic bubble-refractory test or determination of rate of change of bubble size during fining/refining will be the first topic to be evaluated. Bubble analysis with other methods than MS (Raman Spectroscopy, know-how restrictions but maybe only on its basic physics) will also be discovered with round robin tests. Numerical model of bubble behavior will be the third topic and they plan to find a numerical relation between rate of change of bubble size with respect to temperature and glass composition.

Finally, a poster and a video record (<https://sisecam.sharefile.com/d-553c9a96d76b43f8>) explaining the focus, aim, and the activities of TC 14 have been prepared for ICG2019 in Boston.

TC18: Glass Melting

The committee on Glass Melting” promotes both fundamental and applied research on phenomena connected to glass melting processes. It supports co-operation among technical committees involved in the cluster Glass Production.

A new experimental project was initiated on batch melting kinetics. The goal of this project is to propose and test simple laboratory procedure to evaluate melting kinetics of glass batches. In the initial stage of the project, the suitable test procedure was discussed and the experimental setup was proposed. Laboratory melts will be run for two to three types of glasses which will be selected for the study – E-glass, soda-lime-silica (container glass) and borosilicate (Pyrex type). Raw materials will be delivered to the laboratories which will take part in the RRT. The evaluation of RRT results is planned to be discussed at the TC18 meeting during ICG Congress 2019 in Boston, USA.

TC21: Furnace Design & Operation

The main activity of TC21, Technical Committee on Glass Furnace Design and Operation, is to improve the quality and reliability of glass furnace simulation modeling and optimization of software packages of different suppliers and glass producing factories that describe heat transfer, flows and temperatures in glass furnaces (melt, batch & combustion space).

The most effective way to understand the strong and weak points is by simulating with the different participants the same well defined existing glass melting furnace and ideally with actual measured and validated data. This allows the different participants to compare and validate results with each other and also with real measured data.

TC21 is conducting a round robin test (RRT) for modeling a small cold top electric glass melter with C-glass. The geometry description and necessary data to develop a full 3D CFD model was compiled and distributed to the TC21 members. The first phase consists of modeling the melter and discussing the results and Phase 2 will be variations of this design as recommended by those participating in the discussion of Phase 1. They will discuss the results of the round robin test and will document with future presentations.

The committee will organize a session called «SYMPOSIUM III: GLASS TECHNOLOGY AND MANUFACTURING» for the ICG Congress in Boston USA. The session will focus on designs or new technology leading to improvements for glass furnaces and operations.

2.3 CHARACTERISATION – Coordinator: Mathieu Hubert

This cluster comprises 4 TCs: TC02 (Durability and Analysis), TC06 (Mechanical and nanomechanical properties), TC10 (Optical measurement techniques), and TC19 (Surfaces – reactivated in 2017). The activities of these TCs during the year 2018 were:

TC02 – Durability and Analysis. This committee focuses on chemical durability testing and analysis and is committed to the pursuit of analytical excellence through the standardization and harmonization of analytical methodology throughout glass and associated industries. TC02 members met on two occasions in 2018, first for a spring meeting in April in Mainz, Germany. The second meeting took the form of a workshop on chemical durability testing was organized in November in Paris, France, funded by an ICG grant received by the TC. During that workshop, an inventory of the chemical durability testing standards was established and communicated to the ICG.

The members of the TC have also been very active and engaged in proficiency tests on the determination of heavy metals in container glass. Other significant achievements of TC02 include the validation of the application of the ICP-MS and ICP-OES for the determination of arsenic in the norm Ph. Eur. 3.2.1 on hydrolytic resistance of glass containers. The TC members also actively collaborated with the German organization BAM regarding the certification of Borosilicate Glass for hydrolytic resistance testing (Grains Testing according to the norms ISO720, USP<660>, Ph.Eur. 3.2.1). The work on this certification will be continuing in 2019, in order to finalize of the certification of a new glass as CRM (certified reference material). Other activities planned for 2019 include work on certification of other CRMs for norms on resistance of technical glass to boiling acid (DIN 12116) and boiling alkaline solutions (ISO 695), as well as development of methods for chemical durability testing, chemical composition of filter dust, as well as proficiency testing for the determination of low levels of fluorine in technical glasses.

TC06 – Mechanical and nanomechanical properties TC06 covers the mechanical, including nanomechanical, properties of glasses. The work of the committee involves both test methods (e.g. edge strength measurement) and understanding the fundamentals of glass fracture and the growth of cracks. In 2018, TC06 organized technical sessions during two major conferences: a “Mechanical properties of glass” session at the GOMD 2018 in San Antonio, USA, and a session on “Glasses under elevated pressures” session during the 2018 ICG conference in Yokohama, Japan. The TC also organized “Young researcher day events” at two occasions during the year, In Hannover, Germany, in February and in Jena, Germany, in September.

Members of TC06 started two sets of Round Robins Tests (RRT). The first RRT focuses on the scratch testing of blank and surface-modified glasses. The second set of RRT is dedicated to methods for the determination of surface hardness. The list of active members in the TC was also updated this year.

The activities of the TC in 2019 will include the continuation of the RR testing. The TC is also organizing the 2019 International Workshop on Glass & Entropy (Sept. 08-12, 2019, in Jena, Germany). This 4-day event is expected to gather over 100 participants from > 20 countries.

TC10 - Optical measurement techniques. This TC focuses on the different optical measurements of glass and coated glass, as well as on their basic optical properties. This TC connects and engages industrial companies, research institutes, and academics. TC 10 held 2 meetings in 2018, in April in Murano, Italy, and in Mons, Belgium, at the INISMA in October. In 2018, the members of the TC10 finalized their work on the measurement methods for transmission in diffusing glasses using commercial spectrophotometers and worked on the next steps to take to better understand the characterization of these diffusing materials. TC10 members also organized two sets of Round Robin Testing. The first RRT focused on the calculation of transmittance, reflectance and emissivity according to the norms EN410 and EN673, which involved 21 participants from 13 countries. The second RRT concerned measurement of low iron glasses, with focus on measurements in the UV range. The TC members have also been interacting with the European Committee for Standardization (CEN) and ISO committees, providing support and guidance for the revision of several measurement standards.

In 2019, TC10 plans to continue the interaction with CEN and ISO committees, and will be actively engaged in the National Fenestration Rating Council task force for characterization of diffusive glazing. The TC also plans to re-activate workstreams on the correlation between chemical composition and optical properties of glasses. Members of the TC have planned 2 meetings, one in Murano (Italy) in April and one in Wurzburg (Germany) in October.

TC19 – Surfaces. The overall objectives of this TC are to establish a forum to present, discuss and disseminate new findings on fundamental surface science of glass materials, catalyze exchange of technical information relating to surface science of glass materials between academia and industry, identify grand challenges in glass surface science and engineering, and foster collaborative research among glass scientists and engineers. TC19 organized a session on “Advanced Surface Characterization of Multicomponent Glasses” during the ICG conference in Yokohama, in September 2018. Members of TC19 contributed 2 invited talks, 5 oral presentations and 4 posters. In 2019, TC19 is organizing a dedicated session during the ICG/GOMD congress (Symposium 2, Session 6: « Glass Surfaces – TC19 »),

during which the latest developments in surface analysis and surface science issues in pharmaceutical and display glasses will be discussed. The members of the TC will meet at the occasion of this congress.

2.4 APPLICATIONS – Coordinator: Julian Jones

Applications Cluster Executive Summaries

Julian Jones (Cluster Coordinator)

TC₄: Bioglasses

Chair Delia S. Brauer

TC₄ aims to promote global visibility of biomedical glasses and stimulate collaborations between academics and industry.

2018 activities highlights

Publications

- Chengtie Wu has edited a special issue on [Tissue Therapy & Regeneration](#) in *Applied Materials Today*, which was completed in late 2018
- [Biomedical Glasses](#) (editor-in-chief: Aldo Boccaccini; TC₄ members Julian Jones, Delia Brauer, Chengtie Wu and Mohamed Rahaman are associate editors and several others are on the editorial board) has received its first CiteScore (Scopus database) of 2.05

Awards;

- Aldo Boccaccini and Julian Jones have been elected Fellows of the Society of Glass Technology.
- Congratulations to Wolfram Höland on being the 2018 awardee of the [ACerS GOMD Stookey Lecture of Discovery](#) Award. He gave his talk at the 2018 GOMD Meeting in San Antonio, Texas, US.

Interfacing with ACerS

- Steve Jung and Julian Jones are Chair and Vice-Chair, respectively, of a new [Bioceramics Division](#) of the American Ceramics Society. TC₄ and the Bioceramics Division work together on organising sessions at the MS&T annual meeting and the ICG Congress 2019.

Conferences

- Ashutosh Goel gave his award talk at the [2018 ICG annual meeting](#) in Yokohama, Japan as the [2017 Vittorio Gottardi](#) awardee.
- Robert Hill and Wolfram Höland were invited speakers at the [2018 ICG Annual Meeting](#) in Yokohama, Japan.
- Julian Jones gave a plenary presentation at [Bioceramics 30](#) in Nagoya, Japan, 2018, and several invited lectures in 2018, e.g. at MS&T in Columbus, Ohio, at the International Sol-Gel Society Summer School in Alghero, Italy and at the 7th International Congress on Ceramics at Iguacu Falls, Brazil
- Delia Brauer organised a special session on bioactive glasses at the 2018 ICG Summer

School in Montpellier, France. Delia Brauer, Robert Hill, Leena Hupa and Aldo Boccaccini gave lectures.

- A Glasses in Healthcare symposium organised by Delia Brauer, Ashutosh Goel and Julian Jones was held at the [2018 GOMD](#) in San Antonio, TX. Alastair Cormack and Steve Jung were invited speakers, Ifty Ahmed and Qiang Fu presented.

Exchange Projects & Joint Funding

- TCo4 acknowledges a grant from ICG to fund student exchange projects between TCo4 member groups. Jonathan Massera, Enrica Vernè, Aldo Boccaccini, Dana Rohanová, Robert Hill and Delia Brauer are participating in bilateral student research exchanges. Six students were given the opportunity to gain research experience in a research lab abroad.

2019 Plans

- Delia Brauer, Qiang Fu and Julian Jones organised the Glasses in Healthcare session at the [ICG Congress 2019](#) in Boston. TCo4 members Dave Greenspan and Amy Nommeots-Nomm are invited speakers.
- Aldo Boccaccini and Delia Brauer are Special Session organisers at the [Annual Conference of the European Society for Biomaterials](#) (ESB) held in Dresden, Germany, in 2019. Julian Jones is keynote speaker.
- Aldo Boccaccini Delia Brauer and Markus Rampf organizing a Glasses in Healthcare session at the joint DGG (Germany) and USTV (France) Conference to be held in Nuremberg, Germany, in 2019.
- Building on the success of the SBF round robin study and publication, which is available [online](#) and has been cited over 100 times, it is timely to do a round robin study on cellular response. The test will include a protocol based on the ISO standard (extracts) and propose a method for cell culture studies on bioactive glasses. It will be led by Julian Jones, Steve Jung and David Greenspan, who is also leading an ASTM working group to define bioactivity.

TC o6 Waste Vitrification (green)

Chairman: Oliver Pinet

Activities in 2018

- Sessions organized at ESG PNCS Congress in Saint-Malo (France) & ICG Yokohama (Japan).
- The 4th ICG Wuhan Winter School on glass (China) 2 days on glasses for hazardous waste immobilization
- Dr Jim Marra (previous TCo5 chair) received the Turner award 2018.

PLANS AND DELIVERABLES FOR 2019

- TCo5 sessions at: PACRIM Okinawa (Japan), ICG2019
- Special session on waste vitrification at ICG Summer school in Montpellier (France) – July 2019
- MRS Symposium on Scientific Basis for Nuclear Waste October 21st to 24th in Vienna (Austria)

TC 16 Nanostructures (green)

Chairman: Alex Martucci

TC16 has very much a collaborative research project focus.

2018 activities

- Focus on collaborative research of doped-glass coatings (e.g. sol-gel) for photovoltaic solar cells and coatings based on ZnO doped with aliovalent cations (for example Ga, Ge, Si, etc.) for solar control.
- CTC-funded collaborative research project "Nanocrystalline sol-gel coatings for solar energy applications", the sol-gel method was used to prepare multi-component films. Master's student from Univ. of Padova (Daniel Tezze) visited the IST lab (in Lisbon). Luís Santos, from IST, visited Padova.

2019 Plans

- Development of nanostructured sol-gel coatings doped with sensitizer/acceptor lanthanide pairs for frequency conversion in photovoltaic solar cells, in order to increase their efficiency.
- R. Almeida and A. Martucci will edit a book entitled "Sol-gel derived optical and photonic materials".

TC 16 Nanostructures (green)

Chairman: Alex Martucci

TC16 has very much a collaborative research project focus.

2018 activities

- A scientific paper, based on round robin activity on the delamination propensity of glass vials by all members of TC12 was published in the PDA Journal of Pharmaceutical Science and Technology (doi:10.5731/pdajpst.2018.008599).
- Presentations were given by Massimo Guglielmi and Daniele Zuccato on the Round Robin results at ICG2018
- A new Round Robin test (11 labs) on delamination started using the TC12 protocol for predicting the delamination propensity. The best vials made available by the members of the TC to be compared with a set of "positive" vials. Nine labs completed the work in 2018.
- Massimo Guglielmi and Daniele Zuccato gave 4 lectures at the Summer School of ICG in Montpellier.
- Organization of an open session on Glasses for Pharma at ICG2019, ending with a roundtable.

2019 plans

- Deeper discussion on step 1 latest Round Robin Study.
- The second step of the Round Robin study: using a more aggressive testing protocol on the same type of vials used in step 1, with the minimum objective to provoke delamination at least in the "positive" ones, in order to support the results of the predicting test for

delamination.

TC 20 Optoelectronics (Green)

Chairman: Gian Carlo Righini,

Focusing on glasses for photovoltaic applications

2018 activities (highlights)

- Setsuhisa Tanabe and Giancarlo Righini organized a symposium at ICG2018 .
- Joint meeting with TC03 and TC28, beginning collaborative projects
- S. Tanabe gave a keynote lecture at 21st International Symposium on Non-Oxide and New Optical Glasses (ISNOG)
- Petit and D. Dorosz were guest editors, with W. Blanc (TC28), of special issue of Applied Sciences. The issue contains 8 articles from TC members.
- S. Taccheo is chair of the COST action MP1401 "Advanced fibre laser and coherent source as tools for society, manufacturing and life science" and L. Petit is Management Committee (MC) member.

Awards

- S. Tanabe: Varshneya Frontiers of Glass Science Award at GOMD2018
- X.-H. Zhang: Varshneya Frontiers of Glass Technology Award at GOMD2018
- A. Jha made Fellow of The Optical Society

2019 Plans

- Highlighting open access articles on the website. www.ifac.cnr.it/~righini/TC20
- S. Jiang and G.C. Righini organizing a symposium at ICG2019
- PRE'19 (8th International Workshop on "Photoluminescence of Rare Earths: Photonic Materials and Devices): G. C. Righini is honorary chair and M. Ferrari is in the Local Organizing Committee.
- J. Ballato will organize the 6th Workshop on Specialty Optical Fibers
- Special Issue Optical Materials, Guest Ed: D.Dorosz, M. Ferrari, and L. Petit.
- Virtual Feature Issue of Optical Materials Express on Mid-Infrared Materials and their Device Applications, L. Petit is one of the Guest Editors.

TC24 Coatings (Red due to the chair being away from work)

Chairman: Joop Van Deelen

TC28 Glass fibres for reinforcement and insulation (Green but website needs work)

Chairman: Yuanzheng Yue

2018 Highlights

- Glass Fiber Symposium at ICG2018, containing 11 talks from TC members.
- White paper about 10 major challenging problems in glass science planned.
- Half of the book entitled "Fiberglass Science and Technology: Chemistry, Processing, Characterizations, Applications, and Sustainability" was finalized.

2019 Plans

- Contributions from 4 members to *Encyclopedia of Glass Science, Technology, History and Culture*
- Symposium organized for ICG2019
- Completion of the book "Fiberglass Science and Technology: Chemistry, Processing, Characterizations, Applications, and Sustainability"

2.5 INFORMATION, EDUCATION, HISTORY – Coordinator: John Parker

Activities of TC01: Communications in 2018

Several activities within this cluster have involved members of both TC01 and TC23, for example the production of the latest ICG book: 'Teaching Glass Better' to celebrate the 10th Montpellier Summer School. It summarises the schools' development and has detailed teaching material based on the core lectures given during the school written by the lecturers. Additional chapters summarise the content of parallel streams run alongside the basic science sessions. Printed in full colour it has 416 pages and costs 50 Euros. Copies were given to students at both the 2018 ICG Summer and Winter Schools but will in future be sold to raise funds. A5 publicity leaflets have been distributed at several conferences, a press release has been widely circulated and the book is being sold through several ICG NPOs. These NPOs (DGG, SGT, Japanese and Chinese Ceramic Societies) received copies at a discount and can sell them at the full price as an incentive. Copies will also be sold through the booking form for the next ICG Congress in Boston, USA.

Following ICG's representation at the 2017 Vitrum conference in Milan, the 2018 Glass Fair GlasTec in Dusseldorf was also attended. Space on the DGG/HVG stand was made available to ICG thanks to the DGG president, Prof Conradt (also Vice president for ICG) who was also present throughout the event to answer questions. Advertising literature listed ICG books for sale, Technical Committees and promoted 'Making Glass Better' and 'Teaching Glass Better'. A0 posters described ICG, its structure and activities. Participation in such events is time-consuming and its effectiveness needs careful evaluation.

The conference list on the web site was regularly maintained and many organisations now inform us of their planned events. It remains difficult to be comprehensive though because so many conferences overlap with ICG's interests. Promoting ICG through these events should also be a goal and requires high quality publicity. We also need to encourage TCs through CTC to help maintain the currency of these lists.

Attempts to maintain a flow of material to magazines such as *Glass International* and *Glass Machinery* have stalled partly because of the time taken to produce 'Teaching Glass Better' but also because of the time commitment required by TC Chairs. Monthly articles on aspects of Glass History are published in *Glass International* though by the committee chair and acknowledge ICG.

7 press releases concerning ICG and 13 more giving NEWs from elsewhere were published on the ICG web site during 2018. 5 advertised post-doctoral vacancies and studentships – a valuable contribution to members. They were widely distributed by Dr Klaus Bange and made available for publication in other journals and e-media. Recently TCs have started to send items for publicity on this part of the web, a positive trend. Maintaining and developing links to ICG members e.g. by advertising their activities on the ICG web pages offers added values for NPOs and they should be encouraged to submit News items.

Updating the web site is ongoing and the chair of TC01 thanks Professors Bernard Hehlen, Delia Brauer and Julian Jones who have all assisted in maintaining the information content of the web site. New pages have been created to cover the work of TC28 and the Young Persons Committee. Google Analytics can be used to understand better the audience but it is a while since a study was undertaken. Enhancing the web site with more images and more links to social media such as Twitter feeds is another goal, as is development of the 'What is Glass' section, with educational material in mind, such as U-tube videos.

Activities of TC17: Archaeometry in 2018

TC17 has been actively involved in organising a major conference in India as well as developing sessions for the ICG Congress in Boston.

Specifically Dr. Alok Kumar Kanungo organized an international Conference-cum-Workshop on the History, Science and technology of Ancient India Glass at the Indian Institute of Technology, Ghandinagar, India, from January 21-25, 2019 with the help of an ICG CTC grant. TC17 chair Stephen Koob was an invited speaker and resource specialist. *(A full report on this meeting is available as a News Item on the ICG web site)*

TC17 continues to review its membership in the interest of adding new members although no new members were added in 2018. It continued the planning stages for the XXV International Congress, to be held in Boston, MA, USA in 2019. All members were contacted and the initial response was promising. Subsequently, TC17 has organised the topical session 'Archaeometry', a specialized forum for research and application of Archaeometry and Archaeological Sciences in glassy materials, covering the full spectrum of topics, techniques, chronologies and regions:

(1) Archaeometry.

Archaeometry is the investigation of ancient and historical glasses by means of any scientific methods (chemical, isotopic, or any other laboratory technique). It is directed toward solving problems of origin, dating, and provenance of glass objects whether they are delicate vessels, shards, beads, tesserae, frits, faience or slags.

(2) Conservation problems

The focus of this session is the conservation of vitreous materials and the deterioration of glasses. This session focuses less on the understanding of early glassmaking, but on historic and current compositional problems and encompasses the conservation of our cultural heritage, as well as important problems in modern glass science. Corrosion studies have been a major theme in the field of biomedical glasses, but the weathering of archaeological glasses provides real case studies for assessing the long-term stability for vitrified toxic or radioactive waste.

Presentations on other deterioration problems, from bio-degradation to color changes under UV or sun light (solarization) are welcome as well. We also invite papers on the protection of archaeological and historic glasses (on site or in museums or stained glass windows exposed to the elements) and the recommendations for their conservation and protection.

(3) New techniques of analyses in the context of archaeometry

With the advancement of instrumental analysis, portable instruments, studies presenting case studies using these new techniques will be of great interest to the community. In addition, results from round-robin tests or the comparison of sensitivities and detection limits of various techniques are just as valuable.

Activities of TC23: Education in 2018

This year marked the 10th Anniversary of the ICG Summer Schools in Montpellier. This is organised by a local committee and a full report is given on the TC23 web pages. As well as the traditional Glass Science courses, a stream on biomaterials was organised, including the use of glasses to repair body parts, such as teeth and bones, followed by an in-depth discussion of the design of glass containers for specialist products in the pharmaceutical industry. The chemical durability of glasses formed an important theme carried over from the first day into these specialist lectures. Small group tutorials, where topics introduced earlier are explored in greater depth and more interactively, are a developing feature.

During the Friday morning session copies of the book '*Teaching Glass Better*' created in celebration of our Anniversary were distributed to each participant and there was considerable enthusiasm from the students to collect the signatures of the authors present. We were also joined by a group from Wuhan University who wanted to compare the Montpellier Schools with the more recently developed Winter Schools in Wuhan. A representative also gave a talk on the Chinese Glass Industry.

Next year's summer school will be from 8-12th July again in Montpellier). More information about both is on the ICG Web site (icglass.org). Finally, we wish to thank our speakers all of whom give their time without payment; the course could not run without their contribution. The speakers on the Basic Science course were in order of presentation: J Parker, R Conradt, D Brauer, R Vacher, P Florian, H Inoue, J Deubener, J C Sangleboeuf, A Takada, B Hehlen, M Choudhary, R Hand, K Bange, Prof Pan, and on the Biomaterials options: R Hill, L Hupa, A Boccaccini, M Guglielmi and D Zuccato.

4th ICG Winter School, Wuhan, China, 4th-8th November - the largest to date

The fourth ICG Winter School at the Wuhan University of Technology in China began on Sunday 4th November 2018. A full description is included in the TC23 Annual Report on the ICG web pages. A formal Opening Ceremony on Monday morning involved a warm welcome by Prof Zuyuan Liu, the vice president of the University and the ICG president Prof Alicia Durán and immediate past president Prof Manoj Choudhary who together warmly welcomed the 57 student participants in the audience and the 16 international lecturers giving the course. Prof Shou Peng, a past ICG president a strong supporter of the ICG schools in China was unfortunately unable to attend and sent his apologies.

A new feature was the issue of travel grants to 6 students to allow them to travel from Europe to the event. This was a new feature of the schools and we hope it will continue. At the end of the school one of the visiting students explained what being able to attend had meant, '*The school has let me bounce ideas with worldwide experts, and experience China for the first time. A world powerhouse where research is concerned. Massive thanks to organisers and Chinese students.*'

This innovation supported by Prof Shou Peng had a second unexpected and very positive consequence, which was the resulting interactions between students from different cultures. On the questionnaire responses, almost every student without prompting highlighted this as a key benefit of the course. A Chinese student wrote, 'I had a great time these days. I will never forget nice foreign professor, so kind and perfect. Great foreign students – so kind too. This is greatest day.'

The rest of the event followed a traditional format. Two parallel sessions covered 1) Glass formation, structure and properties and 2) Glasses for nuclear waste immobilisation. 22 students registered for the first option and 16 for the second, but numbers for the nuclear option were boosted by 15 attendees from industry. Each student attending the school was given a copy of the 'Teaching Glass Better' textbook and the welcome reception provided an opportunity for students to have their copies signed.

A new way to encourage involvement was to stimulate the asking of questions. Anyone who asked a question was given a stamp on their notebook. The winning student achieved 6 questions and received a small prize on the last day. A new feature was a tutorial session based on written questions by the students submitted during the week.

Activities in Brazil

2nd Glass Technology Course by CeRTEV, São Carlos, Brazil, August, 20-25th, 2018

As part of the activities of TC23 the CeRTEV, *Center for Research, Technology and Education in Vitreous Materials, founded by Fapesp*, the São Paulo State Research Foundation, Brazil, organized a second Glass Technology Course, for glass industry personnel and engineers. The Course was held at the Vitreous Materials Laboratory, LaMaV, Department of Materials Engineering, Federal University of São Carlos. For six days, 33 lectures were presented by ten professors, academics, consultants and glassware specialists, who approached, in addition to themes including basic notions of glass structure and properties, also the glass processing, shaping as well as glass transformation.

The course included two technical visits and practical lessons illustrating several subjects discussed during the lectures. Twelve people joined the course, mostly engineers from seven different glass industries and transformers, as well as two from academia. According to their evaluation, the course was successful, providing very rich discussions including real problems.

A technical course of glass production – teacher training

The course "Techniques in Glass Production", a project in partnership with the Paula Souza Center, Abividro and the glass company Nadir Figueiredo, started with its first cohort. 40 students were selected from among ~160 applicants in a public selection procedure. At the present date, December 2018, students have already completed their second semester and they will complete their whole training in July 2019, at the end of their third semester. CeRTEV has closely followed the course and offered several training sessions, listed on the TC23 web site.

TC23 activities envisaged for 2019

So far, the envisaged activities comprise the support and continuation of ICG schools. At the last committee meeting a list of recommendations for the organization of successful ICG schools were proposed in 2016, and was re-confirmed. These are summarised on the TC23 web site. A need was perceived to define rules under what conditions a school may be run under the ICG label.

The Montpellier Summer School 2019 will be the 11th event in a row. In 2019 the main streams will be: Glass Formation, Structure, and Properties and Hazardous Waste Vitrification. The 5th ICG Winter School is planned for 20th-25th October 2019, Wuhan, China, with the topics: Glass Formation, Structure, Properties

In 2019, ICG will also sponsor the North American Summer School on Photonic Materials (NASSPM) at Laval University in Quebec City, to be held the week immediately after the ICG/GOMD meeting in Boston (www.nasspm.org).

A third CeRTEV Glass Technology course is planned, to be held in São Carlos, Brazil in August 2019.

4. Youth Outreach 2018 activities

The ICG Youth Outreach Team is composed of:

Delia Brauer (DE)
Tunc Goruney (TK)
Mathieu Hubert (US)
Julian Jones (UK)
Erik Muijsenberg (CZ)
Randy Youngman (US)

A Youth Outreach event was organized during the ICG conference in Yokohama. The event was well broadcast prior to the event (efforts from Satoru Tomeno are to be recognized). With over 200 registered participants indicating that they would like take part, the event had to be split over 3 days to allow everyone to participate. On the 1st day, the focus was on networking in academia (mentors mainly from universities), while the 2nd day focused on mentors from the industrial world. The 3rd day was a mix of both.

Every day, a brief introduction to ICG Youth Outreach (Istanbul 2017, and now the 2nd edition) was given, highlighting the importance of networking. A brief presentation was given, before free discussions between the participants. Tables were arranged both inside and outside the room where the event took place, and all the students, young professionals and mentors participating were given a lunchbox and a table number, so they could gather, network and share their experience.

For the 3 days, the program was:

Monday: presentations by Manoj Choudhary and Alicia Duran on the importance of youth outreach to the ICG, and a few tips on networking; networking with focus on academic mentors.

Tuesday: brief presentations by Mathieu Hubert about his career and tips on networking, TCs and the benefits of participation in ICG. Networking with focus on industrial mentors.

Wednesday: brief presentations by Erik Muijsenberg about his career and tips on networking, ICG activities and benefits of participating to ICG. Networking with mentors from both industry and academia.

Overall, the event was a great success, with very positive feedbacks from the participants. 80 people gathered on the first day, and over 60 on the 2nd and 3rd.

Future plans include:

- Preparation of recommendations/guidelines for the organization of youth outreach events, to be circulated to ICG conference/seminar organizing committees
- Supporting the organizing committee of the ICG 2018 seminar Yokohama for the Youth Outreach event planned there.
- Work on a webpage/website dedicated to Youth Outreach activities and events.
- Continue working with ICG to propose strategies that could be implemented to attract, recruit, and retain young glass science and technology (and related disciplines) professionals.

TC23 Education	R Conradt A Rodrigues	
TC24 Coatings on Glass	K Sanderson J Van Deelen	
TC25 Modelling Forming	C Berndhauser A Karadag	
TC26 Structure & Vibrations	B Hehlen	
TC27 Atomistic Simulation	J Mauro J Du	
TC28 Fibre Reinforcement	Y.Yue	

Decisions on the following persons/functions were taken:

L. Zheng became the new member of CTC replacing X. Zhao.

H. Sesigur has started another new term as a CTC member.

J. Parker has also started another new term as a chair of TC01.

J. Jones has completed 9 years as chair of TC04. D. Brauer became the new chair of TC04 (Bioglass)

R. Almeida has also completed 9 years as Chair of TC16 and 1 year as acting chair. A, Martucci will become new chair of TC16 (Nanostructures) in 2019.

R. Conradt has completed 9 years as chair of TC23 and 1 year as acting chair. A. Rodrigues became new chair of TC23 (Education).

B. Helen has also completed a second term of 9 years as chair of TC26 and started another new term as Chair of TC26 (Structure & Vibrations).

4. Reports of the activities of individual TCs

The last year TC chairs have been asked to submit their reports directly to the ICG web site so that they are more accessible to the wider public and also available in a more timely fashion. Thanks to the efforts of the TC chairs this process has been continued and the reader is therefore referred to: www.icglass.org.