INTERNATIONAL COMMISSION ON GLASS
A SOCIETY OF SCIENTIFIC AND TECHNICAL ORGANISATIONS

COORDINATING TECHNICAL COMMITTEE ANNUAL REPORT 2015

January 2016

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CTC MEMBERS

H. Inoue
(vice chair)

K. Richardson

J. Parker

K. Bange
(invited)

J. Jones

H. Sesigur

X. Zhao

1 Executive Summary

CTC Actions in 2015

A CTC business meeting was held on May 19, 2015 in Miami, FL. A second business meeting took place in Bangkok, Thailand, on September 21, 2015, during the ICG Annual Meeting, *Glass Trend Seminar.* In addition to these meetings, telephone conferences among CTC members were organized.

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

The CTC followed the activity of TCs and took care of the necessary adaptations of the TC structure. Large re-organisations were done last year. It was decided that TC06n and TC08 merge into a new TC

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.

ICG Schools

The 7th workshop for new researchers in Glass Science and Technology ran from 6-10th July, 2015 in an exceptionally hot Montpellier, France. Two parallel sessions were arranged following the successful trial of a similar format last year. Their themes were ‘Glass Science' and ‘Surfaces and Thin Film Technology'. Altogether 32 students from 8 countries attended, those with industrial links making up the majority for the first time. A popular new provision was small group tutorials.

The scientific programme was arranged by a core group of lecturers: K Bange, B Hehlen, R Conradt, J Deubener, J Parker and R Vacher. The Surfaces and Thin Film Technology stream was put together by K Bange. Additional Lecturers are invited each year according to the themes chosen and this year we would like to thank the following for their valuable contributions: L Cormier (Univ. Paris, France), P. Florian (France), M George (Univ. Montpellier, France) and A Takada (AGC, Japan) completed the team for the ‘Glass Science’ part, and Dr K Bange (Germany), Prof S Oktik (Şişecam, Turkey), Prof C Pantano (Penn State, US), Dr H Roehl (Switzerland), Dr I Sokmen (Şişecam) and Prof A Mendoza Galvan (Mexico) shared their experience for the ‘Glass Surface’ theme.

During the meeting the lecturers analysed the event and concluded that once again it had been a success. This was backed up by the end-of-course questionnaires completed by the participants. Consequently a date was set for the 8th Summer School, which will run from 4-8th July 2016.

Last year, a new action was initiated: a Winter School in China, at the initiative of the ICG past President, Prof. Peng Shou. The first four day ICG Winter School for Research Students in Glass Science was held in December 2014 at Shenzhen University. The success prompted us to organize a 2d Winter School, which will be held at Wuhan University of

Technology, from March 31 to April 4. These dates, even not in perfect agreement with "Winter", were chosen in order to join this event with the 24th International Congress on Glass which will be held from April 7 to April 11 in Shanghai.

Books

The ICG Road Mapping process began in Strasbourg in 2007, at the XXI International Congress on Glass. Several road-mapping workshops followed, covering the most important R&D fields. The results were documented in the 1st edition of MAKING GLASS BETTER in 2010 and led to the reorganization of the TC cluster structure and the creation of new TCs. Since the world is ever changing - even the scientific one - road mapping must be an ongoing process. In the period from 2010 -2013 new roadmap workshops with invited experts were arranged; the main results were summarized in the 2nd edition of MAKING GLASS BETTER published in 2014. At the same time the content of the 1st edition was critically reviewed.

In this SPECIAL EDITION, material from roadmap exercises that were not designed and organized by the ICG is published for the first time. These results originated in a topical meeting in Sicily, 2013, arranged by the NSF's International Materials Institute for New Functionality in Glass (IMI-NFG) and cover the fields of Information and Energy Technology, which are of crucial interest for future glass applications. Its creation gathered pace through information harvesting and finally it blossomed into the fascinating results and roadmaps published here by the ICG.
The authors of this SPECIAL EDITION of MAKING GLASS BETTER are Klaus Bange, Himanshu Jain and Carlo G. Pantano, and the text has been edited by Klaus Bange, Alicia Durán and John Parker, ICG's Editorial Team .

A book titled: "Molecular Dynamics Simulations of Disordered Materials: from Network Glasses to Phase-Change Memory Alloys",by Springer as Springer series of Material Science in 2015 was published by TC27.

ICG Annual Meeting

From 20-23rd September the Centura Grand and Bangkok Convention Centre at CentralWorld in Bangkok, Thailand became the opulent venue for the 2015 Annual Conference of ICG. Action started early on Sunday 20th September with an all day Workshop led by Prof Arun Varshneya on "Instabilities in Glass." Several TCs met during the day. The opening ceremony on Monday morning was led by the conference chair Dr Tepiwan Jitwatcharakomol, of the Department of Science Service in Thailand. Among the special guests was Dr Pichet Durongkaveroj**,** *Minister of Science & Technology, Thailand* and he made a stirring presentation on the value of supporting scientific study to underpin the Thai economy.

Altogether 273 people participated, giving 113 oral presentations and displaying 51 posters. A high standard was maintained throughout – Profs Austin Angell, Reinhard Conradt, Neville Greaves and Arun Varshneya gave plenary lectures and additionally there were 10 eminent invited speakers.

Turner Award

The Turner Award was given jointly to Drs Rupertus and Dr Köpsel although sadly neither could be present. Both completed the maximum term of 9 years as Chairman of Committees TC19 and TC14 respectively in 2014 and were heavily involved in ICG's EFONGA project as workpackage responsible. Prof. Volker Rupertus was also a member of the Coordinating

Technical Committee for 5 years, during which time he was the coordinator for the Characterisation Cluster. Both are employed by Schott and have given of their energy and time in spite of carrying significant responsibilities at work. The support of Schott AG is acknowledged.

Plan 2016

The 24th International Congress on Glasses will be held in Shanghai, China, from April 7 to April 11, 2016.

- A CTC "brainstorming workshop" will be organized in Madrid on February 18, 2016. This workshop, coordinated by Klaus Bange, will put together CTC members and some specialists of glass science and technology, belonging to industry and academe. The purpose is a roadmapping exercise allowing to develop and orient the activity of TCs, and if necessary to create new ones.
- CTC Business meeting planned in Madrid, Spain Shanghai, China, on April 9, 2016
- The annual Montpellier Student Workshop will be held on July 4-8, 2016 and the school will have two parallel sessions, with some lectures in common: one on "Glass formation, structure and properties" and the other on "Surfaces and thin films".
- The 2d ICG Winter School will be held inWuhan, China, from March 31 to April 4.
- A large number of technical committees will meet in Shanghai on April 8 in the framework of the Congress.

2 Summary of R&D Activity Fields & TC Activities

2.1 BASIC GLASS SCIENCE – Coordinator: Hiroyuki Inoue

TC 03 Glass Structure

TC 03 met once in Miami, USA, during ACerS GOMD-DGG glass conference.

▪ They discussed the connectivity of BO_4, BO_3 and SiO_4 in borosilicate glasses by means of Raman and NMR spectroscopies.

They discussed also the following items:

- ▪ The roles of Te in tellurite and chalcogenide glasses
- ▪ The change in the role of transition element by their valence
- ▪ The roles of Al and B in the glasses with and without Si.

For the future

TC 03 will organize an international school titled "Glass network former vs. network modifiers: state of the art and new developments" in 2017

TC 07 Crystallisation & Glass Ceramics

First meeting: in Maiami, USA, during ACerS GOMD-DGG glass conference.

Second meeting: in Nagaoka, Japan, during 11th International Symposium on Crystallization in Glasses and Liquids.

- ▪ Organize the 11th International Symposium on Crystallization in Glasses and Liquids. The meeting was partially supported by CTC grant.
- ▪ Start the organization of the 12th International Symposium on Crystallization in Glasses and Liquids in Segovia, Spain.
- ▪ Lectures were given at the 7th ICG Summer School in Montpellier.

Plan for 2016

- ▪ Organize a special session during the ACerS-GOMD meeting to celebrate Don Uhlmann's contribution to glass crystallization.

TC 26 Vibrations and Glass Structure

TC 26 held a symposium on inelastic light spectroscopies applied to oxide glasses in Niagara Falls, USA, during Physics of Non-Crystalline Solids congress. The meeting was partially supported by CTC grant.

Plan for 2016

TC 26 meeting will organize at the ICG2016 congress in Shanghai.

TC 27 Atomistic Simulation

TC 27 met once in Maiami, USA, during ACerS GOMD-DGG glass conference.

- ▪ TC 27 held the 2nd International Workshop on Challenges of Atomistic Simulations of Glasses in Wuhan China. The meeting was partially supported by CTC grant.
- ▪ Organize the modeling and simulation session in Niagara Falls, USA, during XIV international Conference on Physics of Non-Crystalline Solids in Niagara Falls, USA.
- ▪ Organize the computational design of ceramic Materials Symposium during MS&T 2015 in Columbus, USA.
- ▪ Publish a book titled "Molecular Dynamics Simulations of Disordered Materials: from Network Glasses to Phase-Change Memory Alloys", by Springer as Springer series of Material Science in 2015.

Plans for 2016

- ▪ TC 27 meeting is planned during ICG congress in Shanghai in April 2016.

▪ Organize the modeling and simulation session in ACerS GOMD meeting and Materials Science and Technology 2016.

2.2 GLASS PRODUCTION – Coordinator: Hande Sesigur

There are seven technical committees in the Glass Production cluster. All these committees continued their activities according to the needs of the glass industry in which Coordinating Technical Committee decided to organize the studies of each TC.

The most important aim for 2015 and 2016 of TC09 is to define a uniform approach to define energy efficiency or specific energy use within or across the various glass industry sectors. With financial support of ICG, TC09 started a project to realize this goal. The existing non-uniformity is compounded by the fact that there is no common approach in the consideration of factors such as the effect of cullet, the efficiency of electric boosting, age, furnace design etc. In first instance TC09 is focussing on glass melting furnaces, the largest energy consumers of a glass factory.

TC09 will develop recommended Best Practices for defining energy use and efficiency so that companies within each glass sector can make useful comparisons. This approach will be used to explain some of the differences in performance between sectors and aid discussions with non-technical and/or external agencies.

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. The first step in this study is an energy benchmark study for six float glass furnaces. In this study glass furnace energy consumption of individual glass furnaces will be benchmarked against a database of energy consumption of (anonymous) glass furnaces.

Besides this study on the definition of energy efficiency, 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 CO_2 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), Heat-Ox systems to preheat fuel and oxygen, the application of the ‘Optimelt’ TCR system and the use of smart batches which melt more easily.

Technical committee working on refractory materials and its interaction with the glass melt, TC11, met once in 2015. Their main aim is to discuss the material related problems in glass melting furnaces and the defects generated by these materials like blisters, stones, knots and cords. So TC11 tries to find solutions and experimental testing methods by exchanging the knowledge and experiences between the members and participants from refractory industry, glass industry and academia. New and improved materials for new solutions of refractory material problems of glass furnaces including refractory materials exposed to molten glass and batch, combustion gases and flue gases (regenerator), are the most important topics of interest for TC11.

The technical committee tried to prepare and publish a document on the recommendations for the Exudation test which they will continue next year as well. They will also try to prepare guidelines for the tests (including sampling) in the frame of the quality assessment.

TC11 decided to schedule two committee meetings in 2016 and one of them will be a joint meeting with TC14 in order to continue the joint work on “blisters in glass generated from refractories”.

The environmental committee (TC13) covers all environmental issues affecting the glass industry. The TC meets twice a year and produces extensive minutes detailing the many topics addressed. Subjects range from characterising and controlling glass furnace emissions to understanding the impact of new regulations on the different sectors of the industry. They regularly produce briefing papers and journal articles.

The first TC13 meeting of 2015 was held on Murano at the kind invitation of Stazione Sperimentale del Vetro. There was a full agenda with many important environmental issues associated with the manufacture of glass and the abatement of emissions. The discussion of many subjects continued from the previous meetings, including the formation of sulphur trioxide in selective catalytic reduction units, the problematic interaction therein of sulphur and ammonia compounds, and the size of particles in the emissions after a catalytic bag house. The committee heard about different ways to measure ammonia emissions and results from a comparative test of two types of analyser.

The second TC13 meeting was held in Aubervilliers, Paris, at the kind invitation of Saint Gobain Conceptions Verrières. St. Gobain provided an update on the operation of their CERCAT ceramic catalytic bag house, and measuring the particle size in the waste gas was discussed. This led to a consideration of the relationship between SOx emission and urea use, and of the influence of different analytical techniques. The benefits and problems associated with recycling of dust collected in abatement plants was also a topic of discussion.

TC14, working on gases in glass, gas inclusions and determining their influence on glass quality and properties, met at October 14, 2015 after the Glass Trend seminar in Eindhoven. The meeting was chaired by the new chairman Dr. Mustafa Oran. Besides the annual meeting of TC14, a joint meeting of TC11-TC14 was held on the same day. Therefore, the agenda of the TC14 meeting was divided into two sections. They discussed the preparation of guidelines for the dynamic blister test and the results of round robin tests on static blister at the TC11-TC14 joint meeting.

Besides the ongoing activities of TC14, they discussed two new proposals, considering the need of new topics to be studied. One is to analyze the bubbles by Raman Spectroscopy, a non-destructive method, different from Mass Spectroscopy. The other is to find a numerical relation between rate of change of bubble size with respect to temperature and glass composition. Such a definition may be supposed to be used in numerical models.

TC18 promotes the activities in the field of both fundamental and application research concerning stages in the glass melting process. It supports co-operation among technical committees involved in the cluster Glass Production. The projects in 2015 included the Round Robin Test on the Determination of the Temperature of the Bubble Nucleation and Round Robin Test on Determination of Batch Free Time. The results of the determination of the nucleation temperature delivered by three participants were presented during TC18 meeting in Eindhoven, October 2015.

Plans for the year 2016 involve the completion of the RRT on *Nucleation of Bubbles in Glass Melt* by collecting the results from remaining participants and evaluation of the results at the TC18 meeting during the ESG Conference in Sheffield, September 2016. The details of the RRT on the *Batch Melting Kinetics* will be specified at the mutual meeting of TC14 and 18 during the ESG Conference in Sheffield, September 2016. The *Batch Melting Kinetics* project will be associated with the proposed project of the TC14 focused on the analysis of bubbles nucleated on dissolving sand grains.

After merging two years ago, the technical committees on sensors and furnace modelling new committee TC21 named “Glass Furnace Design & Operation”. In the past main activity of TC21 has been focussed on how to improve quality and reliability of glass melting furnace modelling and optimization of software packages of different suppliers and glass producing companies. After merging they summarize their future activities including extension of round robin tests on furnace modelling, studies on combustion modelling (tentative), organize sessions on Glass Furnace Designs and Operation at ICG conferences. TC21 have organized 2 Conferences and 2 member meetings in 2015.

First conference was the bi-annual Conference on Furnace Modeling held in June 2015 in Velke Karlovice in Czech Republic, attended by over 140 people. The annual TC21 meeting was held during that conference In October 2015 Glass Trend organized in close cooperation with TC21 a special seminar on sensors attended by around 80 people. Afterwards the committee held their second TC meeting.

The committee on modelling of forming, TC25, TC25 focuses on furthering knowledge pertaining to glass forming process by providing a medium for interaction between researches and practitioners. In 2015, the committee was inactive. TC25 will regroup in 2016 and will work on the BMP-IV as well as preparing a guideline document on numerical simulation of glass forming processes.

2.3 CHARACTERISATION – Coordinator: Julian Jones

TC02 continues to provide analytical solutions to complex issues affecting the glass industry through the development of standard methods of analysis and the production of certified reference materials for analytical calibration supported by extensive round robin/proficiency testing schemes.
A meeting was held this year in Paris
TC02 has published two reports on the results of Round Robin tests, one on coefficient of thermal expansion and the second on viscosity measurements. Reports were also published on Proficiency Test on Chemical Durability Tests of Glass Ceramic, on arsenic leaching according to European directives, and on proficiency Test for Hydrolytic Resistance ISO 4802-1.

The main purpose of the activity of TC10 is to study optical measurement problems common to the glass industry and to develop or improve techniques to resolve those problems. In addition, the TC acts to inform new employees involved in the glass industry of existing optical measurement techniques, to study the properties that influence optical performance of glass. The work of TC10 is also a pre-normative reference for standards committees.

One new round robin test was proposed and launch on optical characterization of glass products.TC10 continued investigations into the measurements of scattering and patterned glass products. A subgroup continued investigations on the modeling of colouring ions in glass and the effect of the tin layer of float glass on the optical properties. A study on solarisation effects was pursued.

Two meeting were held in 2015, one in March in Murano (Italy), the second in September in Prague (Czeck Republic).

2.4 APPLICATIONS – Coordinator: Kathleen Richardson

TC 04 Glasses for Medicine and Biotechnology

TC04 organised a successful TC04/ Bioactive glass symposium at 2nd Joint Meeting of DGG – ACerS GOMD, which took place in Miami, in May 2015. There were 30 oral presentations in this symposium and two student awards were given for best oral presentations. The TC04 annual Meeting was held at 2nd Joint Meeting of DGG – ACerS GOMD in Miami, in May 2015, attended by Delia Brauer, Jamieson Christie, Delbert Day, Larry Hench, Steve Jung, Ashutosh Goel. The first articles of the open access journal "Biomedical Glasses" (editor in chief, Aldo Boccaccini) have also been published.

TC 05 Glasses for nuclear and Hazardous waste vitrification

TC05 conducted very successful programming at 2 meetings in 2015:

- Approximately 50 papers and posters were presented at the GOMD/DGG meeting in sessions organized by TC05 (represented almost 15% of papers in entire conference).

- Approximately 20 papers and posters were presented in sessions organized by TC05 at the PacRim ceramics meeting.

TC05 has strengthened the relationship with the U.S. Department of Energy led international consortium on nuclear waste glass corrosion including conducting programming and technical workshops.

The proceedings from the "2nd international summer school on nuclear glass waste form: Structure, Properties and Long-Term Behavior (SumGLASS 2013)" held in Vers-Pont-du-Gard, France from 23 – 27 September 2013 were published in 2015 Procedia Materials Science Volume 7. It includes about forty articles, several of which were authored by TC05 members.

TC 12 Glasses for Pharma Packaging

During 2015 there were a teleconference in June and a face-to-face meeting in Murano in October. The activity of the TC and the results obtained were presented by Daniele Zuccato at the PDA Particles in Injectable event held in Berlin in September.

Two Round-Robin were run using different categories of vials, with the aim to check a test for evaluating the propensity to delamination. 10 labs participated actively.On the base of the results the experimental procedure was adjusted. The results indicate that the test might be a good diagnostic method. However, after a meeting in Venice in October 2015, it was decided that further work is necessary to find a direct correlation between the results of the test and the occurrence of delamination under stressed conditions.

TC 16 Nanostructured Glasses

In 2015, TC 16 carried out collaborative work on :

- Yb-doped glass coatings for laser applications
- Nano glass-ceramics and nanoparticulate materials
- SAXS measurements on nanostructured glass and glass-ceramic films
- TC16 organized Session 3: Liquid Synthesis and Sol-gel-derived Materials within Symposium 5: Glass Technology ans Cross-cutting Topics at the ACerS GOMD-DGG joint annual meeting in Miami, May 17 – 21.

TC 20 Glasses for Optoelectronics

TC 20 (21 members) keeps pursuing its goals to contribute to the advances in the area of optoelectronic/photonic glasses and to implement outreach strategies in this area.

TC20 members have been involved in the celebrations of the International Year of Light; a major activity concerned the publication of a Special Issue of Journal of Luminescence on the subject "Light, Energy and Life". The papers in this issue, edited by G.C. Righini and S. Tanabe together with J. Capobianco, have been made by Elsevier freely available online until March 31, 2016.

Collaborative research activities have been promoted by the group at University of Southampton, by establishing, in February 2015, ChAMP, the Chalcogenide Glass Manufacturing Partnership and providing chalcogenide glass samples to approx. 50 research groups.

2.5 INFORMATION, EDUCATION, HISTORY – Coordinator: John Parker

The Communications, History and Education Cluster continues to run smoothly. TC01 and TC23 are particularly active and TC17 has continued to pursue its goals. Two of the chairs of TCs in this cluster reach the end of their standard 3+3+3 year terms in 2016. Discussions on ensuring continuity are underway.

The Communications TC (TC01) reports to both the Steering Committee on publication matters and on communication as well as carrying out a variety of tasks for CTC. Its small but active membership includes the chair, Dr Bange and also the ICG Vice-president, Prof Duran. They maintain regular contact using e-mail and Skype. Output in 2015 has included press releases: 20 have been added to the ICG web site; eight have been widely circulated and published in the Glass Literature. Another major achievement has been the publication of the 3rd edition of 'Making Glass Better' to a tight schedule. It was based on a conference arranged by Himanshu Jain and Carlo Pantano on Functional Glasses and was turned into a valuable text in the 'Making Glass Better' series with a major input from K Bange. Free copies were made available to delegates at the ACerS meeting in Miami in May and its advertising value was evident from the doubling of hits on the ICG web site for a 3 week period after the conference. A major revision to the structure of the ICG web site has been completed and will add flexibility. More effort is needed to encourage the involvement of TCs in updating.

TC17 has been re-grouping and continued this process during 2015 with the goal of increasing activity. It has been planning a session for the next Congress in Shanghai, China in April 2016 and a number of abstracts have been submitted. Towards the end of 2014 the committee successfully applied to the CTC for funding for a textbook on ancient sites for bead making in India. This project has proceeded smoothly and the text is now with the Printers. Publication is expected early in 2016.

TC23 met during the ICG conference in Bangkok. Specific activities have included the running of a 7th Summer School in Montpellier. Following the successful Winter School in China in 2014 plans have been made for a 2nd Winter School there. In view of the ICG Congress in Shanghai in 2016 a decision was taken to link the 2 events so that the new school will be more easily accessible to people from neighbouring countries. It will be held in Wuhan from 1-4th April 2016. Following the recommendations of the ICG Management Board TC23, will explore the possibility of expanding ICG TC23 activities. In 2012, the German Museum in Munich presented a series of books covering the basics of glass science and technology at the level of an undergraduate introductory course. The texts are presented in German and English. The opportunity of expanding this series with the assistance of ICG to editions presenting the texts in English plus another ICG language (similar to the ICG

Dictionary) should be explored with the editors. This may result in a win-win situation for both the museum and ICG. ICG funds have also been received to encourage student participation in ICG conferences such as the next one in Shanghai. Allocation of these awards will be an important activity for 2016.

3 Organizational issues

The present situation for CTC officers and TC chairs is summarized in the Table below:

CTC/Coordinator/ TC	Name	2011	2012	2013	2014	2015	2016
CTC-chair	R. Vacher		1st TE		2d TE		3d TE
CTC-Vice Chair	H. Inoue				Start		
CTC-Secretary	J. Parker						
CTC	J. Jones				Start		
CTC	H. Sengel	Start			1st TE		2d TE
CTC	K. Richardson		Start			1st TE	
CTC	X. Zhao		Start			1st TE	
Communication…	J. Parker						
Basics	H. Inoue						
Characterisation	J. Jones	TE = term ends					
Glass Production	H. Sengel						
Applications	K. Richardson						
TC01	J. Parker			2nd TE			3rd TE
TC02	R. Eiden						Start
TC03	D. Neuville			Start			1st TE
TC04	J. Jones		1st TE			2nd TE	
TC05	O.Pinet					Start	
TC06	L. Wondraczek					Start	
TC07	J. Deubener			Start			1st TE
TC09	H. van Limp				Start		
TC10	I. Marenne			Start			
TC11	M Dunkl	1st TE			2nd TE		
TC12	M. Guglielmi		Start			1st TE	
TC13	A. Kasper			Start			
TC14	M. Oran					Start	
TC15-TC21	E. Muijsenberg	1st TE			2nd TE		
TC16	R. Almeida			2nd TE			
TC17	S. Koob			3rd TE	Start		
TC18	J. Kloužek			Start			1st TE
TC20	G. Righini		Start			1st TE	
TC23	R. Conradt			2nd TE			3rd TE
TC24	K. Sanderson	1st TE			2nd TE		
TC25	A. Karadag	Start			1st TE		
TC26	B. Hehlen		1st TE			2nd TE	
TC27	J. Du	Start			1st TE		

For 2016, **decisions** on the following persons/functions have to be prepared:

- R. Vacher is finishing his 3d term as CTC Chair and will have to be replaced. The CTC Vice-Chair, H. Inoue will be proposed to the Council as the new CTC Chair
- If the above proposal is accepted, one position will become open as CTC member. The CTC proposes B. Hehlen to be nominated as a new CTC member.
- H. Sengel is finishing her 2d term as CTC member. She will be invited for the next year and continue as the coordinator of the R1D field Glass Production. A new member will be proposed during the next year.
- J. Parker (TC01) and R. Conradt (TC23) have reached the end of their 3d term as TC Chairs. They will serve as acting Chairs during the next year, and look for new Chairs.
- D. Michiels, Chairman of TC02, has decided to step down. The vice-chair, R. Eiden, has agreed to serve as acting chair and will be proposed as the new Chair.
  E. Muijsenberg, Chairman of TC21, wants to be replaced by the vice-chair A. Huber. He will serve in the same TC as the vice-chair.

4 Activities of the Technical Committees in Detail

4.1 R&D ACTIVITY FIELD « BASIC GLASS SCIENCE »

4.1.1 GLASS STRUCTURE (TC03)

Chairman: *Neuville Daniel R*

See report in pdf format p. 69.

4.1.2 ATOMISTIC MODELING AND SIMULATION (TC27)

Chairman: *Jincheng Du, University of North Texas, USA*
Members: *Douglas Allan, Corning Incorporated, USA*
Yasuhiko Benino, Okayama University, Japan
Richard Catlow, University College London, UK
Alastair Cormack, Alfred University, USA
Ulrich Fotheringham, SCHOTT AG, Germany
Neville Greaves, Aberystwyth University, UK
Liping Huang, Rensselaer Polytechnic Institute, USA
Hiroyuki Inoue, Tokyo University, Japan
Yang Jiang, Bengbu Design & Research Inst. for Glass Industry, China
Jürgen Horbach, Institut für Materialphysik im Weltraum, Germany
Roger Loucks, Alfred University, USA
Walter Kob, Universite Montpellier II, France
Carlo Massobrio, IPCMS, France
Matthieu Micoulaut, Université Pierre et Marie Curie, France
John Mauro, Corning Incorporated, USA
Akira Takada, Asahi Glass Corp., Japan
Monia Montorsi, University of Modena and Reggio Emilia, Italy,

SUMMARY

- The Technical Committee on "Atomistic Modeling and Simulation of Glass" was founded in 2009 and officially approved by ICG during the PACRIM conference in Vancouver, Canada. The focus of the new TC is on developing the theoretical foundation for advancing the modeling and simulation of glassy systems. The scope includes both the development of accurate interatomic potentials for multi-component glass-forming systems, exploring methodologies for glass formation and thermodynamics for atomistic simulations of glasses, as well as the development of new theoretical approaches and algorithms for overcoming the intrinsic time and length scale limitations of existing simulation techniques. John Mauro of Corning Inc. served as the first TC Chair and Jincheng Du of University of North Texas became the Chair of TC27 in 2011. The goal of TC27 is to bring together researchers working on the modeling of simulation of glasses to tackle challenges in the field, to promote modeling and simulation in glass research, and to educate next generation work forces with modeling skills and experiences.

Summary of activities of TC27 in 2015:

- ✓ Had a TC meeting in Aachen Germany during the American Ceramic Society GOMD-DGG joint meeting Miami Florida USA (May 2015).
- ✓ Organized the 2nd International Workshop on Challenges of Atomistic Simulations of

Glasses, Wuhan China (sponsored by ICG)

- ✓ Co-organized the XIV International Conference on Physics of Non-Crystalline Solids, Niagra Falls New York USA. (Sept. 2015)
- ✓ Organized the modeling and simulation sessions in ACerS GOMD-DGG conference in Miami FL. (May 2015).
- ✓ Co-organized the Computational Design of Ceramic Materials Symposium during MS&T 2015 in Columbus, Ohio USA. (Oct. 2015).
- ✓ Published a book titled: "Molecular Dynamics Simulations of Disordered Materials: from Network Glasses to Phase-Change Memory Alloys",by Springer as Springer series of Material Science in 2015.

DELIVERABLES FOR 2015

1. TC meeting of TC27 held in Miami, Florida USA, May 2015

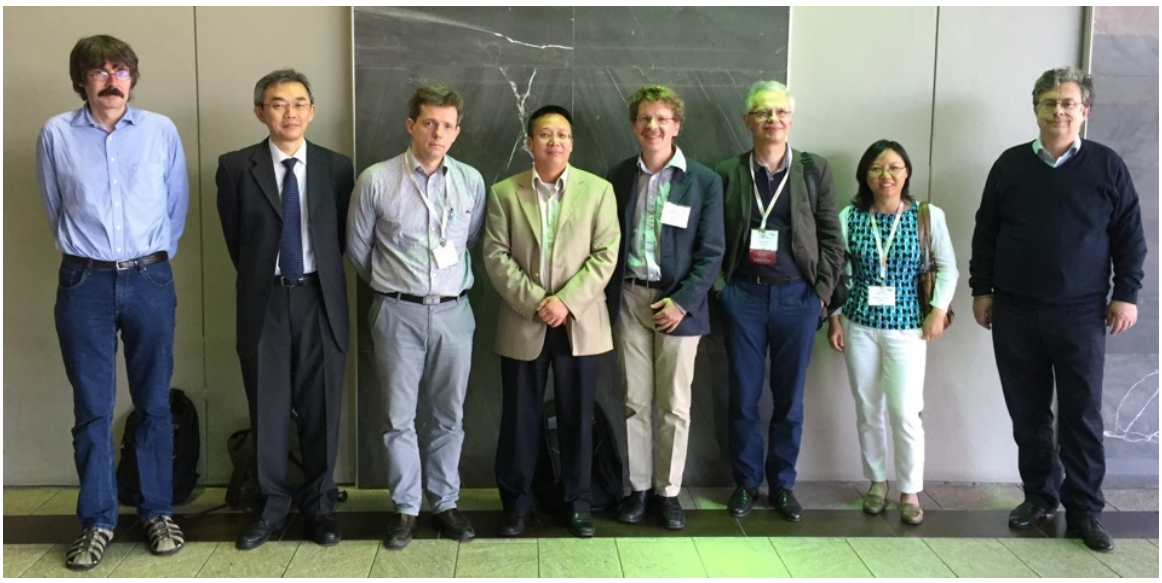


Photo of TC meeting of TC27 at Miami, FL May 2015.
From left: Juergen Horbach (Heinrich-Heine-Universität Düsseldorf, Germany), Hiroyuki Inoue (Tokyo University, Japan), Matthieu Micoulaut (UPMC, France), Jincheng Du (Univ. North Texas, USA), Walter Kob (Univ. Montpellier 2, France), Carlo Massobrio (CNRS, France) Liping Huang (RPI, USA), Ulrich Fotheringham, SCHOTT AG, Germany

- During the TC meeting, TC Chair reported activity and progresses of the TC in the past year. The attending TC members discussed current status TC, ideas on central website, and plans for future activities to enhance communications with other TCs within ICG and other researchers in the field of glass research.
- Reported finishing of the book published by Springers and another project with Wiley on Fundamental of glass simulations.

2. TC27 organized the 2nd International Workshop on Challenges of Atomistic Simulations of Glasses and Amorphous Materials in Wuhan China (June 22-24, 2015)

Photo of all attendees for the 2nd International Workshop in Wuhan China, June 22-24.

- The Workshop was organized by Jincheng Du (TC27 Chair), Carlo Massobrio (TC27 member), Alastair Cormack (TC27 member) and Xiujian Zhao (Wuhan University of Technology). The Workshop was sponsored by ICG and co-sponsored by Wuhan University of Technology.
- The Workshop features 17 invited talks addressing current status and future challenges in the modeling and simulation of glass and amorphous amterials.
- A round table discussion was held during the Workshop on the status and roadmap of TC27.
- The invited speaker of the Workshop include :
  - Benoit Coasne, MIT, USA
  - Alastair Cormack, Alfred University, USA
  - Guillaume Ferlat, UPMC, France
  - Jincheng Du, University of North Texas, USA
  - Jean-Yves Raty, Université de Liège, Belgium
  - Jaakko Akola, Tampere University of Technology, Finland
  - Carlo Massobrio, Inst de Phys et Chimie des Matériaux de Strasbourg, France
  - Hiroyuki Inoue, University of Tokyo, Japan
  - Akira Takada, Asahi Glass Inc., Japan
  - Habasaki Junko, Tokyo Institute of Technology, Japan
  - Maria Christina Menziani, University of Modena and Reggio Emilia, Italy
  - Alfonso Pedone, University of Modena and Reggio Emilia, Italy
  - Simona Ispas, University of Montpellier 2, France
  - Guido Ori, Inst de Phys et Chimie des Matériaux de Strasbourg, France
  - Eric Furet, University Renné 1, France
  - Neng Li, Wuhan University of Technology, China
  - Haizheng Tao, Wuhan University of Technology, China

- Seungwu Han, Seoul National University, Korea

- A detailed report including the conference program and abstracts of the Workshop will be attached with this annual report.

3. TC member organized the XIV International Conference of the Physics of Non-Crystalline Solids (PNCS), at Niagra Falls, New York, USA (Sept. 20-25, 2015)

Conference photo onf PNCS XIV in Niagra Falls, New York USA

- TC member Alastair Cormack is the conference Chair. TC Chair Jincheng Du served on the scientific committee.
- Sessions of the modeling and simulations of glasses was organized during the PNCS conference.

4. TC members organized the Computational Design of Ceramic Materials Symposium of MS&T'15 (Oct. 4-8, Columbus Ohio USA)

- TC member Liping Huang co-organized the 2nd Computational Design of Ceramic Materials Symposium at MS&T conference in Pittsburg PA USA in October 2014.
- Several TC27 members participated and presented topics on glass simulations during the symposium. TC Chair Jincheng Du and TC members John Mauro and Liping Huang gave invited talks on the modeling and simulations of glasses.

5. Book project completed and book on challenges of glass simulations published by Springer in 2015

- C. Massobrio, J. Du, P. S. Salmon, M. Bernasconi, "Molecular Dynamics Simulations of Disordered Materials: from Network Glasses to Phase-Change Memory Alloys", Springer Series in Material Science, Vol. 215, 529 p, Springer, ISBN 978-3-319-15674-3 (2015).
- "This book is a unique reference work in the area of atomic-scale simulation of glasses. For the first time, a highly selected panel of about 20 researchers provides, in a single book, their views, methodologies and applications on the use of molecular dynamics as a tool to describe glassy materials. The book covers a wide range of systems covering "traditional" network glasses, such as chalcogenides and oxides, as well as glasses for applications in the area of phase change materials. The novelty of this work is the interplay between molecular dynamics methods (both at the classical and first-principles level) and the structure of materials for which, quite often, direct

experimental structural information is rather scarce or absent. The book features specific examples of how quite subtle features of the structure of glasses can be unraveled by relying on the predictive power of molecular dynamics, used in connection with a realistic description of forces."

- The contributors were from experts in the fields of glass and amorphous materials simulations and addressed wide range of issues from methodology development to applications.
- This book serves as a milestone of the TC. The plan is to have future updates of the field by providing future series like publications.

PLANS FOR 2016 AND DELIVERABLES

- Next TC meeting of TC27 is planned during ICG Congress in Shanghai April 2015.
- Work on book project on fundamentals of glass simulations with Wiley.
- Organize the computer simulation and modeling sessions during the 2016 American Ceramic Society GOMD meeting and during the Materials Science and Technology 2016 annual meeting.

Appendix:
Conference program and abstract for the 2nd International Workshop of Challenges of Atomistic Simulations of Glass and Amorphous Materials, Wuhan China June 22-14, 2015.

4.1.4 STRUCTURE & VIBRATIONS (TC26)

Chairman: *Bernard HEHLEN*
Vice-Chairs:
Members: *F.J. Bermejo (Spain)*
E.I. Kamitsos (Greece)
A. Chumakov (France-ESRF)
P. Simon (France-Orleans)
D. Massiot (France-Orleans)
I. Farnan (UK)
M. Dove (UK)
S.R. Elliott (UK)
L. Cormier (France-Paris)
A. Pasquarello (Switzerland)
W. Schirmacher (Germany)
M. Foret (France-Montpellier)
B. Rufflé (France-Montpellier)
S. Ispas (France-Montpellier)
G. Monaco (France-ESRF)
H. Schober (Ulich, Germany)
Uli. Buchenau (Germany)
M. Ramos (Madrid, Spain)
D. Neuville (Paris, France)
G. Henderson (Toronto, Canada)
J. Horbach (Mainz, Germany)

ACTIONS 2015

Expert meeting on vibrations in oxide glasses at PNCS conference in Niagara Falls, USA.

A one day symposium on inelastic light spectroscopies applied to oxide glasses was held on the 22th September 2015 in parallel with the Physics of Non-Crystalline Solids (PNCS) congress. The event benefitted from the financial support of the ICG and from the organization and infrastructures at the one week PNCS meeting, led by A. Cormack and M. Wightman.

List of invited lecturers (by order of appearance):

Bernard Hehlen, CNRS-University-Montpellier, France
Introduction
Optic Vibrations and Atomic structure of oxide glasses using Raman spectroscopy(ies)
Liping Huang, Rensselaer Polytechnic Institute-Troy, USA
In-Situ Brillouin and Raman light scattering study of glass under extreme conditions
Nikita S. Shcheblanov University of Missouri - Columbia, USA (absent, talk given by A. Tanguy)
The vibrational modes treatment and Raman analysis of vitreous silica upon mechanical loads
Benoit Rufflé, CNRS-Université Montpellier, France
From elastic properties to macroscopic physical properties of silicate glasses and melts
Simona Ispas, CNRS-Université Montpellier, France
Raman spectra of silica and binary sodo-silicate glasses from first principle calculations
Anne Tanguy, CNRS-University Lyon 1, France
A numerical investigation of the effect of mechanical load on vibration modes, and their Raman signature in silica glasses
Silvia Caponi, Istituto Officina dei Materiali of CNR, Perugia, Italy
Brillouin and Raman spectroscopies: powerful tools for the investigation of structural and vibrational properties in glasses
John Kieffer, University of Michigan, USA
Glass formation and the absence of thermo rheological simplicity

The conclusions of the Symposium were summarized in a press release on the ICG website.

PLANS AND DELIVERABLES FOR 2016

TC26 group meeting at the ICG2016 congress in Shanghai.

4.1.5 CRYSTALLIZATION & GLASS-CERAMICS (TC07)

Chairman: *J. Deubener (Clausthal University of Technology, Germany); joachim.deubener@tu-clausthal.de*

Vice chair: *W. Höland (Ivoclar Vivadent GmbH, Schaan, Liechtenstein); wolfram.hoeland@ivoclarvivadent.com*

Members: *L. Cormier (Sorbonne Universités, Paris, France); Laurent.Cormier@impmc.upmc.fr*
M.J. Davis (Schott North America, Duryea, USA); mark.davis@us.schott.com
R. Hill (Queen Mary University London, UK); r.hill@qmul.ac.uk
T. Komatsu (University of Nagaoka, Japan); komatsu@mst.nagaokaut.ac.jp

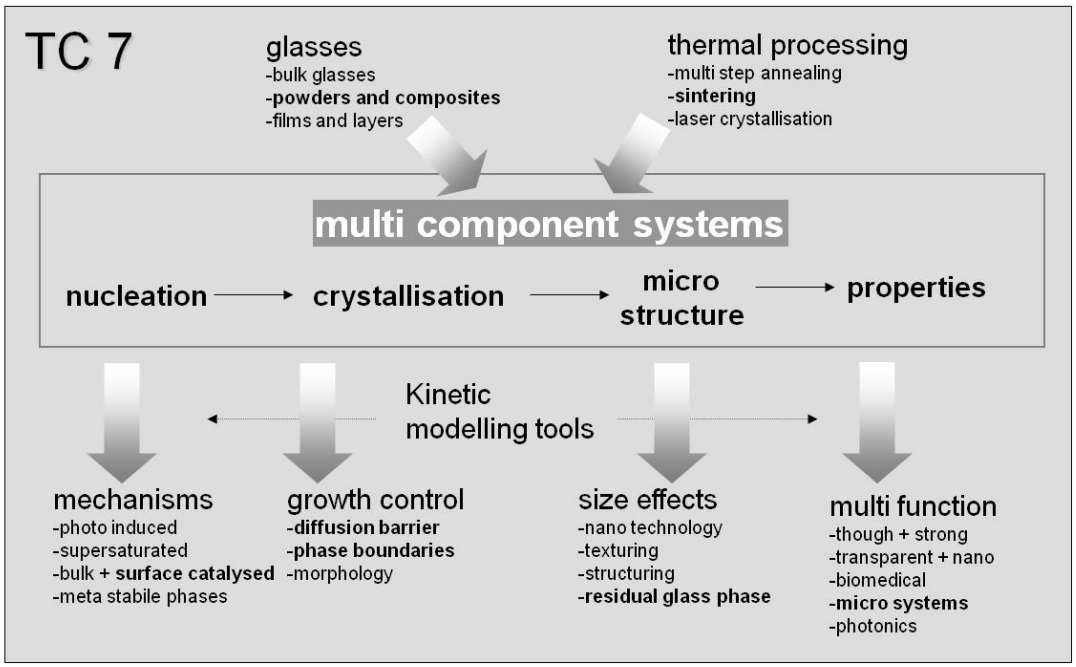
I. Mitra (Schott SG, Mainz, Germany);
ina.mitra@schott.com
R. Müller (Federal Inst of Materials Research and Testing, Berlin, Germany);
ralf.mueller@bam.de
S. Nakane (Nippon Electric Glass, Shiga, Japan);
snakane@neg.co.jp
M.J. Pascual (Instituto de Cerámica y Vidrio, Madrid, Spain);
mpascual@icv.csic.es
P. Pradeau (Corning SAS, Avon, France);
pradeaup@corning.com
E.D. Zanotto (University of Sao Carlos, Brazil);
dedz@power.ufscar.br

Inactive members (not contributing in the last two years):

M.O. Prado (Centro Atómico Bariloche, Argentina);
pradom@cab.cnea.gov.ar
V.M. Fokin (Grebenshchikov Institute of Silicate Chemistry., St. Petersburg, Russia);
vmfokin@gmail.com

1. Main goals

To understand from both theoretical and experimental points of view the fundamental aspects that govern crystal nucleation and growth in glasses; and to foster collaboration between academic, governmental, and industrial researchers to develop, characterize, and optimize existing and novel glass-ceramics with focus on multi-component systems (see mission chart).



2. Projects for the year 2015

- organise at least one business meeting to accommodate the travel windows and opportunities of most members

- organize and operate the Crystallization-2015 conference in Nagaoka, Japan.
- carry out interdisciplinary research, publish joint papers and co-edited books

3. Activity of the TC as a group in 2015

- organized two business meetings

19/05/2015 - 2nd Joint Meeting of DGG – ACerS GOMD in Miami, USA
(5 members attended)

11/10/2015 - 11th International Symposium on Crystallization in Glasses and Liquids, Nagaoka Japan
(9 members and 2 guests attended)

- organized and operated the Crystallization-2015 conference

The 11th International Symposium on Crystallization in Glasses and Liquids, Nagaoka Japan (Crystallization-2015) of TC07 was successfully organized and held in Nagaoka, Japan during October 11-14, 2015. Conference chairs were T. Komatsu (Chair, Nagaoka University, TC07 member) and A. Sakamoto (Vice-chair, OLED Materials Solutions Co. Ltd., till 2014 TC07 member).
Nine TC07 members had invited talks, several members of other basic science TCs were attending and contributing to the conference with their oral and poster presentations. In summa 109 colleagues from academia and industry attended the conference presenting 53 talks and 31 posters. Details of the program and abstracts available under: http://crystallization-2015.jp
In particular during the business meeting and through selected oral presentations the role of residual glasses in glass-ceramics was highlighted and discussed. This expert meeting was partially supported by CTC with a grant of 4767 Euro. The outcome of this expert meeting will be delivered in 2016 to ICG through the 3rd edition of "Making glass better" book by giving a roadmap-type perspective on glass-ceramics with focus on the amorphous fraction.

The series of crystallization conferences in a tri- to biennial schedule is assisted by TC07 as a group since 1996 and is one of the major deliverables of the committee work to the glass community. The conference series has become the first address to present research and development in accordance with the mission and scope of TC07. Each conference was organized by individual TC07 members, who took their own financial risk in realizing this scientific event. The conference in Nagaoka (2015) was number 11 of this strategic series and the following in Segovia (2017) will be number 12.

- started to organize the Crystallization-2017 conference

The organization of the next Crystallization conference was launched. It will be held in Segovia, Spain on September 10-13, 2017. The conference chairs are M.J. Pascual (Chair, ICV-CSIC Madrid, TC7 member) and A. Duran (Vice-chair, ICV-CSIC Madrid, CTC of ICG). The status of the conference will be available under:
http://secv.es/crystallization2017
So far all active members of TC07 confirmed serving for the International Advisory Board. They take action in collecting papers and promoting young scientists to participate on this TC07 event.

- trained young researchers

Lectures were given at the 7th ICG Summer School in Montpellier (06-10 July 2015) on the topics: Liquid-liquid phase separation, nucleation and crystallisation, nanocrystallisation, particle coarsening, glass ceramics: their manufacture and properties. This work was done in cooperation with TC23 and the ICG-Team of the Summer School (most of them are chairing other TCs).

- opened laboratories

TC07 provided open access for their members, especially young professionals (industry) and PhD students (academia) of the of the member's groups to a wide range of research facilities, material resources and unpublished data.

4. Plans for the year 2016

- to organise at least one business meeting. Next meetings are proposed for the ACerS-GOMD Meeting in Madison, USA (May 17-21) and the ESG 2016/SGT100 conference in Sheffield, UK (September 04-08)
- to publish research results in media jointly. A *Stanley Donald Stookey* issue on controlled crystallization of glasses is in preparation. The Editor of Frontiers in Materials /Glass Science agreed with the TC07 proposal to publish this special issue in Frontiers in Materials in 2016.
- to organize a special session during the ACerS-GOMD Meeting to celebrate *Don Uhlmann's* contribution to glass crystallization (organized by TC07 member E.D. Zanotto)
- to complete the Crystallization-2017 conference programme and to help in organization issues.
- to contribute to the next edition of ""Making glass better" with the outcome of the 2015 expert meeting.
- to continue in training young researchers. Contributions at the 8th ICG Summer school are planned. The open laboratories policy turned out to be one of the best measures to attract young researchers to the field of crystallization and glass-ceramics and to share experience among TC07 members.
- to maintain collaboration with other TCs with respect to structural issues (TC03), mechanical properties (TC06) and biological response (TC04) of glass-ceramic materials.

5. Executive summary

TC07 is committed to a long-term strategy in glass crystallisation and glass-ceramic issues that will bring about the services in education of young researchers; the services in providing an international conference within a bi-/triennial schedule, the services of an open information policy, which provides the basis for a scientific discussion without restraints and fruitful collaboration between industry and academia.

4.2 R&D ACTIVITY FIELD « PRODUCTION »

4.2.1 GLASS MELTING (TC18)

CORE TEAM *Jaroslav Kloužek, ICT Prague, Czech Rep.*
Hande Sesigur, ŞişeCam, Turkey
Mathieu Hubert, Celsian, Netherlands

OTHERS *Masataka Kawaguchi, NEG, Japan*
Lubomír Němec, ICT Prague, Czech Rep.
Reinhard Conradt, RWTH Aachen, Germany
Detlef Köpsel, TC14/Schott AG, Germany
Thomas Pfeiffer, Schott AG, Germany
Ulrich Roger, HVG, Germany
Yasushi Kii, NEG, Japan
Leena Hupa, ABO University, Finland
Erik Muijsenberg, TC21/Glass Service, Czech Rep.
Wilfried Linz, TC15/Schott AG, Germany
Papin Sophie, Saint Gobain, France
Marie-Helene Chopinet, Saint Gobain, France
Neill McDonald, Saint Gobain/ Verallia, France
Satoshi Yoshida, Shiga University, Japan
Christina Stålhandske, Glafo, Sweden
Jan Hermans, Philips Lighting, Netherlands
Terutaka Maehara, AGC, Japan
Oleg Prokhorenko, Lab Glass Properties, LLC,Russia

MAIN GOALS OF THE TC18

TC18 promotes the activities in the field of both fundamental and application research of phenomena of glass melting processes. It supports co-operation among technical committees involved in the cluster Glass Production.

PROJECTS FOR THE YEAR 2015

1. *The project on Nucleation of Bubbles in Glass Melt*

The aim of the project is to understand the mechanism and kinetics of bubble nucleation, to restrict bubble defects and to study the effect of bubble nucleation process on melting improvement. First step of the project involves the Round Robin Test on the determination of the nucleation temperature. The proposed method is based on high temperature observation of bubble nucleation on Pt wire immersed in the glass melt. Two samples of commercial float glasses delivered by AGC and Sisecam were chosen for the study. The project is carried out in cooperation with TC14.
The samples were distributed to following RRT participants:
Celsian (M. Hubert)
Schott (D.Koepsel)
AGC (T.Maehara)
NEG (M.Kawaguchi)
UCT Prague (J.Klouzek)
Glass Service (J.Ullrich)

The results of the determination of the nucleation temperature were delivered by UCT Prague, AGC and Celsian. Remaining participants will deliver the results in 2016.

2. *The project on Batch Melting Kinetics*

The goal of the project is to develop a standard test to evaluate melting kinetics of glass forming raw material batches. In the initial stage of the project, the suitable experimental procedure was discussed and the experimental setup was proposed. The project will be associated with the proposed project of the TC14 focused on the analysis of bubbles nucleated on dissolving sand grains.

ACTIVITY OF TC18 IN 2015

TC18 met during Glass Trend Seminar in Eindhoven, October 14, 2015. The meeting was attended by 8 persons.

PLANS FOR YEAR 2016

1. TC18 *meeting during ESG Conference in Sheffield in September 2016*
2. *Nucleation of Bubbles in Glass Melt*

Finishing and evaluation of the Round Robin Test on the Determination of the Nucleation Temperature

3. *Batch Melting Kinetics*

The launch of the Round Robin Test on the Determination of Batch Free Time.

SUMMARY

TC18 promotes the activities in the field of both fundamental and application research concerning stages in the glass melting process. It supports co-operation among technical committees involved in the cluster Glass Production.

The projects in 2015 included the Round Robin Test on the Determination of the Temperature of the Bubble Nucleation and Round Robin Test on Determination of Batch Free Time. The results of the determination of the nucleation temperature delivered by three participants were presented during TC18 meeting in Eindhoven, October 2015.

Plans for the year 2016 involve the finishing the RRT on *Nucleation of Bubbles in Glass Melt* by collecting the results from remaining participants and evaluating the results at the TC18 meeting during the ESG Conference in Sheffield, September 2016. The details of the RRT on the *Batch Melting Kinetics* will be specified at the mutual meeting of TC14 and 18 during the ESG Conference in Sheffield, September 2016. The *Batch Melting Kinetics* project will be associated with the proposed project of TC14 focused on the analysis of bubbles nucleated on dissolving sand grains.

4.2.2 GLASS FURNACE DESIGN AND OPERATION (TC21)

(Formerly: 'Modeling of Glass melting processes' TC21)

Chairman: ***Erik Muijsenberg, Glass Service, Vsetin, Czech Republic***
Erik.Muijsenberg@gsl.cz

Executive Summary:

TC15&21 have organized 2 Conferences and 2 member meetings in 2015.

First conference was the bi-annual Conference on Furnace Modeling held in June 2015 in Velke Karlovice in Czech Republic, attended by over 140 people. The actual TC member meeting was attended by around 40 people.

In October 2015 Glasstrend organized in close cooperation with TC15&21 a special seminar on sensors attended by around 80 people. Afterwards we also held a TC member meeting attended by around 12 people.

Further, the Chairman attended the ICG meeting in Bangkok Thailand and made a presentation on control in the special ICG melting section.

We are planning to have the next TC15&21 meeting at the 2016 ICG Congress in Shanghai.

Members:

List of active attendees at the last afternoon meeting Wednesday 14 October.

1. **Erik Muijsenberg, GS, (Chairman), CZ**
2. Reinhard Conradt, RWTH, (Invitation), D
3. Andreas Prange, RWTH, D
4. Bruno Purnode, OCF, USA
5. Burcin Glu, Sisecam, Turkey
6. Adnan Karadag, Sisecam, Turkey
7. Shinya Azuma, AGC, Japan
8. Jerome Canaguir, Qmasso, France
9. Aaron Huber, JM, USA
10. Hiroyuki Itazu, NEG, Japan
11. Richard Hulme, Guardian, USA
12. Andries Habraken, Celsian, NL

List regular participants, but not attending last meeting.

- Wolfgang Muschick, Mainz Germany (Past Chairman)
- Fabrice Fasilow, AGC, Belgium
- Rene Meuleman, Invensys, Netherlands
- Christian Muller, Schott AG, Germany
- Menno Eisenga, Glass Service, Netherlands
- Graham Unwin, Pilkington, UK
- Gerd Philipp, JSJ-Jodeit, Germany
- Wolf Kuhn, Stein Heurtey, France
- Terntaka Maehara, AGC, Japan
- Klaus Jochem, Schott, Germany
- Neil McDonald, Verallia, France
- Fabien Bouillet, Saint Gobain , France
- Guosheng Kang, PPG, USA
- Wilfried Linz, Schott, Mainz, Germany (Past Chairman TC15)
- Adam Polcyn, PPG, USA
- William Johnson, Corning, USA
- Matthias Lindig, SORG, Germany
- Andrew Keeley, NSG, UK

SUMMARY OF HISTORY TC21

TC21 main activity has been focused on how to improve quality and reliability of glass melting furnace modelling and optimization of software packages of different suppliers and glass producing companies.

Until 2011, the most effective way to understand the strong and weak points is by simulating by CFD models, with the different participants on same and well defined glass furnace cases, and ideally with access to actual measured and validated data. This allows the different participants to compare and validate results with each other and also with real measured data. Such a comparison activity is usually referred to as Round Robin Test (RRT). In the past TC21, has used several different so called RRTs and now has reached definition RRT5.

RRT5 input data was gathered and prepared by TNO. Within RRT5 we have relative well documented data for input and validation of a former TV glass melting furnace. Also it is the first time for this TC21 that combustion modelling has been included into the definition.

TC21 and TC15 started to merge into a new TC: **Glass Furnace Design & Operation**.
Future activities include extension of RRT5, studies on combustion modelling (tentative), organize sessions on Glass Furnace Designs and Operation at ICG conferences.

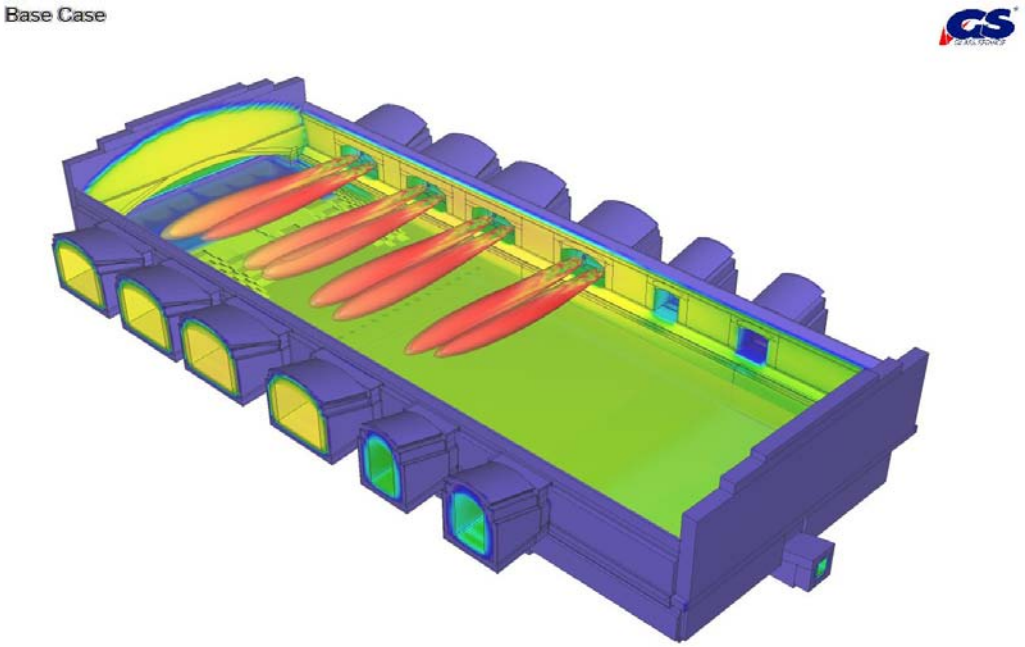


Figure 1. 3D picture of TV panel melting furnace RRT5

GlassTrend - ICG TC15/21 Seminar
SENSORS AND PROCESS CONTROL
13-14 October 2015, Eindhoven, The Netherlands

The Glasstrend Seminar organized in cooperation with TC15&21 focussed on sensors and was attended by about 80 participants. This Agenda really was part of TC15 activities and covered the following interesting lectures:

Objective of the meeting: Bringing together the glass industry (GlassTrend) and the Technical Committee TC 15/21 of the International Commission of Glass to exchange information, analyzing further needs and driving forces in the field of Sensors and Process Control.

Target Group: GlassTrend members and members of ICG TC15/21 (registration limit about 80 persons).

Official members of the ICG-Technical Committee TC15/21, speakers and 2 persons from each GlassTrend member company had free access to the Seminar.

Venue of meeting: Natlab (ex Philips Research Labs), Eindhoven (www.natlab.nl)

Programme Glass Trend Seminar on "Sensors and Process Control in the Glass Industry", October 13 - 14, 2015, Eindhoven, The Netherlands, in co-operation with ICG TC 15/21 (Glass furnace design & operation)

Tuesday October 13, Natlab, Eindhoven

09:30 - 10:45	**Glass Trend Council meeting**
10:45 - 11:00	Coffee Break

Session 1: Needs and use of sensors in the glass and steel industry

11:00 – 11:30	Current glass melting sensor needs, Dale A. Gaerke, Owens-Illinois Inc.
11:30 – 12:00	Needs for sensors in specialty glass industry, Wolfgang Schmidbauer, Schott AG
12:00 – 12:30	Measurement of Fuel Gases with fluctuating characteristics, Sebastian Bialek, VDEh-Betriebsforschungsinstitut GmbH
	12:30 – 13:30 Lunch

Session 2: Sensors for glass melts and refractories

13:30 – 14:00	Refractory wall thickness sensor, Yakup Bayram, PaneraTech
14:00 – 14:30	In-line oxygen sensors for the glass melt and the tin bath, Paul Laimböck, Read-Ox
14:30 – 15:00	Gamma-ray sensor for glass level measurements, Erwin Post, Endress
15:00 – 15:30	Interferometric Radar Technology for Noncontact Glass Level Measurements, Claudio Viti, Glass Service Italy
	15:30 – 16:00 Coffee Break

Session 3: Various sensors and monitoring systems for the glass industry

16:00 – 16:30	Advantages of near infrared imaging inside glass melt furnaces using a NIR borescope, Peter Droegmoeller & Iain Scott, LAND/Ametek (UK)
16:30 – 17:00	Dual CO & O_2 laser sensor system for combustion control, Marco van Kersbergen & A.J. Faber, CelSian Glass & Solar
17:00 – 17:30	Control of furnace-ready cullet: assessment of main parameters, Stefano Ceola, Stazione Sperimentale del Vetro
18:00	**End of first day of Seminar**
	19:30 Dinner in Eindhoven offered by GlassTrend

Wednesday October 14, Natlab, Eindhoven

Session 4: Process control systems in the glass industry

09:00 – 09:30 Using Zircondioxide sensors in reducing fire conditions, Peter Hemman, STG

09:30 – 10:00 Control systems in the glass industry on the basis of CFD models, Piet van Santen, CelSian Glass & Solar

10:00 – 10:30 Intelligent furnace control using multiple sensors, Erik Muijsenberg, Glass Service

10:30 – 11:00 Coffee Break

Session 5: Fast measurements of thermal stresses in glass products

11:00 – 11:30 The Importance of Measuring Cold-End Stresses in Float Glass, Joel Finegold & Tim Wilson, Strain Optics

11:30 – 12:00 Measurement methods of thermal stresses and cord in glass, Henning Katte, Ilis

Concluding remarks

12:30 – 13:30 Lunch

13:30 End of Glass Trend Seminar

The conference was well attended and during the breaks and diners there were active discussion between sensor developers, suppliers and glass industry.

Minutes of Technical meeting TC15 & TC21 13-14 October 2015 afternoon:

The actual technical TC meeting was held on Wednesday 14 October afternoon and was well attended by around 12 participants. About half regular members and about half new attendees (guests).

The Chairman presented to newcomers the history and past activities of TC15 & 21.

The focus was on furnace design with the help of modelling techniques. We invited for this session Professor Dr. Reinhard Conradt. He gave a very good overview about the behavior of batch melting and which properties of batch have been measured in the past. The paper gives some ideas about how we can influence better batch melting but also how we can have more data to be used in Furnace simulation models.

Some interesting conclusion: Batch melting has always 1 rate determining speed, this can be heat transfer to the batch, heat conductivity inside the batch or the melting speed of batch ingredients itself: the chemical turnover rate.

A pdf copy of the paper is available for those who are interested, just contact the Chairman Erik.Muijsenberg@gsl.cz per Email to request a copy.

We had some discussion about possible cooperation on generating a general batch melting model, but this was not conclusive.

Former Activities in 2015: Meeting during Glass Service (GS) Int. Modeling seminar June 2015 in Velke Karlovice, Czech Republic.

Agenda of this meeting was focussing TC15 sensor activities with relation to sensors and control as well as TC21 activities in relation to furnace design and modelling.

Agenda:

1. General introduction TC15 & TC21
2. Summary of former Round Robin test(s)
3. Summary of Survey outcome
4. Discussion on Furnace Design & Operations activities
    a. Joint cooperation effort on batch submodels?
    b. Start of new Round Robin on British Glass Melter
    c. Discussion on new sensors, need and use of Redox Sensor, Viscosity Sensor, Batch and Glass Speed sensors
5. New format for TC15 & TC21
    a. Open discussion by all members on future TC
6. Closing of meeting and decision for next meeting

For more info see also the attached pdf file with the presentation slides.

We started for newcomers with a review of TC15 & TC21 activities.
Mainly once again summarizing the most recent RRT5 Round Robin test on the Cross fired regenerative TV melting furnace.

Before the seminar we sent a survey to most regular TC participants. The survey was filled and returned by around 12 companies. From some companies we received answer from more than 1 employee, so we have taken the average rating. The outcome is given in the pdf file. But main conclusions are summarized here:

The CFD wish list of first 5 priorities is:

- **Improved batch (sub)models**
- Improved glass quality (sub)models
- Dynamic Foam model (improved redox)
- Faster calculation speed
- Improved NOx model

The priority wish list for Model Based Predictive Control is:

- Robust Temperature sensors (no drift)
- More local integral temperature information (optical)
- Control entire process, directly to affect Glass Quality

The wish list for new sensors is:

- Long life (1st glass) redox sensor
- Foam thickness sensor
- Refractory corrosion sensor
- Robust (temperature) sensors

Even so there are logically no real surprises in these lists, the priority seems interesting and to fit to our expectations.

The question is what TC15 & 21 should try to focus on in the (near) future?

We suggested and discussed the following options:

- Cooperate on next generation glass furnace design (low capital cost, flexible tonnage)
- New Melting concepts
- Discussion on new sensors how to improve robustness and how to use them directly into control
- Round Robin test on operational parameters
- Promote precompetitive batch model & sensor development
- Design of future feeder & regenerator
- Discuss use of redox, viscosity and glass flow sensors

Batch melting understanding and batch modeling seems to be an important issue. We all feel sufficient know-how is still lacking so we can imagine to start some joint activity in this field:

1. Consider to define a project under the Umbrella of Glasstrend or some other funding project (to be further discussed during coming Glasstrend meeting)
2. Define goal of what Glass Furnace Models need
3. Invite University to carry out the work,
   most likely Vscht Prague & RWTH Aachen

Also we will try to start a new Round Robin Comparison test with a new furnace that is planned to be equiped well with sensors and could be a new generation type furnace planned by British Glass. British Glass has indicated to be open for cooperation with TC 15&21 on sharing the furnace design for modeling purposes.

In close cooperation with Glasstrend organizers we have decided to assist in organizing the next Glasstrend meeting in October to focus on sensors and control (mostly under the umbrella of former TC15). This is one of the methods how a TC can help the glass industry to discuss new available sensors that are available to the market, but not commonly used yet.

Plans for 2016:

NEXT TC MEETING of ICG TC15 + TC21 Glass Furnace Design & Operation during the ICG meeting in Shanghai China 7-11 April 2016.
Exact date of TC meetings will be announced.
See also attached agenda of the Glasstrend meeting.

For more details see this link:
http://www.icg2016shanghai.com/dct/page/1

The 77th Glass Problems Conference in the USA will held a one day seminar on modelling of glass melting probably in November. TC21 will be assisting in soliciting papers and part of the group organize the agenda for that 1 day conference.

Exact date will be announced.

There is a chance to choose a new chairman for the period after ICG 2016

4.2.3 ENERGY EFFICIENCY (TC09)

Chairman: *Hans van Limpt*
Vice-Chair: *Wolfgang Schmidbauer*
Secretary: *Richard Hulme*
Webmaster: *Diego Ochoa Escalona*
Members: *Alfeo Caputo*
Emre Dumankaya
Bernhard Fleischmann
Olga Martin Garcia
Roel van Herten
Gustav Huuskens
Sven-Roger Kahl
Andrew Keeley
Andrea Marostica
Valli Murthy
Christian Roos
Simone Tiozzo
Toru Hasegawa
Yudai Katagami
Stefan Laux
Sho Kobayashi
Oscar Verheijen

SUMMARY

The most important aim for 2015 and 2016 is to define a uniform approach to define energy efficiency or specific energy use within or across the various glass industry sectors. With financial support of ICG, TC09 started a project to realize this goal. The existing non-uniformity is compounded by the fact that there is no common approach in the consideration of factors such as the effect of cullet, the efficiency of electric boosting, age, furnace design etc. In the first instance TC09 is focussing on glass melting furnaces, the largest energy consumers of a glass factory.

TC09 will develop recommended Best Practices for defining energy use and efficiency so that companies within each glass sector can make useful comparisons. This approach will be used to explain some of the differences in performance between sectors and aid discussions with non-technical and/or external agencies.

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. The first step in this study is an energy benchmark study for six float glass furnaces. In this study glass furnace energy consumption of individual glass furnaces will be benchmarked against a database of energy consumption of (anonymous) glass furnaces.

Besides this study on the definition of energy efficiency, 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 CO_2 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), Heat-Ox systems to preheat fuel and oxygen, the application of the 'Optimelt' TCR system and the use of smart batches which melt more easily.

ACTIVITIES in 2015

1. TC09 Meetings

In 2015 two TC09 meetings were organized, the first meeting was organized on 20th April 2015 in Bilbao, Spain in connection with the Glass Trend/TC09 seminar on energy efficiency. The 2nd meeting took place on 15th October in Eindhoven, the Netherlands. The meetings were attended by respectively 21 and 17 (guest) members.

2. Energy benchmark project

As explained in the summary an energy benchmark project has been started for 6 float furnace with the aim to define a uniform approach to define energy efficiency or specific energy use within or across the various glass industry sectors

3. **Co-organizer of workshop on energy efficiency**

On 21 and 22 April 2015 a seminar on: 'Glass furnace heating technologies and energy efficiency', was organized in cooperation with Glass Trend in Bilbao Spain. The workshop was hosted by Vidrala and more than 50 people attended the workshop.

4. **Exchange of information**

TC09 exchanged information on running projects and new initiatives to reduce energy consumption in the glass production process.

5. Publications & Presentations

- Hans van Limpt, 'ICG's TC09 focuses on energy', p52, Glass International July/August 2015;
- Hans van Limpt, Activities of the new ICG TC9 on Energy efficiency, paper presented at the workshop on energy efficiency, 22nd April 2015, Bilbao, Spain;
- Abstract of Glass Trend / TC09 event: 'Experts gather in Bilbao for Glass Trend seminar', p49-51, Glass International July/August 2015.

PLANS FOR 2016 AND DELIVERABLES

- Organization of 2 annual meetings.
- Execution of energy benchmark project for float furnaces.
- Exchange of information on running projects and new initiatives to reduce energy consumption in the glass production process

4.2.4 GASES IN GLASS (TC14)

Chairman: *Mustafa Oran*
Vice-Chair: *Noriyuki Yoshida*
Members: *Harald Behrens*
Detlef Köpsel
Hayo Müller-Simon
Jan Hermans
Jaroslav Klouzek
Jiri Ullrich
John Mason
Juergen Daniel
Leonid Giebov

Lubomir Nemec
Martin Gaber
Masataka Kawaguchi
Mathi Rongen
R. Müller
Rei Kitamura
Sean Marsden
Stefano Ceola
Wolf Kuhn
Yukihito Nagashima

SUMMARY
The mission of TC14 is to investigate gases in glass and gas inclusions and determine their influence on glass quality and properties. TC14 promotes activities to better understand evolution mechanisms of gases in glass and bubble formations. TC14 supports cooperation with other Technical Committees in order to fulfill its mission.

ACTIVITIES in 2015
The first annual meeting of TC14 chaired by Mustafa Oran was held on October 14, 2015 after Glass Trend seminar in Eindhoven. The attendees of the meeting:
Mustafa Oran (SISECAM)
Detlef Koepsel (Schott AG)
Terutaka Maehara (Asahi)
Jan Hermans (Philips Lighting)
Masataka Kawaguchi (NEG)
Toru Hasegawa (NEG)

Besides the annual meeting of TC14, a joint meeting of TC11-TC14 was held on the same day. Therefore, the agenda of TC14 meeting has been divided into two sections. The following topics were discussed at TC11-TC14 joint meeting:

- Dynamic Blister Test (discussion on guideline)
- Static Blister Test (RRT-TC11/TC14)

Both activities have been designed as RRT in the past but could not be completed since the experiments of some participants have been failed with the experiments. The guidelines for both dynamic and static blister tests, prepared and revised by Dr. Michael Dunkl, the chair of TC11 were distributed to the participants.

The following topics were discussed with TC14 meeting:

- **CO_2 Solubility - comparison of the methods (advantages & disadvantages):** Two analytical methods for the determination of CO_2 in molten glass; vacuum high temperature extraction and helium carrier gas extraction give different results for the same samples since both methods have advantages and disadvantages. This was reviewed again and it has been considered that a dedicated meeting with other experts, especially Geochemists would be valuable to discuss the methods. In this context, it was decided to contact primarily with Prof. Dr. Harald Behrens from Institut für Mineralogie, Leibniz Universität, Hannover.
- **Nucleation of Bubbles in Glass Melt:** This is a RRT work organized together with TC18. Mechanism of bubble nucleation is one of the important subjects to better understand melting and fining processes. This RRT was proposed to determine the nucleation temperature of single bubble, based on the method of high temperature

observation. Two commercial float glass samples from AGC and Sisecam have been delivered to following participants:

- Celsian (M. Rongen)
- Schott (D. Koepsel)
- AGC (T. Maehara)
- NEG (M. Kawaguchi)
- ICT Prague (J. Klouzek)

Schott and NEG informed that they will complete RRT. On the other hand, common laboratory work of two participants, ICT Prague and Asahi has been published as the paper entitled: Vernerova M., Cincibusova P., Klouzek J., Maehara T., Nemec L.: Method of examination of bubble nucleation in glass melts, Journal of Non-Crystalline Solids 411 (2015) 59–67.

- **RRT on Batch Melting:** This is another co-activity proposed by TC18 and TC14. TC18 has proposed to develop a standard test to evaluate melting kinetics of glass forming raw materials. TC14 participates to analyze the bubbles nucleated on dissolving sand grains. Jaroslav Klouzek, chair of TC18 was not able to attend the meeting. Instead of him, Mathieu Hubert from Celsian informed TC14 members about Klouzek's work.
- **Web Page of TC14:** Jan Hermans as a volunteer member will develop a web page of TC14 under official web site of ICG. It was decided that Mustafa Oran will contact with Prof. John Parker for this issue.

Besides ongoing activities of TC14, Mustafa Oran suggested two proposals, considering the need of new topics to be studies. One is to analyze the bubbles by Raman Spectroscopy, a non-destructive method, different from Mass Spectroscopy. Schott and Asahi already have some works on this method. Sisecam has recently started to study this method with a university. This method may not be very accurate and quantitative but it is worthy to investigate. The other one is to find a numerical relation between rate of change of bubble size with respect to temperature and glass composition. Such a definition may be supposed to be used in numerical models. These two proposal are postponed to the near future since ongoing activities have to be completed primarily.

The place and date of the next TC14 meeting were not decided yet since the last meeting didn't have majority. It will be decided soon after asking the opinions of all members.

4.2.5 ENVIRONMENT (TC13)

Chair	Andreas Kasper, St. Gobain, Germany
Vice-Chair	Laurent Piranda, Guardian, Luxembourg
Secretary	Simon Slade, Pilkington NSG, UK
Members	Guy Van Marcke, AGC Glass Europe, Belgium
	Denis Lalart, Arc International, France
	Zsuzsa Varga, GE, Hungary
	Nicola Favaro, SSV, Italy
	Walter Battaglia, SSV, Italy
	Mark Pudner, British Glass, UK
	Thomas Hünlich, Schott, Germany
	Marco Van Kersbergen, CelSian Glass and Solar, The Netherlands
	Karlheinz Gitzhofer, HVG, Germany
	Phil Ross, GICI, USA
	Hugues Abensour, St. Gobain, France
	Etienne Senechal, Arc International, France

Egolf Maier, St. Gobain Isover, Germany
Barış Orhan, Şişecam, Turkey
Claas Heymann, Heymann Engineering, Germany
Hans van Limpt, Sibelco, Belgium
Jan Boogaardt, AGC Glass Europe, Belgium

SUMMARY

TC13 is the environment committee of ICG. All environmental issues affecting the glass industry are covered. Members are drawn from industry, consultancies and glass federations. The TC meets twice a year and produces extensive minutes detailing the many topics addressed. Subjects range from characterising and controlling glass furnace emissions to understanding the impact of new regulations on the different sectors of the industry. The TC regularly produces briefing papers and journal articles.

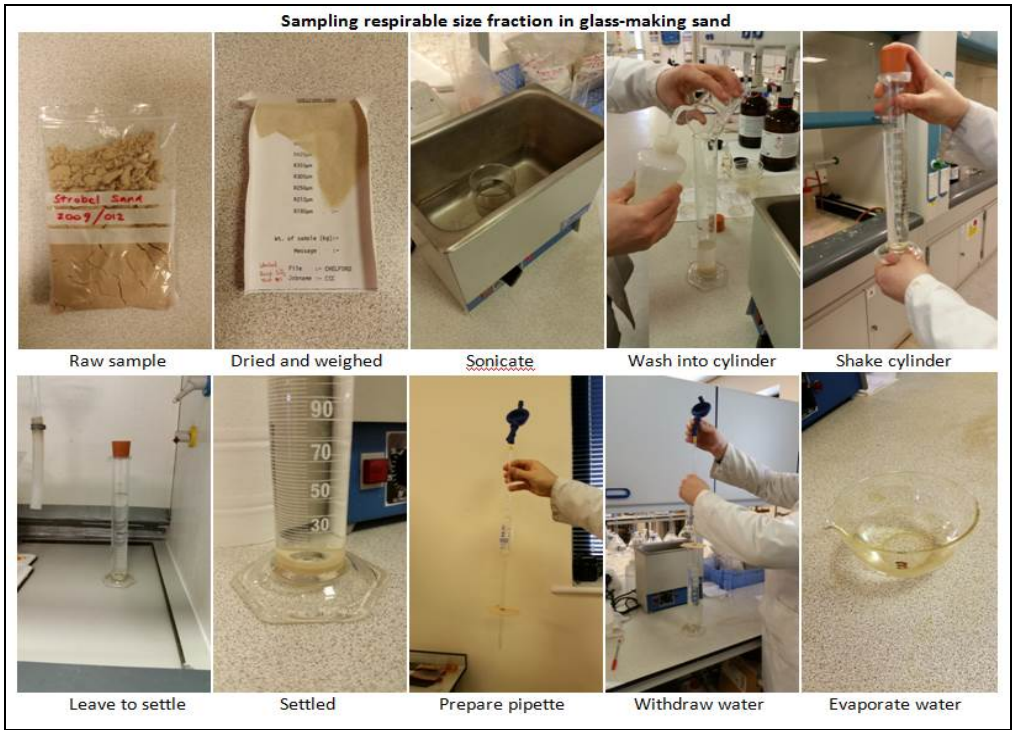
All members actively contribute during the meetings. Minutes are written by the secretary. Reports and external publications are written by the secretary and jointly authored.

The TC13 website, kindly hosted by CELSIAN, houses an extensive collection of data and is regularly updated with useful information on the work of the TC. http://www.celsian.nl/TC13/ (Note that the bulk of the documents are in a members-only password-protected area.)

ACTIVITIES IN 2015

The first TC13 meeting of 2015 was held on Murano at the kind invitation of Stazione Sperimentale del Vetro. The meeting was well-attended, with thirteen participants and four guests. As usual, there was a full agenda with many important environmental issues associated with the manufacture of glass and the abatement of emissions. The discussion of many subjects continued from the previous meetings, including the formation of sulphur trioxide in selective catalytic reduction units, the problematic interaction therein of sulphur and ammonia compounds, and the size of particles in the emissions after a catalytic bag house. The committee heard about different ways to measure ammonia emissions and results from a comparative test of two types of analyser.

There was a presentation on the current operation of the catalytic ceramic bag house at Arboç, now five years old, and a discussion of the merits and problems associated with recycling EP dust. Results were presented of an assessment of the respirable fraction of particles in glass-making sand, done to support glass industries' response to changing legislation and the fact that respirable crystalline silica is carcinogenic.

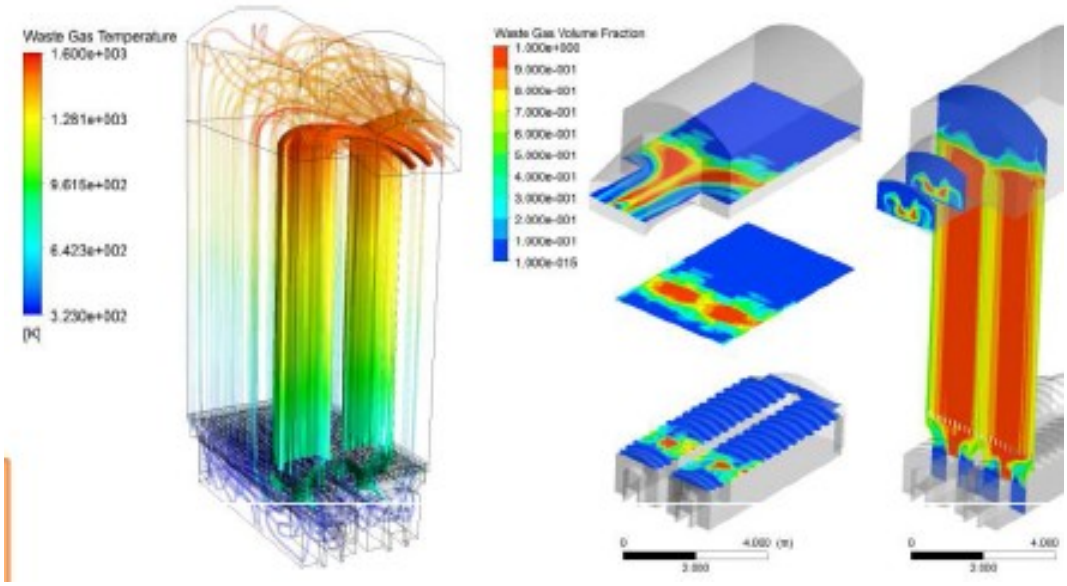


There was a discussion of the status of papers being written by committee members describing techniques used to measure particulate emissions in USA and Europe. After the TC13 meeting, members enjoyed a tour of the SSV facility.

The second TC13 meeting was held in Aubervilliers, Paris, at the kind invitation of Saint Gobain Conceptions Verrières. This meeting was also very well-attended, with sixteen participants and there was the usual full agenda with many important environmental issues associated with the manufacture of glass being discussed.

St. Gobain provided an update on the operation of their CERCAT ceramic catalytic bag house, and measuring the particle size in the waste gas was discussed. This led to a consideration of the relationship between SOx emission and urea use, and of the influence of different analytical techniques. The benefits and problems associated with recycling of dust collected in abatement plants was also a topic of discussion.

The committee then addressed measurement of emissions from glass furnaces, with focus on boron (CELSIAN project), selenium (new ISO standard), and ammonia (use of FTIR). This was followed by a comprehensive presentation of the Prime glass project for primary NOx abatement by the member from SSV.



Example of CFD used in the PRIME GLASS project

The importance of new European regulations affecting respirable crystalline silica was expressed, leading to presentations on workplace monitoring (SSV update) and an extensive study of measurements of the respirable fraction in supplied sand (NSG, GTS and StG).

The secretary was pleased to inform the committee that the two papers on particulate emission measurement techniques in Europe and USA were published in Glass Worldwide magazine in 2015. The committee also discussed leaching of boron from glass and the meeting concluded with a round table discussion on new regulations and abatement.

PLANS FOR 2016

There are two meetings planned for 2016. The first will be in Sheffield, hosted by GTS, British Glass, on 20th and 21st April. The second will be held in November, hosted by SIBELCO in Belgium. The rolling assessment of environmental issues addressed at each meeting will continue. In addition, the important and on-going practical studies of furnace boron emissions and of respirable crystalline silica in the workplace and in glass-making sand will be reported.

4.2.6 MODELLING FORMING (TC25)

Chair *Adnan Karadag, Sisecam, Turkey*

Members *Shigeaki Aoki, NEG, Japan*
Christian Bajart, ARC international, France
Gesine Bergmann, HVG, Germany
Christoph Berndhauser, Schott AG, Germany
Yifang Cai, Johns Manville, USA
Quentin Choufart, 3B-Fıberglass, Belgium
John H Chumney., Logotec Constr., USA
Maxime Cousin, Verallia Chalin, France
Oliver Fontaine de Ghelin, AGC Flat Glass, Belgium
Dominique Lochegnies, Univ of Valanciennes, France
Bernard Hocq, Ansys, Belgium
Matt Hyre, Northwestern College, USA
David Martlew, Pilkington, UK

Ivo Matusek, TU Liberec, Czech Rep.
Alfons Moller, No Grid, Germany
Miroslav Moravsky, 2M Consulting, Slovak Rep.
Philippe Moreau, Univ of Valanciennes, France
Kenji Oda, Asahi Glass Company, Japan
Roger Penlington, Univ of Northumbria, UK
Andrea Perla, Bottero, Italy
Soeren Primdahl, Rockwool Int, Denmark
Oleg Prokhorenko, Lab Of Glass Prop., Russia
Mike Van Iseghem, France
Francois Vianey, Saint-Gobain, France
Peter Vrabel, Rona Crystal, Slovak Rep.
Allen Yi, Ohio State Univ, USA
Hiroshi Watasuki, ACG, Japan
Youssef Youmani, Air Liquide, France

GOAL
The main goal of TC25 is to promote information exchange in the field of glass forming processes with specific emphasis on numerical simulation on both the scientific and technological level.

ACTIVITIES IN 2015
TC 25 was inactive during 2015.

PLANS FOR 2016

A committee meeting will be held. The location of this meetings has not been determined yet. BMP-IV will be completed and the results will be published/presented. First draft of guideline document on modelling glass forming will be prepared.

EXECUTIVE SUMMARY
TC25 focuses on furthering knowledge pertaining to glass forming process by providing a medium for interaction between researches and practitioners. In 2015, the committee was inactive. TC25 will regroup in 2016 and will work on the BMP-IV as well as preparing a guideline document on numerical simulation of glass forming processes.

4.2.7 MATERIALS FOR FURNACES (TC11)

Chairman: *Michael Dunkl, Dr. M. Dunkl Consulting, Germany (C)*
Vice-Chairman: *Jean-Pierre Meynckens, AGC Flat Glass Europe (C)*
Rongxing Bei, RHI AG, Germany
Michel Gaubil, Saint Gobain-SEFPRO, France (C)
Stefano Sanchetti, SSV, Italy
Christian Kunert, Schott, Germany
Burak Izmirlioglu, Sisecam, Turkey
Beyhan Bozdemir, KÜMAS, Turkey
Toshiro Ishino, AGC Ceramics, Japan
Janusz Zborowski, AGH, Poland (C)
Detlef Köpsel, SCHOTT, Germany
Stef Lessman, CelSian, The Netherlands
Olivier Bories, Saint-Gobain/SEFPRO, France
C = Core member

MAIN GOALS OF TC11

- Discussion of material related problems in glass melting furnaces and generated glass defects like blisters, stones, knots and cords.
- Finding of solutions by exchange of knowledge and experiences between the participants (material researcher, material producers and glass manufacturer).
- Continuation of TC11/TC14 Round Robin for “Blisters in Glass from Refractories”.

ACTIVITIES in 2015

One TC11 meeting was hold at CelSian in Eindhoven on October 14, 2015.

The main project of this TC11 meeting in 2015 was Petro-Coke-Firing and behavior of Refractory Materials.
Another project in 2015 was problems in regenerators of glass melting furnaces.

1) Presentation
Jean-Pierre Meynckens: Effect of pet coke on refractories in glass furnace

After 3 months of pet coke usage in a float furnace (700TPD), several refractories samples amongst Magnesia, Alumina-Chrome and Magnesia-Chrome have been analysed. The effect of V_2O_5 and SiO_2 attack have been observed on all the refractories. The most severe corrosion was observed on Magnesia (lime bonded) refractories leading to a crumbly material and a target wall collapsing. Due to these severe deteriorations after a short time period, the pet coke trial has been stopped. The presentation opens the question related to the refractories selection under these conditions as well as the health concerns.

2) Presentation
Michel Gaubil: Diverse industrial experience in glass furnace using pet coke (shutdown visit), furnace atmosphere measurement in Pet coke usage in float tank (600TPD; 8 months; 90t pet-coke per day), *in situ* float furnace recently converted to pet coke testing and laboratory tests on refractories.
Besides the commonly reported impurities (V_2O_5, NiO, S), the article indicated also the effect of SiO_2 and Fe_2O_3 included in the pet-coke and the diversity of the sourcing. The mandatory excess air required for the pet-coke combustion implies a low CO but high NOx observed during the furnace campaign.
The effect of pet-coke has been observed *inter alia* on the silica crown (front corrosion, rat-holing and joints attack) due to the vanadium attack as well as FeO vapour attack and on Magnesia Bonded Product (as regenerator wall or chimney block)

3) Presentation
Rongxing Bei: Regenerator Lining Concept under Pet-Coke Firing

The first pet-coke usage in glass furnaces has been observed in Mexico more than 20 years ago. Today, the pet-coke usage looks to be concentrated in Asia (China, India) and some countries in Africa. Various sources of pet-coke are existing and some fuels have been observed without V_2O_5 (Korea).
For the pet-coke firing, RHI has recommended different refractories.

For the second project in 2015 “Problems in regenerators of glass melting furnaces”

Stef Lessmann presented: Experimental device to test the refractories for regenerators.

The device consists into a combustion chamber from which several liquid compounds may be added coupled with a gradient furnace to test the refractories (unit size 50x10x10; almost 24 samples tested at once). The device allows to test the refractories under oxidised and reduce atmosphere. A laboratory tour was organised by the CelSian to see the furnace.

One joint TC11/TC14 meeting was hold at CelSian in Eindhoven on October 14, 2015.
The project for 2015 was to continue the RRT "Blisters in Glass from Refractories".

PLANS FOR 2016
One or two TC11 meeting and one joint TC11/TC14 meeting in 2016.

One TC11 meeting on June 2016, e.g. during German Glass Society meeting and the second TC 11 during the Glasstec in Düsseldorf on October 2016.

A joint TC11/TC14 meeting can be hold after the residual test results are finished and all results are evaluated.

Continuation and evaluation of TC11/TC14 Round Robin results for "Blisters in Glass from Refractories.

Recommendations and publication of proposal for the *"TC 11 Exudation test guidelines, results interpretation and limits"* will be prepared.

Offering some guidelines for tests (including sampling) in the frame of the quality assesment of a product already known by the glassmaker; keeping in mind the particularity of the produced glass.

4.3 R&D ACTIVITY FIELD « CHARACTERISATION »

4.3.1 OPTICAL PROPERTIES (TC10)

Chairman: Ms. Marenne Ingrid, AGC, Belgium
Vice-Chair: Mr. Peter van Nijnatten, OMT Solutions bv, The Netherlands
Members: Mrs. Akmaz Fehiman, Sisecam, Turkey
Mr. Aldrich Scott, Corning, USA
Mr. Anderson Charles, Saint Gobain, France
Mr. Bretschneider Joachim, Pilkington, Germany
Mr. Chen Gourong, East China University of Science and Technology, China
Mr. Daneo Antonio, Station Sperimentale del Vetro, Italy
Mr. Dotsenko Alexander, Corning, Russia
Mr. Efimov Andrei , ITMO University (National Research University of Information Technologies, Mechanics, and Optics), St. Petersburg, ,Russia
Mr. Farmer James, NSG, Great Britain
Mr. Gagliardi Giovanni, Pilkington, Italy
Mr. Goussarov Andrei, SCKCEN, Belgium
Mr. Gurianov A, Institute of high pure compounds, Russia
Mr. Hofmann Thomas, Centro Solar, Germany
Mr. Hutchins Michael G, Sonnergy, Great Britain
Mr. Jonsson Jacob, Lauwrence Berkley Laboratory, USA
Mr. Kappertz Olivier, Interpane, Germany

Ms. Kermel Christine, INISMA, Belgium
Mr. Kinoshita Taito, NSG, Japan
Mr. Mika Martin, VSCHT, Czech Republic
Mrs. Nilsson Annica, Uppsala University, Sweden
Mr. Olive François, CSTB, France
Mr. Ottermann Clemens, Schott, Germany
Mr. Roos Arne, Uppsala University, Sweden
Mr. Rossi Giuseppe, INRIM, Italy
Mr. Saito Takayoshi, AGC, Japan
Mr. Stemmler Ivo, Perkin Elmer, Germany
Mr. Veiga Pilar, Guardian, Spain
Ms. Wilson Helen Rose, ISE Fraunhofer, Germany
Mr. Zhang Long, Shanghai Institute of Optics and Fine Mechanics, China

Guests: Mr. Behrends Andrea, Guardian, Germany
Mr. Bolles Michael, Agilent, Australia
Mr. Freinberger Michael, Ift Rosenheim, Germany
Mr. Klaus Jäger, TUV Delft, Netherlands
Mr. Sartenaer Yannick, AGC, Belgium
Mr. Weis Hansjoerg, Interpane, Germany
Mr. Wuelfken Jan, Agilent, Germany
Mr. Feldmeier Franz, fh Rosenheim, Germany
Mr. Schultz Marcus, Agilent, Germany
Mr. L'Heureux Didier, CSTC, Belgium

The main goals of TC 10 are:

- Study optical measurement problems common to the glass industry and to develop or improve techniques to resolve those problems
- Inform new employees involved in the glass industry of existing optical measurement techniques
- Study the properties that influence optical performance of glass
- Act as a pre-normative reference for standards committees

Meetings of TC10 in 2015:

- March 26-27th : Murano Italy
  September 24-25th Prague, Germany

Projects and activities of 2015:

In 2015, our TC continued on three major activities that were followed by the entire TC: diffusing products measurement and optical properties calculation of complex glazing. One new round robin test was proposed and launch on optical characterization of glass products. Our different activities have looked at:

- The continued investigation of optical characterization of diffusing and patterned glass products. This subject is important because standards are vague on the subject and there are more and more such products on the market. Standards workings groups are starting to consider the subject. In addition, patterned glass is now used by the photovoltaic industry for light trapping and even tenths of a percent of trapped light is important for their performance. Last year, we highlighted a new way to better measure such kind of product with the use of a diffusor. This year, we focuses on the characterization of a "good diffusor". A method that we called "pull back method" was

tested by some of the participant to try to determine if the selected diffusor fulfilled the properties needed to be used the new method.

- Façades are more and more complex and include more and more elements like double skin, active glazing, louvers… In addition, architects are proud to innovate and find new solutions to improve building efficiency (in terms of heating, cooling, …). It is thus very important to be able to calculate the visual and thermal properties of such complex buildings. This year, we put in place a new round robin test to test the capability of our members and tools available to estimate those properties. We have defined the structures, material, configuration,… that will be tested in 2016. Data were distributed this year. First results are expected in 2016.
- The RRT on calculation according to EN410 was showing good agreement between all members except for laminated samples. It appears that the annex of the standard on laminated calculation is not easy to understand. A new set of data was proposed, based on real samples to confront calculations and measurements. An alternative method using matrix calculation was proposed and explained to the participants.
- Certified labs are requested from time to time to prove their ability to measure correctly. For that reason, one member of TC10 initiated a round robin test on optical properties (transmission, reflexion, emissivity). We took this chance to propose also to all members of TC10 to participate to this round robin test. Samples are under preparation, checking homogeneity, and sending to participant if foreseen for end of 2015.

Other Activities / Information:
TC10 had a very efficient website for archiving and sharing projects, papers, agenda,… Unfortunately, due to a move of a share, the website was not available any more (some functions were not working). We get a funding from the CTC to repair our database. 2015 was the year of the update of our website. The new website was presented to the group during our last meeting in Prague. The website is thus again accessible. We have now to download the documents of the last 2-3 years.

Optical properties subgroup
The subgroup meeting was hold twice the year also, the day before the main TC10 meeting. The subgroup is focused on the link between the optical properties and the chemical composition of the glass.

2 lectures were given on “The delamination and decolouring of flat glass with polymer interlayers” and “Laser active glass for photonics”.

A first project is running on the effect of tin on the optical properties of float glass. The profiles of tin concentration was presented. It was proved that the oxidation states of Sn and Fe varies with distance from surface. The Sn-containing glass layer has a higher refractive index.

A second project is running on float glass with colouring ions. In the past, the subgroup had work on the sample preparation method that is not obvious to avoid contamination when using very low level of colorant. This year, the group has stated sample preparation with Co and Cu.

PLANS FOR 2016

- The RRT on optical properties will be running in 2016 and results are expected in 2016.
- We expect the first results on the calculation RRT of complex glazing. The complex calculation should include shade, solar protection, louvers,…
- The subgroup intend to investigate the effect of two new colorants: Se and Ni in a matrix of low iron glass.
- A paper should be delivered about angular measurements.
- Two meetings for the entire TC membership are planned in 2014, one in Murano, Italy March 11th at the "Statione Experimentale del Vetro" and one still to be defined in September but probably in UK organized by NSG. Two meetings for the subgroup are also planned in conjunction with the above meetings.

4.3.2 DURABILITY AND ANALYSIS (TC02)

Chairman: **Ralf Eiden, Schott AG, German*
Vice-Chair: **Peggy Georges-Diraison, Corning SAS CETC, France*
Secretary: **Daniel Capon, GTS, UK.*
Members: *John Clark, NSG European Technical Centre, UK*
Sylvie Abensour, St. Gobain Recherche, France
**Peter Sundberg, GLAFO, Sweden*
Aysegul Yorur, Türkiye Şişe ve Cam Fabrikalari A.S., Turkey
Kanit Tapasa, Department of Science Service (DSS), Thailand
Martina Scarpa, Stazione Sperimentale del Vetro, Italy
Philippe Pradeau, Corning SAS CETC, France
Andreas Kasper, SAINT-GOBAIN SEKURIT Deutschland, Germany
Isabelle Lesieur, St Gobain ISOVER, France
Sebastian Recknagel, BAM, Germany
Christine Strubel, Schott AG, Germany
Jean-Marc Carpentier, INISMa, Belgium
Yuichi Suzuki, Asahi Glass Company, Ltd, Japan
Sam Leese, Sibelco Europe, Belgium
Honorary Members:
Emanuel Guadagnino, Italy
Orhan Corumluoglu, Turkey
Dominique Brochot, France.
*Core Group

New Members:
Pauline Andrieux (CRITT, France), France
Vincent Gignoux (Isover Saint-Gobain), France
Vincent Meignent, AGC Glass Europe, Belgium

TC02 thanks Dominique Michiels for his longtime active engagement as member and chairman.

MAIN GOALS OF THE TC

TC02 continues to provide analytical solutions to complex issues affecting the glass industry through the development of standard methods of analysis and the production of certified reference materials for analytical calibration supported by extensive round robin/proficiency testing schemes.

The Committee actively supports other TC work programs upon request and has well established (and respected) links with external Organizations working across the chemical analysis arena - including The Society of Glass Technology, Bureau of Analysed Samples, BAM, DGG, BSI and soon to include NIST.

ACTIVITIES in 2015

- Meeting in Paris, 26.-27.11.2015
- ICG/TC2/15-1590 Report Proficiency Test on Chemical Durability Tests of Glass Ceramic
- ICG/TC2/15-1592 Report on arsenic leaching acc. to Ph. Eur., chapter 3.2.1
- ICG/TC2/15-1593 Report on proficiency Test for Hydrolytic Resistance ISO 4802-1
- ICG/TC2/15-1596 Report on coefficient of thermal expansion round robi.
- ICG/TC2/15-1597 Report on viscosity measurement round robin
- Collaboration with DGG (German Society of Glass Technology): Round Robin Test on trace analysis of Sand

ACTIVITIES FOR 2016

Drive for new members to increase capability and diversify product areas.

Pure Proficiency Tests

- B_2O_3 in glass
- Hydrolytic resistance (USP)
- B_2O_3 in fiber glass (DGG)
- Sulfur in Glass (20 ppm level)
- Chlorine in glass (UV-VIS, 100 ppm level)
- Fluorine in glass (approx. 0.3%)

New CRMs

- Technical Glass: Resistance to boiling acid (DIN 12116)
- Technical Glass: Hydrolytic resistance 98° (ISO 719)
- Technical Glass: Resistance to boiling alkaline sol. (ISO 695)

Method development

- Hydrolytic resistance: correlation between grain test and surface test?
- Analysis of filter dust (main comp., traces)
- Elemental impurities from glass containers acc. to USP/EP/ICH (depending on collaboration with TC12)
- Respirable crystalline fraction of silica (potential collaboration with TC13)
- Determination of Cr6+ in Chromite refractories
- Chemically strengthened glass: Wet chemical depth profiling (surface ablation cell) and chemical durability

Solve problems

- Hydrolytic resistance surface test on narrow syringes (0.5 mL)
- Accuracy/reproducibility of titration ISO 4802-1

Meetings

TC02 plans to have a spring and an autumn meeting in 2016. The spring meeting will take place at GTS in Sheffield, dates have to be confirmed.

4.4 R&D ACTIVITY FIELD « APPLICATIONS »

4.4.1 NANOSTRUCTURES (TC16)

Chair:	***Rui M. Almeida, IST/CQE, Portugal***	***(core group)***
Vice-Chair:	***Alex Martucci, Univ. Padova, Italy***	***(core group)***
Members:	***Alicia Duran, ICV/CSIC, Spain***	***(core group)***
	Gang Chen, Ohio Univ., USA	***(core group)***
	Sidney Ribeiro, São Paulo State Univ, Brazil	***(core group)***
	Kiyoharu Tadanaga, Osaka Pref. Univ., Japan	
	Luís Santos, IST/CQE, Portugal	
	Mario Aparicio, ICV, Spain	
	Yolanda Castro, ICV, Spain	
	Nathan Mellot, Alfred Univ., US	
	Hui Yang, Zhejiang Univ., China	
	Jian Xu, Univ. Ningbo, China	

SUMMARY

In 2015, TC16 performed collaborative research on *transparent oxyfluoride glass-ceramics* doped with optically active elements, using melt-quenching and sol-gel processing techniques, as well as on Yb-doped aluminosilicate and phosphosilicate nanostructured sol-gel glass films. The work included preparation of the oxyfluoride nano glass-ceramics in Madrid and Yb-doped films in Lisbon, both of which were characterized by different techniques, in particular SAXS measurements done in Athens (OH). In addition, TC16 organized Session 3: Liquid Synthesis and Sol-gel-derived Materials within Symposium 5: Glass Technology and Cross-cutting Topics at the ACerS GOMD-DGG joint annual meeting in Miami, May 17 – 21.

MAIN GOALS OF TC16

The main goals of TC16 for the past three years have been: (1) to perform collaborative research focused around the development of a nanostructured functional coating on glass, simultaneously with solar control and self-cleaning properties, based on aluminosilicate glass and TiO_2 layers, plus certain types of nanoparticles (NPs) with good reflectivity in the near infrared range; (2) the study of Up- and Down-conversion phenomena of lanthanide ions in glasses, glass-ceramics and nanoparticulate materials, e.g. to improve solar cell efficiency; (3) the study of Yb-doped nanostructured sol-gel glass fims for high power disk lasers.

PLANS for 2015

In 2015, TC16 planned to work on nano glass-ceramics in bulk and thin film form, consisting of lanthanide-doped fluoride precipitates in a silica or aluminosilicate glass matrix, prepared by sol-gel processing. In addition, TC16 planned to organize Session 3: Liquid Synthesis and Sol-gel-derived Materials within Symposium 5: Glass Technology and Cross-cutting Topics at the ACerS GOMD-DGG joint annual meeting in Miami, May 17 – 21.

TC activity in 2015

In 2015, most activities we the result of collaborations between the Lisbon, Athens and Madrid laboratories. In Lisbon, several Yb-doped aluminosilicate glass films were prepared by sol-gel (spin coating) and they were characterized in-house by Spectroscopic Ellipsometry and FTIR spectroscopy, after which they were sent to Athens (Ohio, USA) for Small-angle X-ray scattering (SAXS) measurements. Figure 1 shows an example of such measurements, performed using a commercial SAXS system (SAXSess, Anton Paar GmbH), confirming the

nanostructured character of the film, with an average primary particle size between ~ 3 - 4 nm, probably due to incomplete densification of the colloidal particles at the temperature of heat treatment (650ºC) and possible aggregation of the particles. The occurrence of phase separation is also a possibility which needs further investigation in 2016.

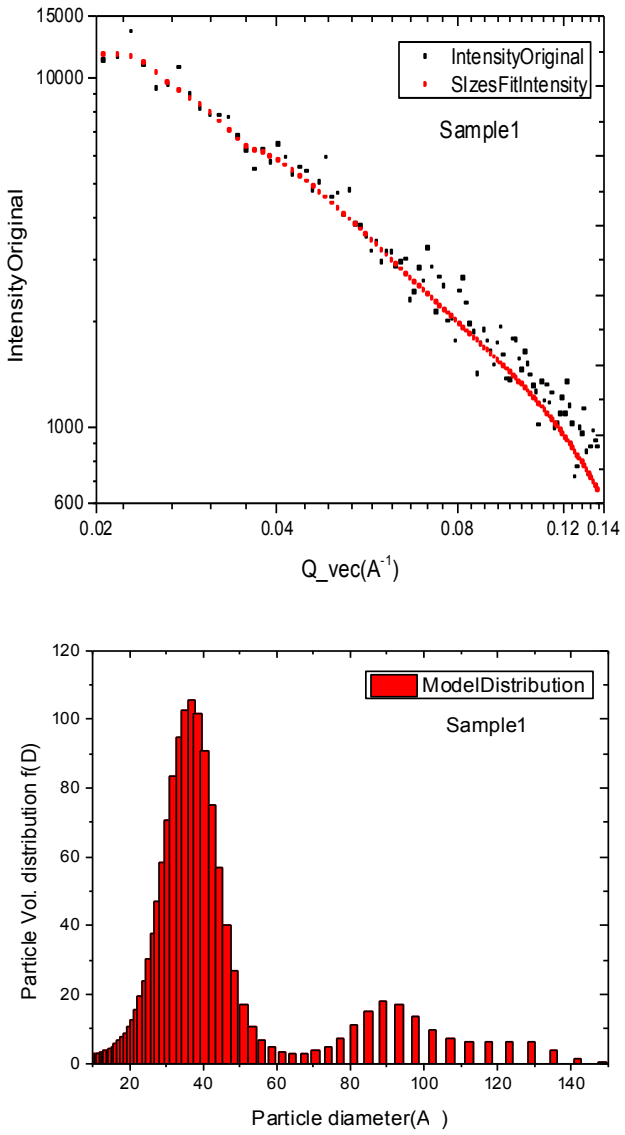


Fig. 1 – SAXS intensity / particle size fit (top plot) and particle size distribution (bottom plot) for a 79 SiO_2 – 16 $AlO_{1.5}$ – 5 $YbO_{1.5}$ (mol%) film, deposited on a mica (Muscovite) substrate, having an average primary particle size of 3.7 nm.

The other main collaborative activity developed between ICV (CSIC), Madrid (Spain) and Ohio University, Athens (USA), focused on the synthesis and characterization of ***transparent oxyfluoride glass-ceramics*** doped with optically active elements using melt-quenching and sol-gel techniques. In particular, nano-glass-ceramics on the system $80SiO_2$-$20LaF_3$ both undoped and doped with 2% Nd^{3+} were prepared by sol-gel method; while the composition $55SiO_2$-$20Al_2O_3$-$15Na_2O$-$10LaF_3$ with the same dopant, 2% $Nd^{3+,}$ was also prepared by melting (labeled *55Si-10La* and *55Si-10La 2Nd*, respectively). All the materials were studied by different techniques, including TEM and SAXS in collaboration with Ohio University, Dr. Gang Chen.

Sol-Gel materials

Transparent and homogeneous $80SiO_2$-$20LaF_3$ sol was prepared using TEOS as silica precursor and lanthanum acetate $La(CH_3COO_nH_2O)_3$ and trifluoracetic acid (TFA) as sources of lanthanum and fluorine, respectively. Furthermore, $80SiO_2$-$20LaF_3$ sol incorporating 2% Nd^{3+} was also prepared using neodymium acetate.

Both sols, undoped and doped $80SiO_2$-$20LaF_3$, were used to prepare thin films by dip-coating at 30 cm/min. These coatings were sintered between 350 and 750ºC for 3 hours. Homogenous and crack-free coatings were obtained after sintering, with thickness between 500 and 400nm. Figure 2 shows the HRTEM image and the corresponding electron diffraction (ED) pattern for one of these films.

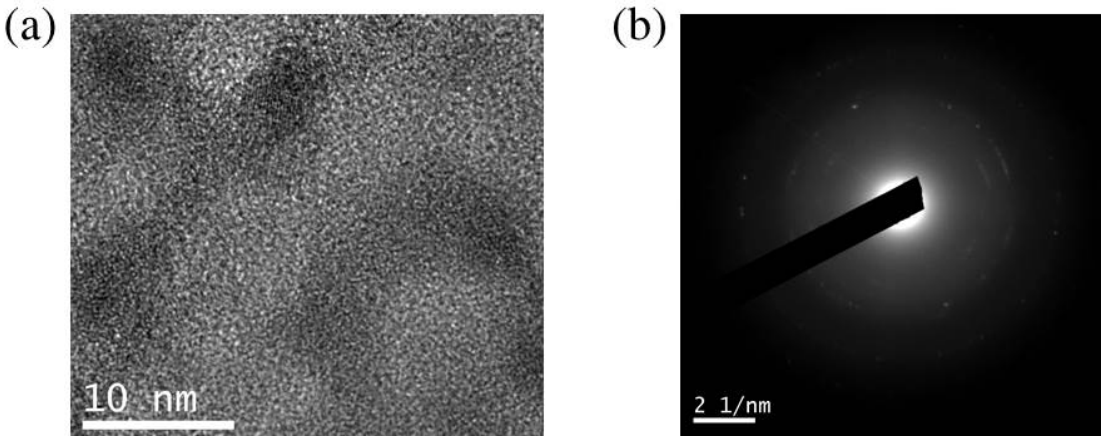
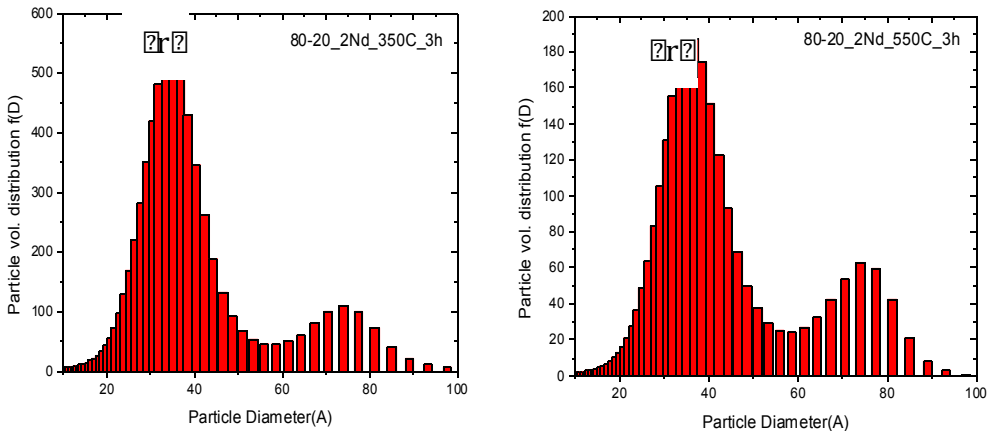


Fig. 2 (a) HRTEM image and (b) ED pattern for $80SiO_2$-$20LaF_3$ thin film treated at 750ºC-3h

SAXS measurements were done on undoped and doped $80SiO_2$-$20LaF_3$ thin films deposited in mica substrates and treated at 350, 550 and 750C for 3h. Figure 3 shows the particle size distribution of the doped coatings treated at different temperatures for 3h.

According to the SAXS analysis, coatings treated at 350 and 550ºC show two major sizes of phase separated particles, while the one treated at 750ºC shows a narrower and more monosized particle size distribution. This contrast may suggest that the phase separated particles at low temperatures were transformed into well-separated and monodispersed nanocrystals at 750ºC.



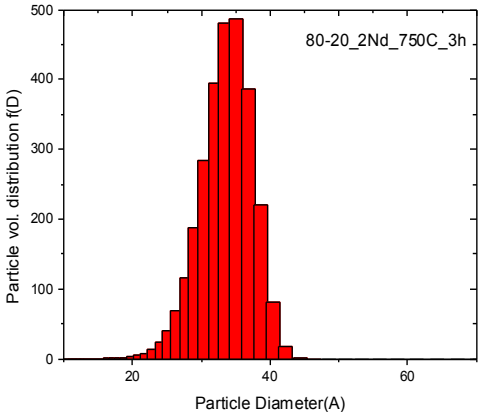


Fig. 3 Particle size distribution obtained by SAXS for $80SiO_2$-$20LaF_3$- 2Nd thin films treated at 350ºC a), 550ºC b) and 750ºC c), for 3h.

PLANS FOR 2016

In 2016, TC16 plans to continue the work initiated in 2015, in particular the SAXS analysis of nanostructured glassy materials prepared by sol-gel or other techniques and to submit a joint paper with the main results obtained so far. During the international ICG Congress in Xanghai, in April, TC-16 will hold a meeting to reformulate the plans for the future.

4.4.2 BIOGLASSES (TC04)

Chairman: Julian Jones
Vice-Chairs: Alexis Clare, Wolfram Höland
Members (new members in bold):

Bob Baier
Aldo R. Boccaccini
Delia Brauer
Jamieson Christie
Alastair Cormack
Delbert Day
Jonathan Earl
Ashutosh Goel
David Greenspan
Matthew Hall
Ron Iacocca
Steve Jung
Robert Hill
Jonathan Massera
Leena Hupa
Matthew O'Donnell
Dana Rohanova
Enrica Vernè
Chiara Vitale-Brovorone
Chengtie Wu

Executive summary

The grant from the CTC was well used, with student prizes being awarded for oral presentations at the TC04 symposium at the of DGG – ACerS GOMD in Miami and

publications fees being covered for Frontiers (Nature Publishing Group) special issue. A YouTube channel has been launched. The first articles have been published online in TC04's open access Journal, Biomedical Glasses. TC04 are putting together a Festschrift special issue for Professor Larry Hench, in ACerS' International Journal of Applied Glass Science, with a submission deadline of January 2016, Jones, Wu, Boccaccini and Brauer are co-Editors, with contributions from TC04 members, particularly those close to Larry. Delia Brauer was awarded the 2015 Vittorio Gottardi Award by the ICG and gave the Plenary Award lecture at the annual meeting.

Activities in 2015

1. Conferences and collaborations

- Successful TC04/ Bioactive glass symposium at 2nd Joint Meeting of DGG – ACerS GOMD, which takes place in Miami, in May 2015. Aldo R. Boccaccini co-organised the symposium with M. N. Rahaman the symposium "Glasses in Healthcare Fundamentals and Applications" at the GOMD meeting in Miami, May 2015. There were 30 oral presentations in this symposium, including an opening keynote from Professor Larry Hench and another from Julian Jones, with contributions from other TC04 members.

  As part of the grant awarded to TC04 from ICG, two student awards were given for best oral presentations, to cover registration. The awardees were Amy Nommeots-Nomm, Imperial College London, UK for "Porous bioactive glass foam scaffolds: Comparison of 3 compositions by 2 Processing Methods" Co-authors *Peter Lee ; Eduardo Saiz; Julian Jones, and* Sharon Krenkel, TU Ilmenau, Germany for "Manufacturing of highly porous, anisotropic glass monoliths with a honeycomb-like structure" Co-authors *Hans Uhlig; Dirk Enke; Edda Rädlein.*
- Robert Hill held a Bioactive Glass meeting at QMUL, UK in February 2015.
- Aldo R. Boccaccini co-organised a symposium on Bioceramics and Bioactive Glasses at the conference on the European Ceramic Society, Toledo, Spain, June 2015. Delia Brauer and Enrica Verne gave Keynotes.
- Leena Hupa and Delia Brauer won a bilateral exchange grant (funded jointly by the German Academic Exchange Service (DAAD) and the Academy of Finland) on the dissolution behaviour of intermediate oxide containing bioactive glasses.
- Students have been on exchanges between TC04 members' laboratories:

Name	Degree	Topic	From	To	Duration
Edoardo Buffa	MSc	Characterization and functionalization of bioactive borosilicate glasses	Politecnico di Torino (Prof. E. Verné)	Tampere University of Technology (Dr. J. Massera)	4 months
Giulia Ferlenda	MSc	Development and characterization of bioactive coatings by electrophoretic deposition	Politecnico di Torino (Prof. E. Verné)	Univ. of Erlangen-Nuremberg, Germany (Prof. A. R. Boccaccini)	3 months
Cristina Romolo	MSc	Development and characterization of	Politecnico di Torino (Prof.	Univ. of Erlangen-	3 months

		bioactive coatings by electrophoretic deposition	E. Verné)	Nuremberg, Germany (Prof. A. R. Boccaccini)	
Raika Brückner	MSc	Dissolution of mixed alkali bioactive glasses	University of Jena (Prof. D. Brauer)	Abo Akademi (Prof. L. Hupa)	2 months
Max Blochberger	MSc	Dissolution of zinc and magnesium substituted bioactive glasses	University of Jena (Prof. D. Brauer)	Abo Akademi (Prof. L. Hupa)	2 months
Johan Sangder	MSc	Zinc and strontium substituted bioactive glasses	Abo Akademi (Prof. L. Hupa)	University of Jena (Prof. D. Brauer)	6 weeks
Laura Aalto-Setälä	PhD	Density and thermal expansion of glasses as coatings	Abo Akademi (Prof. L. Hupa)	University of Jena (Prof. D. Brauer)	1 month
Preethi Balasubramanian	PhD	Surface modification of bioactive glass scaffolds	Univ. of Erlangen-Nuremberg, Germany (Prof. A. R. Boccaccini)	Imperial College London, UK (Prof. J. R. Jones)	2 months
Valentina Miguez-Pacheco	PhD	Bioactive glasses with therapeutic ion delivery ability	Univ. of Erlangen-Nuremberg, Germany (Prof. A. R. Boccaccini)	Imperial College London, UK (Prof. J. R. Jones)	2 months

2. **Congratulations**

- **Congratulations** to Delia Brauer, who was awarded the 2015 Vittorio Gottardi Award by the ICG and gave the Plenary Award lecture at the annual meeting.
- **Congratulations** to Aldo R. Boccaccini who won the Materials Science Award of the German Materials Society (DGM) (Sept. 2015)
- Several students were successful in the UK Society for Glass Technology Oldfield Award for the best undergraduate/MSc theses. 1st place was to Theresa Büttner (University of Erlangen-Nuremberg) “Analysis of lithium containing Bioglass and comparison with 45S5 Hench Bioglass”, Supervised by Aldo R. Boccaccini ; 2nd place to Oliver Eckardt (Jena) "Synthesis of core-shell hybrid materials", supervisors Felix Schacher and Delia Brauer and 3rd place to Brian Sum (Imperial College London) “Synthesis of poly(butyl) methacrylate (PBMA)/silica sol-gel hybrids for tissue engineering using different PBMA architectures”, Supervised by Justin Chung and Julian Jones.

3. **Interfacing with ACERS**

- See section 1
- TC04 are putting together a Festschrift special issue for Professor Larry Hench, in ACerS’ International Journal of Applied Glass Science, with a submission deadline of January 2016, Jones, Wu, Boccaccini and Brauer are

co-Editors, with contributions from TC04 members, particularly those close to Larry.

- Steve Jung and Julian Jones are Chair and Co-Chair respectively of a new Technical Interest Group on Bioceramics in the American Ceramics Society. TC04 will enjoy strong links with this TIG. The TIG's mandate is to improve links between industry and academia in the field.

4. New members

- Ashutosh Goel (Rutgers, USA), Jonathan Massera (Tampere, Finland) and Chengtie Wu (Shanghai, China) were welcomed.

5. Publications

- Article based on the round robin study on bioactivity testing was published and has 10 citations in its first 6 months;
- Maçon, A. L. B., Kim, T. B., Valliant, E. M., Goetschius, K., Brow, R. K., Day, D. E., Hoppe, A., Boccaccini, A. R., Kim, I. Y., Ohtsuki, C., Kokubo, T., Osaka, A., Vallet-Regí, M., Arcos, D., Fraile, L., Salinas, A. J., Teixeira, A., Vueva, Y., Almeida, R. M., Miola, M., Vitale-Brovarone, C, Verné, E, Höland, W., Jones, J. R. "A unified in vitro evaluation for apatite-forming ability of bioactive glasses and their variants". Journal of Materials Science: Materials in Medicine: 2015: 26: 115 DOI 10.1007/s10856-015-5403-9.
- Papers are all submitted for the open access special issue in Frontiers (a Nature Publishing Group journal) on bioceramics and glasses being led by Wolfram Höland and Aldo R. Boccaccini. The ICG grant awarded to TC04 in 2015 is being used to co-fund this venture.
- Aldo R. Boccaccini, Delia Brauer and Leena Hupa are editing a new book on "Bioactive Glasses for Biomedical Applications", with the publisher Royal Society of Chemistry.
- Robert Hill, Julian Jones and Delia Brauer are writing a comprehensive textbook on bioactive glass for the graduate student – Due in 2015.
- Festschrift special issue for Professor Larry Hench, in ACerS' International Journal of Applied Glass Science, with a submission deadline of January 2016, Jones, Wu, Boccaccini and Brauer are co-Editors, with contributions from TC04 members, particularly those close to Larry.
- The special issue "Glasses in Healthcare" in J. of Non-Crystalline Solids (JNCS), co-edited by A. R. Boccaccini and M. N. Rahaman, which features several papers of TC04 members, has been completed, and it will be published on line in early 2016 (JNCS, issue 432C).

6. TC04 annual meeting

The TC04 annual Meeting was held at 2nd Joint Meeting of DGG – ACerS GOMD in Miami, in May 2015. Attendees; Delia Brauer, Jamieson Christie, Delbert Day, Larry Hench, Steve Jung, Ashutosh Goel. Outreach was the main topic discussed.

7. Journal

- The first articles of the open access journal "Biomedical Glasses" (editor in chief, Aldo Boccaccini) have been published, http://www.degruyter.com/view/j/bglass.

8. Outreach/ Education

- Larry Hench has released short courses on bioceramics and on bioactive glass https://www.youtube.com/watch?v=vp29GsAnpds and http://ceramics.org/meetings/ceramic-materials-courses/bioceramics-dvd/surface-chemistry-characterization-of-bioactive-glasses

- Jones set up a Youtube channel for TC04, s currently being populated by TC04 members, https://www.youtube.com/channel/UCNKc2if3dCNM1a1ynoFEh1A

PLANS FOR 2016 AND DELIVERABLES

1. Conferences and collaborations

- Julian Jones, Delia Brauer and Ashutosh Goel are organizing a TC04 Biomedical Glass session at GOMD, Madison. S2: GLASSES IN HEALTHCARE—FUNDAMENTALS AND APPLICATION http://ceramics.org/meetings/glass-optical-materials-division-and-deutsche-glastechnische-gesellschaft-joint-annual-meeting-2015/gomd2016, 22nd – 25th May 2016
- Julian Jones and Delia Brauer have been asked by ICG president Manoj Choudhary to join a team of 5 "young" ICG members to recommend strategies that ICG could implement to attract, recruit, and retain young glass /materials science professionals. The group will be chaired by Randall (Randy) E. Youngman at Corning.

2. **Congratulations**

- Aldo R. Boccaccini is the TC04 nominee for the Turner Award, which rewards outstanding contributions to the activities of the TCs.

3. **Interfacing with ACERS**

- See section 1
- TC04 are putting together a Festschrift special issue for Professor Larry Hench, in ACerS' International Journal of Applied Glass Science, with a submission deadline of January 2016, Jones, Wu, Boccaccini and Brauer are co-Editors, with contributions from TC04 members, particularly those close to Larry.
- Steve Jung and Julian Jones are Chair and Co-Chair respectively of a Technical Interest Group on Bioceramics in the American Ceramics Society. The plan is to rebrand Steve's Annual Bioceramics Applications conference as the TIG annual meeting.

4. New members

- Dr Anthony Maçon, Assistant Professor at Nagoya Institute of Technology and first author of the TC04 round robin SBF study has been put forward for membership and has volunteered to be our webmaster.

5. Publications

- Papers submitted for the open access special issue in Frontiers (a Nature Publishing Group journal) on bioceramics and glasses being led by Wolfram Höland and Aldo R. Boccaccini will be in print.
- The special issue "Glasses in Healthcare" in J. of Non-Crystalline Solids (JNCS), co-edited by A. R. Boccaccini and M. N. Rahaman, which features several papers

of TC04 members, has been completed, and it will be published on line in early 2016 (JNCS, issue 432C).

- Aldo R. Boccaccini, Delia Brauer and Leena Hupa are editing a new book on "Bioactive Glasses for Biomedical Applications", with the publisher Royal Society of Chemistry.
- Robert Hill, Julian Jones and Delia Brauer are writing a comprehensive textbook on bioactive glass for the graduate student – Due in 2016.
- Festschrift special issue for Professor Larry Hench, in ACerS' International Journal of Applied Glass Science, with a submission deadline of January 2016, Jones, Wu, Boccaccini and Brauer are co-Editors, with contributions from TC04 members, particularly those close to Larry.
- Julian Jones and Delia Brauer will contribute a chapter on bioactive glass to an Encyclopedia on Glass, due out in 2016.

6. TC04 annual meeting

- The TC04 annual Meeting will be held at GOMD in Madison, 22nd May 2016 at the Madison Concourse Hotel and Governor's Club.

7. Journal

- The first articles of the open access journal "Biomedical Glasses" (editor in chief, Aldo Boccaccini) have been published, http://www.degruyter.com/view/j/bglass.

The editors are actively requesting submissions for Volume 2 to be published in 2016, hoping that TC04 members will submit their top papers to the journal.

8. Outreach

- Population of the Youtube channel by TC04 members, https://www.youtube.com/channel/UCNKc2if3dCNM1a1ynoFEh1A.

4.4.3 WASTE VITRIFICATION (TC05)

Chairman: *O. Pinet*, Commissariat à l'Énergie Atomique, France*
Vice-Chair: *C. Veyer*, Areva, Inc., France*
Secretary: *D. K. Peeler*, Pacific Northwest National Laboratory, USA*
Members: *P. Bingham*, Sheffield Hallam University, UK*
A. Boccaccini, University of Erlangen-Nuremberg, Germany*
E. Chauvin, Areva, Inc., France*
N. Chouard, Areva, Inc., France*
W. Ebert, Argonne National Laboratory, USA*
R. Hand, University of Sheffield, UK*
M. Harrison, National Nuclear Laboratory, UK*
C. Kim, MO-SCI Corporation, USA
M. Kovacova, Slovak Academy of Sciences, Slovak Republic*
M. LaRobina, Extreme Science Pty. Ltd, Australia
C. Leonelli, University of Modena and Reggio Emilia, Italy*
J. Marra, Savannah River Consulting, USA
R. Monteiro, Nova. University of Lisbon, Portugal
M. Ojovan, University of Sheffield, UK*
J. Rincon, Inst. E. Torroja de Ciencia y Tec de la Construcción, CSIC, Spain*
C. Scales, National Nuclear Laboratory, UK
G. Sharma, Kanya Maha Vidyalaya, India
S. Stefanovsky, SIA Radon, Russia*
J. Vienna, Pacific Northwest National Laboratory, USA*
S. Weisenburger, Institüt für Nukleare Entsorgung, Germany

*Core group member

GOALS FOR TCO5

The Technical Committee on Nuclear and Hazardous Waste Vitrification was approved by the ICG Coordinating Technical Committee (CTC) and the Steering Committee (SC) in 2006. The vision and mission of the committee are as follows:

- The vision of this committee is to establish a forum to present, discuss and disseminate technical information on waste glass chemistry, vitrification processes, vitrification melter technologies, and waste glass environmental performance.
- The mission and goals of the committee are to facilitate the dissemination of technical information through promoting programming at technical conferences, conducting technical workshops and facilitating publication of information through established channels. Promoting the exchange of technical data is also a goal of this committee.

PROJECTS FOR 2015

In 2015, TC05 planned and executed two primary activities. The first activity was to sponsor technical programming at major glass conferences. This built on successful technical programming conducted previously by TC05. In 2015, TC05 planned and conducted technical programming at the ACerS GOMD/DGG conference in Miami, USA and the PacRim 11 Conference, Jeju Island, South Korea.

In conjunction with the GOMD/DGG meeting, TC05 also planned and participate in an international glass corrosion workshop sponsored by the US Department of Energy.

The second was to continue to develop the TC05 web page to align with recent ICG guidance and to add content to the website.

ACTIVITIES IN 2015

As noted, a primary objective for 2015 was to organize and conduct technical programming at the ACerS GOMD/DGG conference in Miami and PACRIM 11 in Jeju Island.

At the ACerS GOMD/DGG conference, there were 8 sessions organized and sponsored by TC05. In the 8 sessions, there were 46 oral presentations (1 withdrawn) and 7 posters. The sessions were very well attended with over 75 attendees at several of the sessions. At the conference, there was also an international workshop on corrosion of waste glasses that was supported by TC05. At the GOMD/DGG conference TC05 member Bill Ebert presented a paper discussing a round robin study of the Product Consistency Test (PCT) procedure sponsored by the U.S. Department of Energy. Four of the five institutions supporting the study were associated with TC05. A two days international glass corrosion workshop was held following the ACerS GOMD/DGG conference. 30 participants took part in this workshop dealing with fundamental understanding of nuclear waste corrosion over geological time scales. As part of this international collaboration over 20 institutions across the world are currently performing corrosion tests with the International Simple Glass (ISG) promoted by TCO5 members. The ISG is a six component glass designed to simplify waste glass compositions and provide a standard glass for international testing. SRNL (a TCO5 representative institution) acts as custodian of the ISG and distributes to institutions. A journal article is planned to summarize testing with the ISG.

At the PacRim conference 15 oral presentations and 5 posters dealing with TC05 activities were presented. Six countries were represented by speakers in these sessions.

The proceedings from the "2nd international summer school on nuclear glass waste form: Structure, Properties and Long-Term Behavior (SumGLASS 2013)" held in Vers-Pont-du-Gard, France from 23 – 27 September 2013 was published in 2015. Procedia Materials Science Volume 7. It includes about forty articles several of which were authored by TC05 members.

After 9 years spent as chairman of the TC05, Jim Marra turned over chairmanship to Olivier Pinet at the end of September 2015. Beyond his kindness, we recognize the work he performed to link the scientific community in the field of waste vitrification.

PLANS AND DELIVERABLES FOR 2016

The primary objective for 2015 will be to organize and conduct technical programming to continue to further TC05's mission to facilitate the dissemination of technical information. Due to continued travel restrictions for most TC05 members, it was determined that conducting programming at least two meetings located in two different continents would provide the most benefit to TC05 members and the technical community at large.

Therefore, TC05 is planning to organize a TC05 session at Glass and Optical Materials Division Meeting (GOMD) in Madison, WI USA from 22 to 26 of May. It was agreed that programming should continue to be aligned with the international glass corrosion workshop since this results in strong attendance and presentations. Dialog with Joe Ryan, PNNL, (lead organizer for the international corrosion workshops) will continue to coordinate TC05 programming with the corrosion workshop. A TC05 session will be organized at ESG/SGT meeting that will be held at the University of Sheffield from 5 to 9 September. This event marks the Society of Glass Technology's centenary anniversary, which will be held alongside the European Society of Glass's annual conference.

Other opportunities for meetings on nuclear and hazardous waste vitrification will be:

- The MRS meeting in December 2016 in Boston, MA USA. The MRS meeting will commemorate the 40th anniversary of the "Scientific Basis for Radioactive Nuclear Waste Management" symposium series.
- MS&T Conference in October 2016 in Salt Lake City, UT, USA.

In 2016, TC05 will also work to update and provide new information on the website in an effort to improve communications and promote TC05 activities.

4.4.4 OPTOELECTRONICS (TC20)

Chairman:	*Giancarlo C. Righini, CNR and Enrico Fermi Center, Italy**
Chair Emeritus:	*Kazuyuki Hirao, Kyoto Univ., Japan*
Vice-Chair:	*Shibin Jiang, AdValue Photonics Inc, USA**
Secretary:	*Jianrong Qiu, South-China Univ. Sci. Tech, PRC*
Members:	*Jean-Luc Adam, Univ. de Rennes, France*
	Rolindes Balda, Univ. del País Vasco, Spain
	*John Ballato, Clemson Univ., USA**
	Heike Ebendorff-Heidepriem, Adelaide Univ., Australia
	Maurizio Ferrari, IFN – CNR, Italy
	Ulrich Fotheringham, Schott Glas, Germany
	*Jong Heo, Pohang Univ., Korea**

Daniel Hewak, Southampton Univ., UK*
Animesh Jha, Univ. of Leeds, UK
Marcelo Nalin, Univ. Estadual Paulista, Brazil
Yasutake Ohishi, Toyota Technological Institute, Japan
Laeticia Petit, nLIGHT Corp., Finland
Guodong Qian, Zhejiang Univ, PRC
*Kathleen Richardson, CREOL, Univ. Central Florida, USA**
Naoki Sugimoto, AGC, Japan
*Setsuhisa Tanabe, Kyoto Univ., Japan**
Xiang-Hua Zhang, Univ. of Rennes, France
(members of the core group)*

MAIN GOALS of TC20

To monitor international trends in optoelectronic/photonic glasses; to contribute to the advances of scientific knowledge in this area; to disseminate information on photonic glasses and to do outreach. The global aim is to maintain the centrality of glass in the next generations' optoelectronic devices. Attention is therefore also devoted to advanced materials such as glass ceramics and hybrid glasses.

ACTIVITIES in 2015

The 2015 meeting of TC20 was held in San Francisco on February 11th, during the SPIE Photonics West Conference, with the participation of 7 members, in person or through a delegate (*R. Balda, J. Ballato, M. Ferrari, S. Jiang, G.C. Righini*; *D. Hewak* was represented by *John Lincoln,* and *X.-H. Zhang* was represented by *Johann Troles*). Plans of activities in 2015 and for 2016 were discussed there.
Here a summary of 2015 activities is presented:

a) International Year of Light - IYL2015

Some TC20 members have been deeply involved in the celebrations of the International Year of Light, since the official opening ceremony of IYL2015 in Paris, on January 19-20, 2015 (G.C. Righini participated). As examples, M. Ferrari participated in the *Photonics4All* outreach European project, and J.-L. Adam was plenary speaker in the IYL2015-related ICPMCSC 2015 Conference in Mumbai, India.
A major activity concerned the publication of a Special Issue of Journal of Luminescence "Light, Energy and Life", which appeared as Volume 170, Part 3 (on-line in December 2015; printing date: February 2016). Guest Editors were two TC20 members (G.C. Righini and S. Tanabe), together with John Capobianco. Authors include several TC20 members.
The development of a mobile app (application software) for tablet computers, linking the keywords "light" and "glass", and aimed at explaining young people what glass is and how important it is in the everyday life, was not completed and work is still going on.

b) Collaborative research projects

Collaborative research activities have been carried out at the University of Southampton, as reported by D. Hewak. In February 2015 they established ChAMP, the Chalcogenide Glass Manufacturing Partnership and have provided chalcogenide glass samples to approximately 49 research groups. ChAMP is an EPSRC funded partnership between 5 leading universities and 15 industrial partners dedicated to establishing the UK as a world leader in chalcogenide-glass technology through the development of advanced manufacturing techniques and practical application demonstrations. Active collaborations have also been established between the UK and USA, through TC20 member K. Richardson.

c) Organization of international conferences and publishing

In 2015, the Proceedings and selected topics from the ICOOPMA 2014 (6th Intl. Conference on Optical, Optoelectronic and Photonic Materials and Applications), co-chaired by TC20 member A. Jha, were published with the support of Institute of Physics. A. Jha also actively supported the Glass Focus Group led by British Glass in May 2015 in Manchester with industry partners, as well as SGT and ICTON Conferences in Cambridge and Budapest, respectively.

Members of TC20 also actively participated to many other conferences, such as *(list is not exhaustive, since not all members provided the relevant information)*:

- Symposium "Recent developments in photonics", Bialystok University of Technology, Poland, 9 March 2015 (M. Ferrari and G.C. Righini, IS)
- International Conference "Smart Systems Integration", Copenhagen, DK; 11-12 March 2015 (G.C. Righini - PC)
- GOMD – Glass & Optical Division Annual Meeting, ACS, Miami, USA; 17-21 May 2015 (K. Richardson was there also as President of ACS; S. Tanabe attended SteCo meeting of ICG)
- 17th International Conference on Transparent Optical Networks ICTON 2015, Budapest, HU; 5-9 July 2015 (J.-L. Adam and M.Ferrari - IS)
- Glass Reflections - Glass in the Year of Light, Cambridge, UK; 7-9 September 2015 (A. Jha - IS)
- Photonic materials and structures: breakthrough applications and cutting edge systems, Symposium P, XIV SBPMat, Rio de Janeiro, Brazil; 27 Sepr. - 1 October, 2015 (M. Ferrari and M. Nalin, co-organizers)
- PNCS - Physics of Non-Crystalline Solids, Niagara Falls, Sept. 20-25 (J. Heo and X.-H. Zhang, IAC; J. Qiu, IS)-
- 20th Microoptics Conference (MOC'15), Fukuoka, Japan; 25-28 October 2015 (G.C. Righini - IAC)

(legenda: IAC - Intl. Advisory Committee; IS - Invited Speaker; PC - Program Committee)

Moreover, J. Ballato has been working hard to organize PRE'16 Workshop, and various members have been collaborating to the organization of ICOOPMA 2016 and of other initiatives (see below).

PLANS FOR 2016

The research and outreach activities of TC20 will keep being related to materials for “Green Photonics”, with focus on the following topics:

- Glass ceramic phosphors for solid-state lighting,
- New glasses and fibers for fiber lasers and nonlinear optics,
- New materials and process for infrared imaging and sensing,
- Optical computing becoming more practical based on new materials,
- Advanced materials and structures for increased efficiency of solar cells

As well known, the Workshop on Photoluminescence of Rare Earths (PRE'16) will be the key TC20 activity in 2016. It will be held in Greenville, SC, on 8-10 June 2016 (J. Ballato - co-chair; R. Balda, J. Ballato, M. Ferrari, J. Heo, G.C. Righini, S. Tanabe - Executive Committee). The Annual TC20 Meeting will be held there. Another TC20 meeting could be organized in Trento, Italy, in the second half of the year, during a meeting of the European COST Action MP1401 (Advanced fibre laser and coherent source as tools for society, manufacturing and lifescience).

Besides it, however, TC20 members will keep being actively involved in a number of additional conferences, such as:

- SPIE Photonics West 2016, San Francisco, 16-18 February; "Optical Components and Materials XIII" Conference (S. Jiang - co-chair; J-L Adam, G.C. Righini and S. Tanabe - PC)
- International Conference on Photonics, Optics and Laser Technology - PHOTOPTICS 2016 - Rome, Italy 17-19 February (G.C. Righini - Key Speaker)
- CIMTEC, Perugia, Italy, 5-9 June; "Advances in Inorganic Luminescent Materials and Applications" (M. Ferrari - IAC)
- 7th International Conference on Optical, Optoelectronic and Photonic Materials and Applications (ICOOPMA), Montreal, Canada, 12-17 June 2016 (D. Hewak, A. Jha, M. Nalin - PC)
- 18th Intl. Conf. on Transparent Optical Networks ICTON 2016, Trento, Italy; 10-9 July 2015, (M.Ferrari, co-chair)
- International Conference on Optics, Photonics and their Applications (ICOPA), Bordeaux, France, 5-7 December 2015 (M. Ferrari and G.C. Righini - IS).

Moreover, contacts are being carried out to organize a Symposium, with the sponsorship of TC20, on "Photoluminescence Phenomena: Materials and Applications", to be held in Mazatlan, Mexico, at the end of September. It should be one of the Symposia in the frame of the IX International Conference on Surfaces, Materials and Vacuum.

As to other activities, according to 2015 plans, TC20 should complete, in the first semester of 2016, the development of the *app* for tablets having as a theme "Glass and Light"; ICG had already approved in 2015 the funding of such initiative. By the same time, or even earlier, TC20 should publish an extended report listing the Conference presentations and the papers published by TC20 members during 2015, in order to make more evident the scientific contributions by the Committee members to the advances in science and technology of glasses for optoelectronics and photonics.

Collaborative research could also be done through existing international projects, such as an European COST action and an Italy- South Africa bilateral collaboration.

CONCLUSIONS

Most of TC20 members have kept being quite active (even if not so much interactive!) during 2015. As anticipated in the previous year, some rotation of membership is now necessary to further increase the efficiency and representativity of the Committee: the issue will be soon discussed in the core group.

While the PRE Workshop remains the flag meeting of TC20, the participation, in key roles, to several other important international conferences and schools also ensures a good visibility of TC20 and ICG.

Annexes:

- pictures of TC20 meeting in San Francisco (February 2015)
- note on the closing of the International Year of Light IYL2015
- copy of the Preface to the Special Issue of Journal of Luminescence

4.4.5 PHARMA PACKAGING (TC12)

Chairman: *Massimo Guglielmi (Univ of Padova, Italy)*
Vice-Chair: *Ronald Iacocca (Lilly, USA)*
Secretary: *Daniele Zuccato (Nuova Ompi, Italy)*
Members: *Oliver Bellina (Gerresheiner, Germany)*
Juan Cerdan-Diaz (Nipro, USA)
Ken Choju (Nippon Electric Glass, Japan)
Mads Espersen (Novo Nordisk, Denmark)
Sun Huimin, China National Pharma Packaging Association, China)
Amy Meysner (Glass Technology Services Ltd, UK)
Jingwei Zhang, (SGD, France)
Lodovico Gavioli (Bormioli Rocco, Italy)
Joachim Pfeifer (Amgen, USA)
Holger Roehl (Roche, Switzerland)
Volker Rupertus (Schott, Germany)
Martina Scarpa (Stazione Sperimentale del Vetro, Italy)

EXECUTIVE SUMMARY

The Technical Committee TC12 on Pharmaceutical Packaging, founded and officially approved by ICG in 2013, had as first objective a round robin activity to set up an experimental protocol for the evaluation of delamination propensity in glass vials. After analyzing the results of the first run, a second and a third run were performed in 2015 with the aim to optimize the procedures and propose a reliable method. Although the results are promising, this activity cannot be considered concluded yet, and it will continue in 2016. This is a priority for the TC, and other possible activities will be postponed.

MAIN GOALS OF TC 12

TC12 has the main general objective to verify the "weaknesses" of glass containers for pharmaceutical products in front of the demands of new drugs and new drug delivery systems, and to identify the R&D needs in this field. The first goal is to achieve a better understanding of the interaction of the glass surface with pharmaceutical products, with specific focus on the "delamination" phenomena, adsorption effects and the influence of big molecules.

ACTIVIES PLANNED.

- A first run of experiments ended in 2015 by using the agreed method. **(2015)**
- a second run of experiments was concluded with the aim to conclude the activity on the agreed test method to determine the propensity to delamination; **(2015)**
- the setup of a protocol for a second test based on the Amgen test, and Round Robin with it; **(2016)**
- preparation of a review paper on delamination by several members of the committee, enlisting external contribution, if needed; **(2016)**
- a decision on the possibility to start a scientific investigation on the most important and interesting aspects of the phenomena related to delamination; **(2016)**
- extension of the activity to adsorption effects and the influence of biomolecules **(2017)**.
- Mechanical behavior of glass containers **(2016)**

ACTIVITIES in 2015

During 2015 there were two meetings of the TC, a teleconference in June, and a face-to-face meeting in Murano in October. The activity of the TC and the results obtained with the first and second round robin tests were presented by Daniele Zuccato at the PDA Particles in Injectable event held in Berlin in September 2015.

The second run of the round robin was performed in 2015 with the aim to optimize the procedures and propose a reliable testing method. More specific and detailed instructions were given to all labs. This activity was limited to one type of tubing vials, characterized by an expected high delamination propensity. The results of this round robin confirmed those of the first run, but with a much lower dispersion of data, confirming the usefulness of very precise specifications in the protocol and a more rigorous application of instructions.

A further run was planned, to enlarge the base of data by using a new set of vials with a different S/V ratio. The results were in a general agreement with those already available, and therefore the test can be used to compare the delamination propensity of vials with the same dimensions and glass composition but produced under different conditions.

As during the meeting in October there was a deep discussion showing that there is only a partial agreement among the members of the TC on the interpretation of the output of the test, the Chairman proposed that all the members should elaborate the aspects emerged during the discussion and should provide, in written form, their opinions.

A road map for the future activity of TC12 will be based on this.

At the meeting in Murano it was also discussed if to start a parallel activity on the mechanical behavior of glass vials deciding to postpone it.

PLANS FOR 2016

As stated above, a plan will be discussed at the beginning of the year, based on the collection of the abovementioned opinions.

4.5 R&D ACTIVITY FIELD « INFORMATION, EDUCATION, HISTORY »

4.5.1 COMMUNICATIONS OFFICE (TC01)

Chairman	*Prof J M Parker, University of Sheffield, UK*
Members:	*Dr K Bange, Germany*
	Prof A Duran, Instituto de Ceramica y Vidrio, Madrid, Spain

SUMMARY

2015 was a busy year. A key development was the publication of a third book on ‘Making Glass Better’ in time for the ICG Committee meetings in Miami, in May 2015. The number of hits on the web site has continued to grow rapidly. As part of a process of continuous improvement though another major upgrade of the ICG web site at www.icglass.org has been undertaken. Much energy has been expended writing press releases both for ICG news items and also for items of wider interest, as well as maintaining the standard means of communication such as meeting minutes.

GOALS FOR 2015

There were a number of important actions in progress which were to be completed during the year. The list below is from last year’s Annual Report:

1) The web site is a major activity and continual updating is needed, including the generation of Press Releases. Particular developments needed include:

a. Filling gaps in the members database (e-mail addresses) and promoting its use,
b. Ironing out some initial teething problems in the use of the data storage area of the web site,
c. Provide more detailed instructions on the facility to upload documents for password protected access,
d. Develop the 'What is Glass' section in more detail, with educational material in mind e.g. from the Summer Schools.

2) Maintain and develop links to ICG members and associate members, to advertise their activities on the ICG web pages and to provide them with News items from the ICG.

3) Although little progress has been made for the last two years on the Glass/ICG Entries on Wikipedia TC23 and TC01 will continue to pursue this area as time permits.

ACTIVITIES in 2015

In the first half of 2015 the plans made in 2014 went out of the window. Although only a suggestion at the last CTC meeting in Parma in 2014, the Editorial Team worked hard to generate, edit, and publish a special edition in the Series 'Making Glass Better' within the first 5 months of 2015 in time for release at the combined AcerS-DGG conference in Miami. Its contents were based on a Topical Meeting in Sicily organised by NSF's International Materials Institute for New Functionality in Glass (IMI-NFG). The authors were Klaus Bange, Himanshu Jain and Carlo Pantano, with editing and publication undertaken by the ICG Editorial team: K Bange, A Duran and J Parker. Copies were issued to all delegates at the Miami meeting and are also available for purchase from the DGG.

Interestingly there was a major knock-on effect on the ICG web site. Around the date of the Miami conference, particularly during the 3 weeks after the number of daily hits on the ICG web site almost doubled, before falling back to their original level. The powerful advertising effect of this new book was clearly evident.

While a volume 4 in the series is not currently planned – in fact several workshops are being arranged as part of the funded projects currently underway within CTC. It is hoped that some of these may generate suitable material for publication.

In reporting the concepts underpinning the 'Making Glass Better' series during a talk at an SGT conference a significant issue raised with the chair was the question of aesthetics/art. This merits a wider discussion and conversations have been initiated.

Apart from the positive perturbation after Miami, the ICG web site, has continues to attract a growing number of hits (30% growth in traffic p.a.). 21 press releases were added to the web site in 2015. 7 of these have covered major events linked to ICG and these have been widely circulated by K Bange. Several are published in major Glass trade journals increasing the exposure of ICG. Other press releases related to items received from NPOs, in particular AcerS, GMIC, DGG, SGT, SSV and AIGMF. Items from other NPOs and glass organisations outside of ICG are solicited.

Every attempt will be made to ensure that the Conference list on the web site is current but this needs increased cooperation from those organising events. One aspect of this issue is a lack of visibility of the existing conference data and this is one of several reasons for modifying the web site.

Indeed the web site is beginning to show its age, having been first created 4 years ago. Also several imperfections in the design have become apparent such as the list of key words forming the banner headline. Other problems were linked to the use of the site by TCs for online data storage. A major re-vamp was therefore proposed. At the same time new software was available for installation which would facilitate the creation of a site with more visual impact. The CTC agreed that these modifications were needed and the costs should be covered by ICG.

Updating & development of the web site has continued throughout the year as part of the plans outlined in last year's report. The proposed changes to the web site have also been put in place but are not yet live. It is hoped that this will be achieved before the year end. One aspect of these changes, a new and significantly more powerful Content Managed System, allows easier linking to Facebook and other social media, and facilitates site construction – the actual changes visible initially will be small but the potential is great. The facility for TCs to upload files has also been improved, to include for example folder structures. A new set of instructions will be prepared for Chairs based on revisions to the site.

An ongoing activity is to produce minutes of the CTC meetings. Other similar activities include maintaining the data on the web site, producing a list of officers, and assisting with the editing of the Annual Report, including the transfer of this information onto the web site.

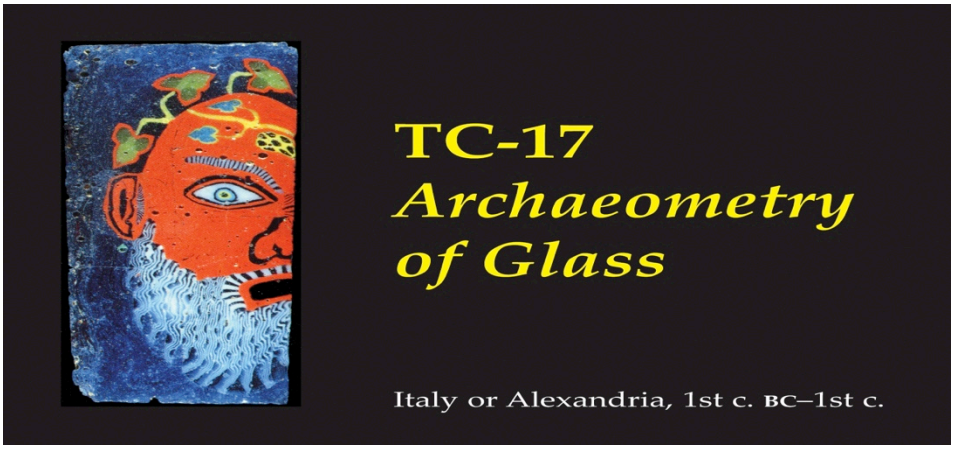
Although it has not been possible this year to add new material to Wikipedia, the opportunity has arisen of producing an article on ICG for a new Glass Encyclopedia. This will be submitted before the year end.

PLANS FOR 2016

There are a number of important actions in progress:

1) The web site is a major activity and continual updating is needed, including the generation of Press Releases. Particular developments needed include:
    a. Continue to fill gaps in the members database (e-mail addresses) and promote its use,
    b. Iron out any initial teething problems in the use of the new web site,
    c. Populate the Education section in the new web site with more detail, e.g. advertisements for the Summer Schools,
    d. Consider security aspects of the use of the web site for data storage.
2) Maintain and develop additional links to ICG members and associate members, to advertise their activities on the ICG web pages and to provide them with News items from the ICG.

4.5.2 THE ARCHAEOMETRY OF GLASS (TC17)



Chairman: *Mr Stephen P. Koob (Corning Museum of Glass, USA)*
Vice-Chair: *Dr Robert H. Brill (Corning, NY, USA)*
Members *Dr Abdugani A. Abdurazakov (Nat Inst of Arts & Design, Uzbekistan)*
Prof H. C. Bhardwaj (Chandua Chittupur, India)
Ms Catarina Carvalho (Museu do Vidro, Portugal)
Prof Christopher R. DeCorse (Syracuse Univ, USA)
Prof Dr. Gan Fuxi (Shanghai Inst of Optics & Fine Mechanics, China)
Dr. Manual Garcia-Heras, Institute of History, CCHS, Government Agency Spanish National research Council, CSIC, Madrid, Spain.
Ms An Jiayao (Chinese Acad of Social Sciences, China)
Mr Takayasu Koezuka (Nara Nat Cultural Properties Res Inst, Japan)
Dr Alok Kumar Kanungo (Dept of Archaeology, Deccan College, India)
Dr M.O. Kozlova (State Hermitage, St. Petersburg)
Prof. Cristina Leonelli, Universita' degli Studi di Modena, Italy.
Dr David Martlew (Soc of Glass Technol, United Kingdom).
Dr Patricia Pongracz (American Bible Society, USA)
M Rainer Richter (Staatliche Kunstsammlungen, Germany)
Prof Colleen P. Stapleton (Mercer Univ, USA)
Dr Norman Tennent (Glasgow, UK)
Elzbieta Greiner-Wronowa (Univ of Mining & Metallurgy, Poland)
Dr. Maria-Angeles Villegas, Institute of History, CCHS, Government Agency Spanish National Research Council, CSIC, Madrid, Spain
Consultative Members
Jerzy Kunicki-Goldfinger (Inst of Nuclear Chemistry & Technology, Poland)
Dr In-Sook Lee (Busan Museum, Korea)
Prof Carlo G. Pantano (Mat Sci & Engg Dept, Pennsylvania State Univ, USA)
Members Emereti
Mr Shi Meiguang (Distinguished Scholar, China Building Mat Acad, China).

SUMMARY
The objectives and activities of TC17 differ somewhat from those of other TCs. The purpose of TC17, unchanged since its beginning in 1982, is to bring together glass scientists, archaeologists, museum curators, and conservators to present and discuss the results of research on early glass and glassmaking, and on the conservation of historical glass objects. TC17 centers its programs on the research and glass problems of the regions where the Congresses are held.
Two very important aspects of TC17 are that it promotes collaboration among glass specialists in widely-separated countries and it serves as a stimulus and encouragement for glass scientists and historians in developing countries.

ACTIVITIES in 2015
Meetings
TC17 had little activity in 2015, except for soliciting abstracts for the Triennial ICG Meeting in Shanghai, April 2016. A good turn-out is expected.

Membership
TC17 continues to review its membership. We recommend Dr. James Lankton as a new member (below)

Plans for 2016
Chairman Stephen Koob and Vice-Chairman Robert Brill are committed to increasing and updating our membership in order to have a more active committee. TC17 is in the planning stages for the XXIV International Congress, to be held in Shanghai, 2016.

New Membership Requests
We request that ICG approve the addition of one new member:
Dr. James Lankton, independent researcher, Seoul, Korea, as a new member.
He has done extensive work on the archaeometry of glass and collaborated with Dr. Brill on analyzing samples for future studies on the technology of ancient glass.

4.5.3 EDUCATION (TC23)

Chairman: *Reinhard Conradt, RWTH Aachen Univ, Germany*
Vice-Chair: *Ales Helebrant, Inst of Chemical Technology, Czech Republic*
Core Team: *Alicia Duran, Inst de Ceramica y Vidrio, Spain*
John Parker, Univ of Sheffield, Great Britain
Hiroyuki Inoue, Inst of Industrial Materials, Japan
Members: *Ana Candida M. Rodrigues, Univ of Sao Paolo, Brazil*
Alexis Clare, Alfred Univ, USA
Elisabeth Flygt, Glafo, Sweden
Clara Goncalves, Inst Superior Técnico, Portugal
Russell Hand, Univ of Sheffield, Great Britain
Bernard Hehlen, Montpellier University, France
V Hotar
M Hubert, Celsian, The Netherlands
Marek Liska, Trencin University, Slovak Republic
Seema Ubale, Dharampeth MP Deo Memorial Science College, Nagpur, India
Xiujian Zhao, Wuhan Univ of Technology, China
Guests: *Chao Liu, Wuhan Univ of Technology, China*
Klaus Bange, Germany
Kathleen Richardson, Clemson Univ, USA

MAIN GOALS OF TC23
It is the mission of TC23 to organize courses, workshops, and schools, to provide information on such events organized by others, and to explore both well-established and new formats of instruction.

PLANS FOR 2015
- Organization of the 7th Montpellier Summer School, 6-10th July 2015. This will combine threads on both Glass Science and Glass Surfaces.
- Planning presentations from the 2014 Summer School at the ICG conference in Thailand.
- ICG funds have also been received to encourage student participation in ICG conferences such as the next one in Thailand. Allocation of these awards will be an important activity for 2015.

ACTIVITIES in 2015

Montpellier Summer School

The 7th workshop for new researchers in Glass Science and Technology ran from 6-10th July, 2015 in an exceptionally hot Montpellier, France. Two parallel sessions were arranged following the successful trial of a similar format last year. Their themes were 'Glass Science' and 'Surfaces and Thin Film Technology'. Altogether 32 students from 8 countries attended, those with industrial links making up the majority for the first time. A popular new provision was small group tutorials.

The 'Glass Science' course has evolved with new PhD students in mind, although it also attracts a few from industry. On the first day, run jointly with the Surfaces session, Prof Conradt (Aachen) covered chemical properties - durability in particular – while Prof Parker (Sheffield) talked on optical spectroscopy and on diffusion with ion exchange processing as an underpinning theme. Structural analysis based on diffraction (neutrons, EXAFS, Prof L Cormier, CNRS UPMC), and spectroscopic tools such as Raman (Prof B Hehlen, Montpellier) and NMR (Prof P Florian, CEMHTI CNRS) followed. Glass crystallization (Prof J Deubener. Clausthal) and mechanical properties (Prof M George, Montpellier) filled another morning. On the final day the power of atomistic simulation for understanding structure-property relations was explained (Prof A Takada, Asahi Glass, Japan) and Prof Conradt introduced more on the thermodynamics of glass forming systems.

After the joint lectures on day 1, the Glass Surface and Thin Film course split off for the three subsequent days, each starting with a talk emphasising basics. More technology-oriented topics followed. The concluding presentation each day demonstrated the importance of surfaces and thin film currently and potential future applications. The first day focused on tools for characterization, the second concentrated on the glass surface and the final day was devoted to thin films on glass. A wide range of lecturers shared their expertise including: Dr K Bange (Germany), Prof S Oktik (Şişecam, Turkey), Prof C Pantano (Penn State, US), Dr H Roehl (Switzerland), Dr I Sokmen (Şişecam) and Prof A Mendoza Galvan (Mexico).

A final presentation on Thursday afternoon was given by Prof Pan to the whole class on the "Current Status and Prospect of Modern Glass". He stood in at the last minute for the ICG President, Prof Peng Shou who was detained on urgent business. His talk proved inspirational, giving the students insights into what can be achieved by hard work and determination.

On the first afternoon each student described his or her own academic or professional interests. This assisted project allocation, but also served to introduce participants to each other and to expand the horizons of all present. On Tuesday afternoon eight groups, each with 4 students, were created and allocated to an individual project. Selection criteria included: the separation of students who knew each other, mixing students with academic and industrial backgrounds, and giving students a project related to their individual interests. The rest of the afternoon was free to start work, particularly with the aim of unravelling what the key issues were. Wednesday afternoon was free for projects, but most groups also chose to visit the beach. No doubt further discussions continued there until late, when temperatures had begun to fall. By Thursday evening most had a set of well-illustrated slides on their topic ready to display at the Friday morning closing session.

The presentations are both informative and competitive. Students are encouraged to give of their best but also to ask questions that probe even undermine the content of other talks. This adds spice to the occasion. The competition winners, announced with all the

razmataz of a TV reality show, were Gulin Demirok, Paul Jacquet, Marina Konon and Branislav Velev for their talk on *Li Glass Ceramics for Batteries*. Coming a close second were Merve Kutlug, Barbora Holubova, Matej Drobny, and Aref Cevahir who looked at: *What factors affect the adhesion of organics to glass surfaces and how might they be controlled?*

A change this year was to introduce tutorial sessions. They were organized during the afternoons and overlapped slightly with project preparation. In each case small groups worked together with the teachers on selected topics from their lectures; the basic concept, "*an informal tutorial under the pine trees for 3-4 persons",* was not realized because it was too hot and the students preferred to stay in cooler air-conditioned rooms. Indoors also offered blackboards and chalk which remain invaluable assets for lecturers. The participants really appreciated these tutorials and were willing to spend a little less time on project work.

This year new lecture rooms were needed for the first time because of programmed renovations in our previous venue. These were closer to the Student Residences and the tram stop for those staying in hotels. But as a consequence our morning walks took in an incomplete set of planets on the posters lining the route.

The same venue as previously was used for the reception and the School Dinner on the final evening. These social events are an important part of the school, and students are encouraged to speak to people they do not know including the lecturers. From their responses this is a unique and invaluable feature of the event. Comments at the end of the week showed their appreciation e.g. "This Summer School was wonderful; THANK YOU VERY MUCH" Common themes in their choices of the 3 best features were: quality of teaching, networking opportunities and project work. A more unusual item on one list, fortunately only in 3rd place, was 'French Wine'.

Both participants and lecturers came from many different countries. The lecturers were from France (4), Germany (3), the UK (1), Turkey (2), USA (1), Mexico (1)Japan (1), and Switzerland (1). While most students were from Bulgaria, Czech Republic, France, Germany, Slovakia and Turkey (29), we also had representatives from continents further afield particularly Japan (2) and Russia (1). Numbers were down from previous years, attributed to other international glass summer schools running this year, with exceptionally high levels of funding.

We thank all those who helped to make the event a success again, particularly the teachers listed above who give their services without charge and the local organizing team (Mylene Boscus, Prof Bernard Hehlen and Prof Rene Vacher).

A meeting of TC23 was held on Sunday 20th September and was attended by 7 members. We were joined by Chao Liu, Wuhan Univ of Technology, China. He is the person responsible for the arrangements for the Wuhan Winter School. After a long discussion it was agreed that this event should be organised alongside the Shanghai Glass Congress in April 2016. Prof Parker agreed to act as the point of contact for arrangements. It was also agreed that Prof Hehlen would arrange the Montpellier Summer School Science thread while Prof Conradt would make arrangements for a Glass Technology thread in Montpellier.

73her activities

The ICG web pages have advertised a number of student schools taking place at various international venues for example a Summer School in Brazil. J Parker reported that the Web

pages are currently being re-vamped and that Prof Hehlen had agreed to help populate a specific section on Education.

PLANS FOR 2016

Organization of the 8th Montpellier Summer School, 6-10th July 2016. This will combine threads on both Glass Science and Glass Technology.

The 8th Montpellier will offer two topical threads which will be presented in parallel courses, with some fundamental courses common for both. The first thread (running under the headline GLASS FORMATION, STRUCTURE, AND PROPERTIES) will overview fundamentals in glass science emphasizing structure-to-property relationships as well as experimental techniques and numerical simulation. Specific properties, their structural dependence, and applications will be discussed, such as: optical behavior, viscosity, aging, transport phenomena, nucleation and crystallization. In the second thread (running under the headline GLASS TECHNOLOGY - PRIMARY INDUSTRIAL GLASS FABRICATION) lectures will be devoted to primary industrial glass fabrication. The first part consists of six lectures presenting an overview by sketching the process path from the raw materials to the workable melt. Recent progress related to reaction kinetics, melt chemistry, energy and emission issues, and process control will be addressed. In the second part, individual attention will be given to each of the product segments of container, fibre, and float glass, addressing for each segment the typical problems encountered in industrial practice, and highlighting some future challenges.

Assisting with the 2nd Winter School, this year in Wuhan, China just before the ICG Congress in Shanghai (31st March- 5th April 2016).

The programme will comprise the following topics:

(1) Glass colour and redox chemistry. Optical absorption and colour coordinates. Very transparent glasses for PV, telecommunications.
(2) Ion exchange. Diffusion profiles, particles growth. Mechanical and optical properties.
(3) Chemical durability: Measurement and standards. Physical chemistry and mechanisms of corrosion. Effect of composition.
(4) Calculating phase equilibrium and chemical activities in melts with exercises.
(5) Vibrations in glasses (I): Basics of IR absorption, Brillouin and Raman scattering.
(6) Vibrations in glasses (II): Vibrations and glass properties.
(7) Atomistic simulations of structure. Reliability, limitations, problem solving.
(8) Atomistic simulations and glass properties.
(9) Neutron, X-ray and light diffraction. Results for various oxide and non-oxide glasses.
(10) Thin film deposition technologies PVD, CVD, sol-gel, etc.
(11) NMR for studying structures of various glasses.
(12) Mechanical properties of glasses.
(13) Liquid-liquid phase separation. Nucleation and crystallization. Nano-crystallization. Particle coarsening.
(14) Glass-ceramics: their manufacture and properties. Some key examples of applications.

Topics no. 1 to 10 will be covered by lecturers from the Montpellier Summer School core team, while lectures no. 11 to 18 will be presented by Chinese colleagues from different academic affiliations. After the first and very encouraging test run of the 1st Winter School in Shenzhen, China, in December 2014, a major challenge now consists in attracting students not only from China, but – in accordance with the nature of ICG – also international students, e.g., from the Asia and Asia-Pacific region.

Planning presentations from the Summer and Winter School participants at the ICG Congress in Shanghai, China

ICG funds have also been received to encourage student participation in ICG conferences such as the next one in Shanghai. Allocation of these awards will be an important activity for 2016.

Supporting the ICG Initiative on Expanding Global Scope of ICG Education/Training

Following the recommendations of the ICG Management Board, an international advisory team will be established in early 2016. The task of this team, under the guidance of TC23, consists in exploring a wider range of options for ICG activities in the field of education and training.

International books

In 2012, the German Museum in Munich presented as series of books on glass science and technology (Vol. 1: “Glass: The Material”, Vol. 2: “Glass Hollowware”, Vol. 3: “Flat Glass”, Vol. 4: “Speciality Glass”). This series covers the basics of glass science and technology at the level of an undergraduate introductory course. The texts are presented in German and English in parallel columns. The opportunity shall be explored whether or not the editors are interested in expanding their series – with the assistance of ICG – to editions presenting the texts in English plus another ICG language (similar to the ICG Dictionary). This may result in a win-win situation for both the museum and ICG.

TC3 Structure and properties of glass

Activity 2015

We have organized a meeting in Miami, 17 May 2015.
Present: Moncke Doris (Dr), Dominique de Ligny, (Prof Dr), Alex Hannon (Prof Dr), Montagne Lionel (Prof Dr), Saito Akira (Dr), Takebe Hiromichi (Prof Dr), Daniel Neuville (chair)

1. Borosilicate activity

During this meeting Doris Moncke reports some activity around borosilicate glasses and more particular around the Connectivity [BØ4]--Tetrahedra in Borate and Borosilicate Glasses. This work was made by D. Möncke*, G. Tricot, A. Winterstein-Beckmann, D. Ehrt, L. Wondraczek and E.I. Kamitsos and it is in press in Phys. Chem. Glasses 2015.

To summarize the paper:

Borate rings based on [BØ$_4$] tetrahedral: the case of glass NBS C

Raman spectroscopy gives evidence for the existence of borate rings consisting of one neutral [BO3]0 and two charged [BØ4]- tetrahedra (see schematic 1a). The characteristic ring breathing mode measured at 750 cm^{-1} is slightly lower in energy compared to the corresponding mode of the ring with one [BØ4]- and two [BO3]0 entities (770 cm^{-1}) or that of the boroxol ring consisting of three [BO3]0 trigonal units (805 cm^{-1}) 1-6. Figure 4 shows Raman spectra with signals of different borate rings taking as an example the sodium borosilicate glass NBS C (42.5 SiO2 - 42.5 B2O3 – 15 Na2O in mol%). The enlarged details of Figure 4 show that slight structural differences can be distinguished in the Raman spectra of quenched and annealed glasses from the same melt. The intensities of the bands assigned to boroxol and borate rings (800 and 768 cm^{-1}) increase for the annealed compared to the quenched glass 1, 7. The network deformation band below 550 cm^{-1} shifts to slightly higher energies for the quenched compared to the annealed glass. A higher fraction of mixed B3-O-Si bonds shifts this band to higher energies 8. The band at 920 cm^{-1} has a higher intensity in the annealed compared to the quenched sample. This band is due to stretching modes of tetrahedral borate [BØ4]- units and reflects therefore a change in the B3/B4 ratio, that is the metaborate equilibrium is shifted to lower coordination numbers at higher temperatures, [BØ4]- →[BØ2O]- 9. The temperature dependence of this equilibrium has been noticed earlier for borate and borosilicate glasses 7, 10-15. Corresponding changes are not observed nearly as strongly for the stretching vibrations of trigonal borate entities, that is in the band envelope between 1300 and 1600 cm^{-1}. However, this might be explained by a strong predominance of B3 over B4 units (N4~0.351), that is by a relatively small change in the population increase of trigonal borate entities, and also by the broadness of this band envelope, which comprises not only B-O stretching modes of the metaborate BØ2O- units, but also modes of ring and non-ring [BO3]0 groups 7, 9. A weak intensity increase might be seen for the band at 1035 cm^{-1}, due to the asymmetric stretch of Si-O-Si bonds, in the annealed compared to the quenched sample 8. Contrary to the intensity increase of stretching modes of rings with borate tetrahedra (768 cm-1) and of Si-O-Si bonds (1035 cm-1), a small decrease in the neighbouring band at 1140 cm^{-1} is observed in the annealed glass. Since this band is typical for stretching modes of mixed B-O-Si bridges 7, annealing appears to favour the demixing of the borate and silicate sub-networks. The observed structural changes are somewhat weaker than those observed for another low alkaline borosilicate glass discussed in detail in reference 7. However, the observed changes are basically of the same kind: mixed B-O-Si links are more frequent in the quenched glasses while annealed glasses contain more tetrahedral borate and boroxol rings and more Si-O-Si linkages.

NMR spectroscopy

The same NBS C glass was also studied by 1D/2D NMR spectroscopy. The borate speciation of quenched (Fig. 2a) and annealed (Fig. 2b) samples was first analysed using standard 1D 11B MAS-NMR experiments. Owing to the high magnetic field used for the acquisitions (18.8 T), the 1D MAS-NMR spectra allow unambiguously to distinguish BO3 from BO4 units through separated chemical shift regions (20 / 5 and 3 /

[1] http://www.icglass.org/technical_committees/?id=1&committee=TC03:_Glass_Structure

-5 ppm for BO3 and BO4, respectively). The N4 ratio determined from signal integration shows a strong decrease after the annealing process (0.34 +/-10% to 0.16 +/-10% in quenched and annealed samples, respectively) suggesting that BO3 units are created at the expense of BO4 species during annealing of the glass.

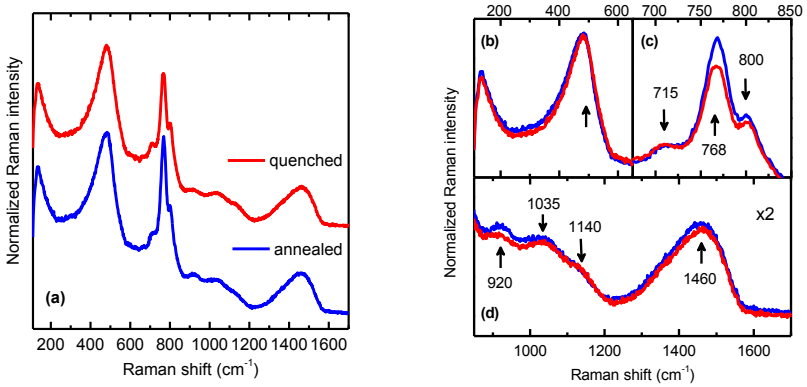


Figure 1: (a) Normalized Raman spectra of quenched (red) and annealed (blue) NBS C glass (42.5 SiO2 – 42.5 B2O3 – 15 Na2O in mol%). Enlarged details show (b) the silicate network deformation modes below 650 cm-1, (c) borate and boroxol ring modes between 675 and 850 cm-1, and (d) stretching modes of borate tetrahedra at 920 cm-1, of mixed Si-O-B bonds near 1140 cm-1 and of trigonal borate entities between 1300-1500 cm-1.

It is also obvious from the 11B MAS-NMR analysis that the non-ring BO3 units, which contribute to the signal in the 8-10 ppm region, strongly benefit from the structural rearrangement induced by the annealing process. A strong decrease of the B(4Si) signal at -3 ppm is also observed in a good agreement with the decrease of the global B-O-Si bonding expected during annealing, as suggested also by Raman spectroscopy. It is noted, that the common NMR assignment is used for the signal at -3 ppm 12.
This last result is supported by the 11B/29Si correlation maps recorded on both samples (Fig. 3). In these 2D maps, correlation signals indicate very short distances between the silicate and borate units and can thus be reasonably discussed in terms of chemical connectivity or B-O-Si linkage. For the quenched sample (Fig. 3 left), the two correlation signals indicate that both trigonal and tetrahedral borate entities are connected to the silicate network and are thus involved in B-O-Si linkages. However, for the annealed glass remains only the signals of B3-O-Si connectivity, while the signals of B4-O-Si linkages disappear (Fig. 3 right). This clearly demonstrates that the B4-O-Si linkages have been removed during the annealing process and that the mixed structure of the annealed sample is based on interconnected silicate and three-coordinated borate species. The BO4 units are thus likely to be involved in linkage with B3/B4 units to create a borate sub-network. These findins are consistent with the relative increase of the Raman bands at 768 and 800 cm-1 (Fig. 4c).

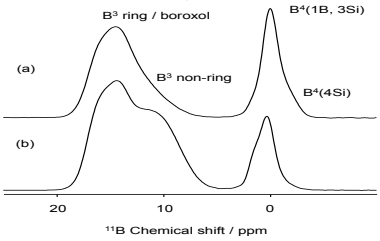


Figure 2: 1D 11B MAS-NMR analysis performed at 18.8 T on the quenched (a) and annealed (b) NBS-C samples. Shift assignments according to conventional use as in Ref. 12.

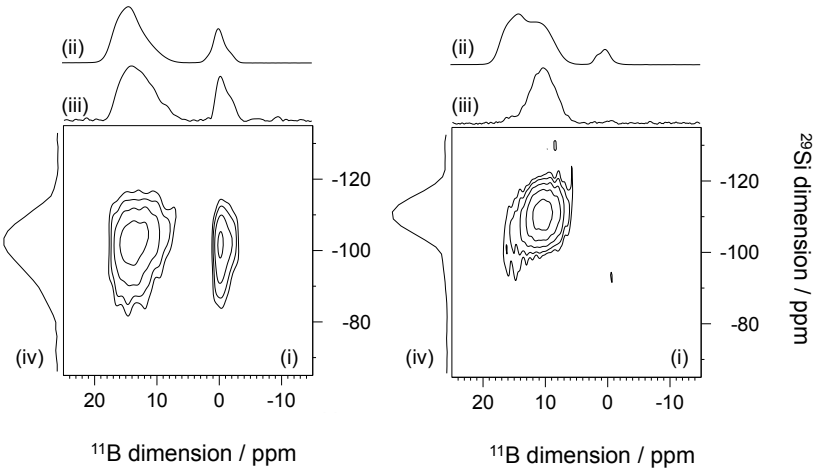


Figure 3: 2D 11B/29Si correlation NMR performed on the NBS-C quenched (left) and annealed (right) samples. The 2D maps (i) are accompanied with the 11B MAS-NMR spectrum (ii) and the 11B (iii) and 29Si (iv) 2D map projections.

The TC3 will continue his activity in borosilicate glasses, continuing its round table which consists of the study of a few glasses by combining techniques, thermodynamic and structure investigated by Raman spectroscopy, IR, Raman…

2. Future activities

Different discussions take place during the meeting, and we decide to try to organize some reflection around:

- - We can summarize the discussion by : Te in glass ? Te can be a network former like in tellurite glass, but Te can also play the role of ligand like O in chalcogenure glasses. It is can be interested to understand the role of Te and how it is role change as a function of composition? Different questions appear :
    - What is a ligand (O in GeO4, Te in GeTe4)?
    - Are there other elements having the same behavior?

- How transition elements are changing their of role based on the redox? Like Fe2+/Fe3+, V2+/V3+/V4+/V5+

- -How Al and B plays together to made glasses with and without Si. How they take alkali and earth alkaline element for charge compensator?

- What is a network former? Last idea about glass network former was proposed by Dietzel (1942) but now with all new investigations tools on thermodynamics and rheological properties, recent advanced on glass and melts structure by using in situ experiment…. Could we propose a new definition more well adapted at the Third Millennium for oxide glasses but also for chalcogenure, metallic glasses….?

  To answer at this question, we have decide to organize an international school in 2017 with the support of the French Glass Society (USTV) and also with the support of the French research group of glass from the CNRS (GDR-Verre). The title of the school should be "**Glass network formers vs. network modifiers: state of the art and new developments"**. The definition of glass forming ability is one of the first concept for which glass scientists tried to propose rules, based on both thermodynamic and structural arguments. On the other hand, today's glass technologists and scientists explore more and more unconventional compositions, and alternative

elaboration methods enable glass preparation under ultra-soft (sol-gel) or extreme (sputtering, pressure) conditions. Today's glass science also beneficiate of outstanding developments in analytical, computational and structural methods, and hence they either confirmed or denied the classical models of network forming. All these elements indicate that there is room for a place to share and discuss the old and new concepts of glass formers and of course of their complementary modifiers.

This is why 3 glass organizations decided to propose a spring-school on the subject "**Glass network formers vs. network modifiers: state of the art and new developments**". It will cover the general rules, some non-classical situations, a wide range of glass systems, and also the arguments brought by the most recent analytical and modelisation methods.

The spring-school will be organized with general lectures presented by international experts, research presentations, and large time-space will be devoted to discussions and round-tables. The public will be both PhD students who wants to get advanced knowledge of the concepts, and researchers who will share their experience. Glass technologists and industrials, who are already involved in the GDR-verres and USTV, will also beneficiate of the discussions on non-conventional glass systems and their applications. The GDR-Verres is a network held by the CNRS, which gathers all the French academic research groups (http://gdrverres.univ-lille1.fr). It is constituted of over 300 members and 60 research groups. Its aim is to organize scientific discussions on glass science. The USTV is a non-profit association (http://www.ustverre.fr). It aims at developing and disseminating knowledge in the fields of glass science, glass technology and glass products. The members are glass manufacturers, industrials as well as academics.

3. Next meeting

- -Shanghai April 2016,
- ESG-Sheffield September 2016

Members:

Chromcikova, Maria (Dr)
Dominique de Ligny, (Prof Dr)
Gedeon, Ondrej (Prof Dr)
Hannon, Alex (Dr)
Kamitsos, Efstratios (Prof)
Karpukhina, Natalia (Dr)
Liska, Marek
Moncke, Doris (Dr)
Montagne, Lionel (Prof Dr)
Munoz, Francisco (Dr)
Neuville Daniel R, Chair
Armenak Osipov, (Prof Dr)
Francesco Rocca, (Prof Dr)
Saito, Akira (Dr)
Takada, Akira (Prof Dr)
Takebe, Hiromichi (Prof Dr)
Tricot, Gregory (Dr)
Vedishcheva, Natalia (Dr)
Wright, Adrian (Prof Dr)
Huidan Zeng, (Prof Dr)

GLASSES FOR OPTOELECTRONICS (TC20)

2015 Annual Report - Annex

a) photo of the TC20 2015 meeting

TC20 Meeting in San Francisco, on 11 February 2015.
From the left: S. Jiang, J. Ballato, J. Troles, R. Balda, J. Lincoln, G.C. Righini, M. Ferrari.

b) note on the closing of IYL2015

The International Year of Light closing ceremony will be held in Merida, Mexico, on February 4-6, 2016 (http://www.iyl2015closing.org). Participation is by invitation, through country members of the International Commission of Optics and other international institutions. *(G.C. Righini will be participating as one of the Italian representatives)*
IYL2015 activities, however, will continue afterwards; as an example, due to the large number of requests to organize events beyond 2015, the French National Committee has decided to extend the IYL 2015 celebrations in the country until 30 June 2016.
TC20, accordingly, proposes to complete the development of the app for tablets on "Glass and Light" by the same date, namely 30 June 2016, also considering that the aim is to explain young people what glass is and how important it is in the everyday life, and, as such, is always valid.
TC20, therefore, asks CTC and SteCom of ICG to be allowed to use in 2016 the grant of 4,767 €, which had been approved in 2015.

c) preface to the Special Issue of Journal of Luminescence - Light, Energy and Life
- attached -

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journal homepage: www.elsevier.com/locate/jlumin

Editorial

Special Issue on Light, Energy and Life

On 20 December 2013, the UN General Assembly 68th Session proclaimed 2015 as the **International Year of Light and Light-based Technologies (IYL 2015)**. UNESCO, the United Nations Educational, Scientific and Cultural Organization, has since taken many initiatives to celebrate IYL 2015, jointly with many other worldwide public and private bodies. The main aim of UN and UNESCO was to highlight to the citizens of the world the importance of light and optical technologies in their lives, for their futures, and for the development of society. IYL 2015, which opened with a ceremony in Paris on 19–20 January 2015, will be brought to an official close with another ceremony, to be held 4–6 February 2016 in Mérida, Mexico, which is close to the Mayan Archaeological Site of Chichen Itza and to El Caracol, one of the earliest astronomical observatories.

The phenomenon of emission of light has certainly been a central topic in many of the events celebrating IYL2015 (the interested reader can look at http://www.light2015.org to get a list of past and future events worldwide). Among the several light-emitting processes occurring in nature, luminescence is one of the most interesting, as it has to do with the study and application of electronic excited states of different systems, crystalline, amorphous, or liquid. It is a complex field, which involves different branches of physics and chemistry. Luminescence is also very important to obtain information about the structure of materials and biological processes. It was therefore quite obvious to involve the Journal of Luminescence in the celebrations of IYL2015 and to propose the present Special Issue (S.I.) on Light, Energy and Life.

By choosing this theme for the S.I., the scope of the guest editors was to collect reviews and original scientific contributions which could effectively highlight the importance of luminescence phenomena and of luminescent materials in three very relevant areas:

- Light, e.g. concerning luminous sources and amplifiers, lighting devices and displays;
- Energy, e.g. concerning frequency conversion phenomena to be exploited in solar cells, and energy saving thanks to advanced LEDs or other lighting devices;
- Life, e.g. concerning fluorescence techniques for bio-imaging but also bio-sensing and medical diagnostics and therapy.

As a result, this special issue presents 19 papers, which provide a comprehensive picture of the progress achieved on different aspects of luminescent materials, of luminescence spectroscopy, and of light sources, from basic science to synthesis and application. Most of the papers are closely related to photoluminescence processes and to the characterization of materials suitable as LED-pumped phosphors or for up- and down-conversion devices or for radiation sensing. A few others are more focused on synthesis processes of rare-earth-doped materials, and on the peculiar properties of activated microresonators. Some of the articles in this issue have been written as a result of invitations by the guest editors, and cover topics such as the first demonstration of the generation of a flat-top beam from a microchip laser, the amplification of luminescence by copper nanoparticles, a review of persistent luminescence for bio-imaging, the use of lanthanide luminescent bioprobes as tools in bioanalysis and bioimaging.

We wish to thank the Editor-in-Chief, Marco Bettinelli, for supporting our proposal and the staff of the Journal for helping us and facilitating the completion of this issue.

The support of the Technical Group TC-20 “Glasses for Optoelectronics” of the International Commission on Glass is also gratefully acknowledged.

We hope that the readers of Journal of Luminescence will find this special issue to be timely and relevant to their current research activities.

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