10th ICG MONTPELLIER SUMMER SCHOOL

GLASS FORMATION, STRUCTURE, AND PROPERTIES
&
BIO GLASS / PHARMA GLASS

2-6th July 2018 - MONTPELLIER, FRANCE

Scientific Program

BASIC GLASS SCIENCE

	Monday	Tuesday	Wednesday	Thursday	Friday
8h30	Introduction to the Course/ICG (JP)				
8h45	Glass colour and redox chemistry. Optical absorption and colour coordinates. Very transparent glasses for PV, telecoms (**J. Parker**)	Structure : Neutron and X-ray diffraction. (**R. Vacher**)	Glass ceramics (I): Nucleation and cristallization (**J. Deubener**)	Modelling (I): atomistic simulations (**A. Takada**)	Heat Transfer in Glass-Forming Melts (**M. Choudhary**)
9h45	Thermodynamics of glasses I :One-component and multicomponent glasses (**R. Conradt**)	NMR in silicates glasses (I) (**P. Florian**)	Glass ceramics (II): Applications (**J. Deubener**)	Vibrations (I): basics of IR absorption, Brillouin and Raman scattering. (**B. Hehlen**)	Surface, waste confinement & durability (**R. Hand**)
10h45	**Coffee break**	**Coffee break**	**Coffee break**	**Coffee break**	
11h00	Ion exchange. Diffusion profiles, particle growth. Mechanical and optical properties (**J. Parker**)	NMR in silicates glasses (II) (**P. Florian**)	Mechanical properties of glass (I) (**J.C. Sangleboeuf**)	Modelling (II): Bridging between macroscopic and microscopic phenomena (**A. Takada**)	Surfaces and thin films for future applications (**K. Bange**)
12h00	Thermodynamics of glasses II : Example Chemical Durability (**R. Conradt**)	Glasses prepared by containerless processing (**H. Inoue**)	Mechanical properties of glass (II) (**J.C. Sangleboeuf**)	Vibrations (II): relation with glass structure & properties (**B. Hehlen**)	The Application and Development of New Glass in New Energy Industry (**S. Peng**)
13h00	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
14h30	Students describe their own research activities (5 min /person).	Project assignments & start project workshops	Tutorials (see list)	Tutorials (see list)	Student Presentation of projects
15h00			Project workshops	Project workshops	
17h45	Overview of bioglass (**D. Brauer**)	17h00 Glass dissolution in bio-fluids (**R. Conradt**)			
19h00	**Evening welcome reception**				**Dinner - Exhibition 10th anniversary**

GLASS APPLICATIONS : Bio & Pharma Glass

	Monday	Tuesday Bioglass (I)	Wednesday Bioglass (II)	Thursday Glasses for Pharma uses	Friday
8h30	Introduction to the Course/ICG (JP)				
8h45	Glass color and redox chemistry. Optical absorption and color coordinates. Very transparent glasses for PV, telecoms (**J. Parker**)	Structure/property relationships (**R. Hill**)	Phosphate and borate biomedical glasses (**D. Brauer**)	Introduction (**M. Guglielmi**)	Heat Transfer in Glass-Forming Melts (**M. Choudhary**)
9h45	Thermodynamics of glasses I :One-component and multicomponent glasses (**R. Conradt**)	Clinical applications (**L. Hupa**)	Composites (**A. Boccaccini**)	Production Processes (**D. Zuccato**)	Surface, waste confinement & durability (**R. Hand**)
10h45	**Coffee break**	**Coffee break**	**Coffee break**	**Coffee break**	**Coffee break**
11h00	Ion exchange. Diffusion profiles, particle growth. Mechanical and optical properties (**J. Parker**)	Bioinert glass-ceramics (**A. Goel**)	Soft Tissue applications (**A. Boccaccini**)	Chemical properties (**D. Zuccato**)	Surfaces and thin films for future applications (**K. Bange**)
12h00	Thermodynamics of glasses II : Example Chemical Durability (**R. Conradt**)	Bioactive glass-ceramics (**A.Goel**)	Dental applications (**R. Hills**)	Mechanical properties (**M. Guglielmi**)	The Application and Development of New Glass in New Energy Industry (**S. Peng**)
13h00	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
14h30	Students describe their own research activities (5 min /person)	Project assignments & start project workshops	Tutorials (see list)	Tutorials (see list)	Student Presentation of projects
15h00			Project workshops	Project workshops	
17h45	Overview of bioglass & TC04 (**D. Brauer**)	17h00 Glass dissolution in bio-fluids (**R. Conradt**)			
19h00	**Evening welcome reception**				**Dinner - Exhibition** **10th anniversary**

TUTORIALS

"Under the pine trees"

Glass and phase diagrams - quantitative treatment of multicomponent systems: assessment of glass properties (thermal, mechanical, chemical), approach to structural features & approach to the energetics of glass melting - How to identify the positions of complex glasses in phase diagrams.

Calculating Raman activities : activity of the Raman modes in crystals for a given symmetry and scattering geometry - Molecular selection rules of simple liquids - the case of glasses.

Diffusion coefficient: Values of D, examples. Activation energies. Balance of D *vs* stress relaxation in ion exchange toughening: Optimum temperature range. Significance of $(Dt)^{1/2}$. Examples of time and distance *e.g.* tin bath depth, chemical toughening, chemical durability effects at room T. Crystal growth, nucleation, coarsening.

Practical aspects on atomistic simulations: how to calculate atomic structures and mechanical, transport and optical properties by simulations.

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International Commission on Glass

LIST OF LECTURERS

K. Bange	Owner of the MK Consulting GmbH	Germany	*Klaus.bange@live.de*
A. Boccaccini	University Erlangen-Nuremberg	Erlanden - Germany	*aldo.boccaccini@ww.uni-erlangen.de*
D. Brauer	University of Jena	Jena - Germany	*delia.brauer@uni-jena.de*
M. Choudhary	President ICG	Reynodsburg (Ohio) - US	*mchoudhary61@gmail.com*
R. Conradt	Aachen University & uniglassAC GmbH Co.	Aachen - Germany	reinhard.*conradt@gmail.com*
J. Deubener	Technishe Universität Clausthal	Clausthal-Zellerfeld, Germany	*jd@tu-clausthal.de*
P. Florian	CEMHTI-CNRS	Orleans - France	*Pierre.florian@cnrs-orleans.fr*
A. Goel	Rutgers University	New Brunswick - US	*ashutoshgoel81@gmail.com*
M. Guglielmi	Dipartimento di Ingegneria Industriale	Padova - Italy	*massimo.guglielmi@unipd.it*
R. Hand	University of Sheffield	Sheffield - UK	*r.hand@sheffield.ac.uk*
B. Hehlen	Université de Montpellier	Montpellier - France	*bernard.hehlen@umontpellier.fr*
R. Hill	Queen Mary, University of London	London - UK	*r.hill@qmul.ac.uk*
L. Hupa	Abo Akademi University	Turku - Finland	*leena.hupa@abo.fi*
H. Inoue	IIS - University of Tokyo	Tokyo - Japan	*inoue@iis.u-tokyo.ac.jp*
J. Parker	University of Sheffield	Sheffield-UK	*j.m.parker@sheffield.ac.uk*
J.-C. Sangleboeuf	Institut de Physique de Rennes	Rennes - France	*jean-christophe.sangleboeuf@univ-rennes1.fr*
S. Peng	Triumph-International ltd	Shanghai - China	*pengshouchina@hotmail.com*
A. Takada	Asahi Glass	Yokohama - Japan	*Akira-takada@agc.com*
R. Vacher	Université de Montpellier	Montpellier - France	*Rene.Vacher@umontpellier.fr*
D. Zuccato	Nuova Ompi a Stevanato Group Company	Padova - Italy	*daniele.zuccato@stevanatogroup.com*

International Commission on Glass

ABSTRACTS

&

BIOMETRICS

Klaus Bange

Head of MK Consulting GmbH
Germany

Bio:

Dr. Klaus Bange (69) attained his diploma in physics in 1980 and his Ph.D. in 1982 at the Technical University in Berlin. Afterwards he was employed by the Fritz-Haber-Institute of the Max-Planck-Society in Berlin and by the National Bureau of Standards in Washington D.C. (USA). His special scientific interests were surface science, electrochemistry, semiconductors, and thin films.

In 1984, he changed to the SIEMENS AG in Berlin, where he was responsible for the process development of thin films. In 1987 he became employed by SCHOTT Glas in Mainz and took over various tasks related with the characterization and development of thin films for "Electrochromic Devices". He headed the departments "Electron Microscopy and Thin Films Analysis" and "Solid State Analysis". From 1997 he succeeded in building up the profit center "Analysis Measurement Services", which marketed the scientific services of 90 employees within the Schott group as well as externally. From 2001 he was heading "Luminescence Technology", which was an independent unit of SCHOTT Spezialglas GmbH. In the time from 2005-2010 he had been “Senior Principal Scientist” for SCHOTT AG. He is now retired but still active as an R&D consultant and owner of the MK Consulting GmbH.

His scientific achievements have been published in over 130 articles and books. For the "International Commission on Glass" (ICG) he was chairman of the TC 19 (Glass Surface Diagnostics), vice-chairman of the "Coordinating Technical Committee" (CTC) and from 2004-2009 he was Chair of the CTC; from 2010-2015 he was Chair of the “Advisory Committee”. For the „Deutsche Glastechnische Gesellschaft“ (DGG) he was organizing the „DGG Glas Forum“ from 2004-2009.

More details you can find at https://www.linkedin.com/in/klaus-bange-20a35831/

Abstract: **Surfaces and thin films for future applications**

The manifold characteristics of glass surfaces possess an increasing significance for the commercialization of products made of glass and their technological importance rises, i.e. the nature of the surface and their modification with different processes are of considerable interest for manufacturers of glasses. Therefore, for the development of advanced and future glass products the understanding of the physics and chemistry of glass surfaces is essential. Some new functionalities, which can be created by manipulation of the glass surface region will be described, some surfaces technologies will be named and application field discussed.

Aldo R. Boccaccini

Professor of Biomaterials
Head, Institute of Biomaterials
University of Erlangen-Nuremberg
Germany

Bio:

Aldo R. Boccaccini is Professor of Biomaterials and Head of the Institute of Biomaterials at the University of Erlangen-Nuremberg, Germany. He is currently Spokesman of the Department of Materials Science and Engineering in Erlangen and also visiting Professor at Imperial College London, UK. He holds an engineering degree from Instituto Balseiro (Argentina), Dr-Ing. from RWTH Aachen University (Germany) and Habilitation from TU Ilmenau (Germany). The research activities of Prof. Boccaccini are in the field of glasses, ceramics and composites for biomedical, functional and/or structural applications. He has pioneered the development of bioactive glasses and their composites for tissue engineering. Boccaccini is the author or co-author of more than 800 scientific papers and 20 book chapters. He has co-edited five books. His work has been cited more than 24,300 times (Web of Science®) and he was named in the 2014 Thomson Reuters Highly Cited Researcher list. His achievements have been recognized with numerous international awards including recently the Materials Prize of the German Materials Society (2015), the Turner Award of the International Commission on Glass (2016) and the Friedberg lecture and prize of the American Ceramic Society (2016). Boccaccini is the editor-in-chief of the journal *Materials Letters* and serves in the editorial board of more than 10 international journals. He is the founder and editor-in-chief of the journal *Biomedical Glasses*. Boccaccini is Fellow of the Institute of Materials, Minerals and Mining of the UK, Fellow of the American Ceramic Society and Academic Member of the World Academy of Ceramics. He serves in the Council of the European Society for Biomaterials (ESB), in the Executive Committee of the Federation of European Materials Societies (FEMS) and in the Review Panel of the German Science Foundation (DFG). He is also an international advisor to the Ministry of Science and Technology of Argentina.

Abstract:

The combination of bioactive glasses and biopolymers to develop a variety of composites for biomedical applications will be discussed, covering i) composite design, ii) fabrication processes, iii) characterization of key properties and iv) selected applications. The course will discuss relevant aspects such as polymer-bioactive glass interfaces, biodegradation of composites in relevant biological fluids, effect on bioactive glasses on enhancing composite bioactivity and time-.dependent mechanical properties. Important applications of such composites as bioactive coatings, biodegradable implants and tissue engineering scaffolds will be addressed. The second part of the course will focus on applications of bioactive glasses (silicate, phosphate and borate) in soft tissue engineering, in particular focusing on the aspects of vascularization (angiogenesis) and wound healing. Different glass compositions which have shown applications in contact with soft tissues will be discussed. The concept of using ion doped bioactive glasses as carriers for biologically active ions will be explained with focus on the effects of such ions on cellular response, soft tissue repair mechanisms, angiogenesis/blood vessel formation (in vitro and in vivo) and as antibacterial agents. Emerging applications of bioactive glasses in soft tissue engineering and bioactive glass based products useful in wound healing will be introduced.

Delia Brauer

Professor of Bioactive Glasses
Otto Schott Institute of Materials Research
Friedrich Schiller University Jena, Germany

Bio:
Delia Brauer studied environmental chemistry with a focus on analytical chemistry. After completing her PhD on phosphate glasses at the University of Jena, she worked as a postdoctoral researcher at the University of California, San Francisco, US, Nagoya Institute of Technology, Japan, and Imperial College London and Queen Mary University of London, UK. In 2012, she returned to Jena as a junior professor at the Otto Schott Institute for Materials Research and was promoted to full professor in 2017. Her research focuses on the structure-property relationship in glasses, with a focus on degradable and highly disrupted glass systems including bioactive glasses. Delia is the designated chair of Technical Committee 04 (Bioglasses) of the International Commission on Glass and the winner of the Gottardi Prize 2015. Delia has edited one book on bioactive glasses, authored several book chapters on the topic and is an associate editor of the new journal "Biomedical Glasses", which focuses on bioactive glasses.

Abstracts:
Overview of bioactive glasses and Technical Committee 04 (Bioglasses) of the ICG
Since their development by the late Prof. Larry L. Hench in the early 1970's and their first clinical use in the mid-1980's, bioactive glasses have constantly attracted the research interest of materials scientists, biologists, tissue engineers or clinicians owing to the fascinating properties these glasses show: They were the first man-made material to form an integrated bond with bone and they also degrade over time and allow for bone to be regenerated. Bioactive glass implants release therapeutic ions which stimulate cell behaviour and can obviate the need for supplementation with growth factors. Lately, bioactive glasses have started to be increasingly successful, both clinically and commercially, and besides the use as synthetic bone grafts new uses for bioactive glasses have emerged, e.g. as remineralising additives in toothpastes.
Technical Committee 04 (TC04) of the International Commission on Glass aims to promote global visibility of biomedical glasses and stimulate collaboration between academics and industry. Examples are outreach projects, input into international standards, organisation of conference symposia, round robin studies and scientific publications including textbooks. We have recently launched a YouTube channel and a scientific journal, "Biomedical Glasses".

Phosphate and borate biomedical glasses
While silicate-based bioglasses are the most successful compositions in the field (both clinically and commercially), there are other important glass systems for biomedical applications, most notably phosphate glasses and borate glasses. Many phosphate glass compositions can dissolve completely in water, and their solubility can be varied over several orders of magnitude by changing the composition. This makes them attractive for use as controlled release devices or resorbable implants and phosphate glasses have thus attracted the interest of researchers for many years. Although their success does not nearly match that of silicate bioactive glasses, research in the field is continuing steadily, exploring options for various uses and further characterising their properties. The interest in borate bioglasses has emerged much more recently and seems to focus on soft tissue applications mostly. One composition has recently obtained FDA approval for wound healing applications in humans for treating slow-healing wounds, e.g. in patients suffering from diabetes.

Manoj Choudhary

President ICG
Reynodsburg (Ohio) – US

Bio :

Dr. Manoj Choudhary is the president of the International Congress on Glass (ICG). He received his doctorate in Materials Science and Engineering from Massachusetts Institute of Technology. Dr. Choudhary worked at Owens Corning's Science & Technology Center in Granville during Sept 1982-February 2018 and was its foremost expert in the application of engineering fundamentals, materials science, and computational approaches for process and product innovation. His contributions have were at the core of some of the most significant technology developments in Owens Corning (OC) during the past 35 years and he received OC's highest technical achievement awards multiple times. Dr. Choudhary is also a recipient of several awards and honors from outside of Owens Corning. These include Professor S. K. Nandi Gold Medal for being the best all-rounder Chemical Engineering Graduate, Institute Silver Medal for securing the first rank in Chemical Engineering (both from Indian Institute of Technology, Khargapur) and Falih N Darmara Award for excellence in academic performance, research, and extracurricular activities from the Department of Materials Science and Engineering at MIT, Arthur L. Friedberg Ceramic Engineering Tutorial and Lecture Award from the National Institute of Ceramic Engineers, Glass Service Modeling Award, and a Best Paper Award from the Glass Industry Committee of IEEE Industry Application Society. He is a Fellow of the British Society of Glass Technology, and a Fellow of the American Ceramic Society. Dr. Choudhary has also presided over several professional organizations including the Industry-University Center for Glass Research at Alfred University, the Glass and Optical Materials Division of the American Ceramic Society, and the Glass Manufacturing Industry Council. He currently serves on the Board of Directors of the American Ceramic Society and is a Specially-appointed Professor of China State Key Laboratory of Advanced Technology for Float Glass.

Abstract : **Heat Transfer in Glass-Forming Melts**

Glass manufacturing involves many complex and mutually coupled heat transfer phenomena. These include solid-melt-gas energy exchange, thermally driven free convection, heat transfer accopmnied by energy sources such as joule heating and combustion, convective heat transfer by Newtonian and non-Newtonian flows, and laminar and turbulent flows. Further, both glass and combustion gases may absorb and scatter radiation passing through them, thus making them participating media.Together, these multitude of heat transfer and related phenomena play critically important roles in glass manufacturing and impact energy efficiency, environmental emissions, process stability, furnace life, and product quality. In this lecture we will focus on analysis and simulation of heat transfer in glass melts, especially on the radiation heat transfer. The lecture will consist of three major parts. The first part will provide background information on thermal radiation in glass forming melts, and discusses the implications of using the commonly practiced Rosseland or diffusion approximation for modeling thermal radiation, especially in glass melting tanks and melt delivery channels. An overview of a more elaborate radiation model that accounts for the spectral dependence of the radiation heat flux in the melt, the Discrete Ordinates Model (DOM) will also be discussed. The second part of the lecture will review high temperature absorption spectra for glasses with a focus on measured spectra of two glass compositions used for reinforcement or composite fibers. We will also discuss the radiation conductivity values of these glasses calculated from the measured absorption spectra. The third part of the lecture will have a sample of results showing the consequences of using the DOM versus the Rosseland approach on temperature distribution in glass melting tanks and delivery channels. These results will be used to identify conditions under which the Rosseland approximation approach would be appropriate. In summary, the lecture will describe the conceptual framework for analyzing radiative heat transfer in processing of glass melts, provide engineering insights, and illustrate the application of these through simulation results.

Reinhard Conradt

Professor
Consultant through own company uniglassAC GmbH,
Aachen - Germany

Bio :

academic education:

1976	Physics (Diploma)
1981	Physical Chemistry (Ph.D.)
1996	Glass Science & Technology (Habilitation)

professoional life:

1981-1986	researcher at Fraunhofer Institute of Silicate Science, Würzburg, Germany, with Prof. H. Scholze
1986-1996	lecturer at the Department of Materials Science, Faculty of Science, Chulalongkorn University, Bangkok, Thailand
1997-2016	full professor (chair) of glass and ceramic composites at RWTH Aachen University, Aachen, Germany; retired since August 2016
since 2017	consultant through own company uniglassAC GmbH, Aachen, Germany (glass development, process analysis, professional education)

miscellaneous:

1981	Borchers Plaque of RWTH Aachen University
1986	Industry Award of the German Society of Glass Technology (DGG)
2001	International Otto Schott Research Award, Ernst Abbé Fonds
2007-2016	Chair of TC23 (education) of ICG
2011	W.E.S. Turner Award, International Commission on Glass (ICG)
since 2015	President of the German Society of Glass Technology
2017	Fellow of STG

Abstract:

THERMODYNAMICS OF GLASSES I – One-component and multi-component glasses.

Glass is a homogeneous and isotropic material characterized by the absence of any internal phase boundaries. At the atomic scale, a glass is characterized by the absence of translational order. Thus, different from most other materials, its properties are determined by chemical composition alone, not by microstructure. According to the traditional understanding, silicate glasses build a random network constituted by the nature of their atomic bonds. Their structure is described in categories of network forming vs. network modifying bonds. In the first lecture, a complementary way of description is developed. It starts from the thermodynamic paradigm that glasses are undercooled and frozen-in liquids, which is a non-equilibrium state of matter. However, its energetic and entropic differences to the corresponding equilibrium state are surprisingly small, amounting to just a fraction of melting enthalpy and entropy, respectively. The short-range order (SRO) of glasses (i.e., the nature of cation coordination polyhedra), as well as their medium-range order (i.e., the nature of linkage among these polyhedral) is – on spatial average – identical with the SRO and MRO of its isochemical crystalline counterparts, in specific: with the low-density crystalline polymorphs. This approach opens the door for a quantitative description of the macroscopic properties of glasses with simple and complex chemical composition alike.

THERMODYNAMICS OF GLASSES II – Example: Chemical Durability.

The approach developed during the first lecture is applied to a prominent and sophisticated problem, namely, the behavior of glasses in aqueous solutions. Chemical durability is one of the key properties of a glass. It is shown how the stability of a given glass composition in an aqueous solution can be predicted in an accurate way as a function of glass composition as well as the properties of the aqueous solution, chiefly, its pH value, but also many other components, comprising organics. By invoking transition state theory, an approach to glass dissolution rates is outlined.

III – Glass dissolution in biological fluids.

This lecture applies the lessons learnt in lecture II to a special field of application, namely, the behavior of glasses in fluids of the human body. The lecture starts with the challenge to define the nature of the physiological environment. Then, the design of *in vitro* experiments is addressed, mimicking the *in vivo* transport mechanisms active at the glass surface. This approach has its merits in minimizing the need for tests performed on animals. Examples refer to the surface differentiation of bioglass surfaces in the human body as well as to the dissolution of inhaled (and potentially carcinogenic) glass fibres in the human lung.

Joachim Deubener

Professor
Institute of Non-Metallic Materials
Clausthal University of Technology
Germany

Bio:

Joachim Deubener is full professor of glass science and engineering at Clausthal University of Technology, Germany since 2002. His research interest is on the dynamics and phase transformations in glasses and on the technologies of thin (sol-gel) and thick (enamel) glass films. He published over 120 peer reviewed articles on the field of glass science. He serves on several boards and committees, inter alia for the ICG (Chairman of the TC07 *Crystallization and Glass-ceramics*), the European Society of Glass Technology (council), the German Enamelling Society (scientific director), J. Appl. Glass Sci. (associate editor), Front. Mater. (associate editor) and J. Non-Cryst. Solids (editorial advisory board). He is awardee of the Vittorio Gottardi Memorial Prize (ICG 2002) and of the Otto Schott Research Award (Ernst Abbe Fonds 2012).
Joachim Deubener studied applied mineralogy at TU Darmstadt and finished his doctorate in material science at TU Berlin in 1994. He did his post-doc research at the University of Arizona and taught at the Stanford University Overseas Campus in Berlin. In 2002 he received his habilitation degree in inorganic non-metallic materials from TU Berlin.

Abstract:

Glass-ceramics are defined as inorganic, non-metallic materials prepared by controlled crystallization of glasses via different processing methods. They contain at least one type of functional crystalline phase and a residual glass. The volume fraction crystallized may vary from ppm to almost 100%.
The course introduces to the underlying transformation kinetics of crystal nucleation and growth and sheds light on the evolution of microstructure, which serves for the desired property portfolio of glass-ceramics. The second part, shows established and emerging processing methods and highlights applications of glass-ceramics, which are noted for their unusual combination of properties and manifold commercialized products for consumer and specialized markets.

Pierre Florian

Research Ingineer,
Conditions Extrêmes et Matériaux : Haute Température et Irradiation (CEMHTI) - CNRS
Orléans - France

Bio:

Pierre Florian is a specialist of Solid-State Nuclear Magnetic Resonance (SSNMR) spectroscopy. His research focuses on the application of the state-of-the-art SSNMR methods to material science and in particular to the characterization of structural and/or chemical disorder. He also has a long standing experience in very-high temperature NMR, up to 2400°C.

He currently holds a position of site manager at the CEMHTI laboratory (CNRS Orléans, France), handling a group of 3 engineers and 6 spectrometers including two very high fields (750 and 850 MHz) part of the french NMR delocalize infrastructure IR-RMN THC for which he is the local contact in charge of a total of more than 300 days of access per year on the NMR platform.

Abstract:

NMR in silicate glasses

We will first briefly recall the basic principles of Nuclear Magnetic Resonance spectroscopy, using a classical formalism. The specificity of this technic when applied to Solid-State will then be exposed, emphasizing the experimental conditions required, the known issues such as sensitivity and the description of two-dimensional NMR.

In a second part, we will illustrate the type of information that can be recovered from NMR in the case of glassy materials. Examples will be given from studies performed on oxides, silicates, alumino-silicates and phosphates glasses. In the course of this overview, various one- as well as two-dimensional technics will be presented along with their use to quantify the short- and medium-range chemical and structural disorder present in glasses.

Ashutosh Goel

Rutgers, The State University of New Jersey, USA

Bio:

Dr. Ashutosh Goel is a materials scientist with experience in academia, industry and national laboratory. He obtained his Ph.D. on glass/glass-ceramic sealants for solid oxide fuel cells from University of Aveiro, Portugal in 2009. At present he works as an Assistant Professor at Department of Materials Science and Engineering, Rutgers, The State University of New Jersey, USA. His research is focused in the field of glass corrosion and crystallization. In the field of bioactive glasses, his research is directed towards understanding the structural drivers governing the dissolution behavior of oxide based bioactive glass chemistries in aqueous solutions relevant for biological applications. A recipient of 2017 Vittorio Gottardi Prize awarded by International Commission on Glass (ICG), Dr. Goel is an inventor on two patents and author/co-author of more than 70 research articles in the field of glasses and ceramics. He is a member of ICG's technical committee on biomedical glasses (TC-04) and secretary of "Bioceramics" division of the American Ceramic Society (ACers). He is also an Associate Editor of the International Journal of Applied Glass Science (Am. Ceram. Soc.), and Frontiers in Materials (Nature Publishing Group), while he serves on the editorial board of the journal "Biomedical Glasses" (official journal of TC-04).

Abstract:

Design of glass-ceramics for biomedical applications

The design of glass-ceramics for biomedical applications encompass both bio-inert and bioactive materials. Accordingly, the lecture will be divided into two parts where the first part of the lecture will focus on design and development of bio-inert glass-ceramics primarily for dental applications, while the second part of the lecture will focus on design and development of bioactive glass-ceramics for application in bone regeneration and tissue engineering.

Massimo Guglielmi

Professor of Materials Science and Engineering
Department of Industrial Engineering
University of Padova, Italy

Bio:

Degree in Chemical Engineering at the University of Padova in 1979.
Researcher in 1983. Associate Professor of Applied Chemistry in 1987. Full Professor of Materials Science and Technology in 2000.
Teaching activity in the fields of Materials Science and Engineering and of Ceramics.
Has been member of the Academic Senate of the University of Padova.
Head of the Department of Industrial Engineering at University of Padova.
Author or co-author of more than 290 publications.
Awarded in 1992 with the Gottardi Prize.
Chairman of the Technical Committee 12 "Pharma Packaging" of the International Commission on Glass.

Main topics of research have been: Surface phenomena in glasses due to chemically or physically induced modifications; synthesis of glasses and ceramics by chemical routes through sol-gel method, their characterization and application; deposition of thin inorganic coatings by the sol-gel method, their characterization and application. The research activity of the last years was aimed to exploit the possibility to apply the sol-gel techniques to the synthesis of nanocomposite and nanostructured materials.

Abstracts:

Introduction to glasses for pharma uses

The first lecture will introduce glasses for pharma uses. Glass is the best material for the storage of delicate pharmaceutical drug products. However, as the market needs for pharmaceutical glass containers (ampoules, cartridges, syringes, vials) increase, the requirements in terms of mechanical resistance, chemical durability, production flexibility and costs become more and more stringent. The composition of glass, as well the manufacturing processes, have been changing over the years to fulfil the requirements of the Pharma Industry, and the efforts to optimize both are far to be at the end. An introductory overview of the type of glasses used and of the production processes will be given, leaving to the other three lectures a more detailed description of specific topics.

Mechanical properties of glasses for pharma uses

This will be the final lecture on glasses for pharma uses. It will deal in particular with the mechanical resistance of pharmaceutical glass containers. A short review of the principles of brittle fracture will be recalled. Then the problems that might arise from the production processes will be discussed, along with the solutions adopted to minimize the risks of breaking. Testing methods will also be discussed.

Russell J Hand

Professor of Glass Science & Engineering
University of Sheffield, UK
Immediate past-President of the Society of
Glass Technology, UK

Bio:

Russell Hand obtained his first degree and PhD in Physics from the University of Cambridge. After a 1 year Post-Doc in Cambridge he moved to the now Department of Materials Science and Engineering, at the University of Sheffield in 1989, as the Redland Research Fellow. He was appointed to a Lectureship in 1990 (Senior Lecturer 2001; Reader 2010; Professor 2012) and in 1999 obtained an MEd in Teaching and Learning for University Lecturers. His research interests are focussed on the mechanical properties of glasses, radioactive waste vitrification and the durability and vitrified wasteforms. Between 2014-2017 Russell was President of the Society of Glass Technology. He is also a member of Technical Committeee 5 (Waste Vitrification), 6 (Mechanical and Nanomechanical Properties of Glass) and 23 (Education) of the ICG.

Abstract:

Mechanical properties of glasses

Glasses are well known as brittle materials with low fracture toughnesses that are flaw sensitive. This has implications for both how we measure the mechanical properties of glasses and also in how we attempt to modify those properties, whether through residual stresses, coatings or even compositional variation. Environmental interactions can also significantly affect the near surface mechanical properties of glasses. In the first lecture I will concentrate on examining on what we can measure, what has to be taken into consideration in making those measurements, and what those measurements reveal to us. Thus material properties such as toughness, hardness and modulus will be considered along with specimen properties such as strength. In the second lecture I will concentrate on examining the techniques used to improve the mechanical performance of glasses as well as the intriguing relationships between mechanical properties and composition that have been identified.

ICG International Commission on Glass

LABORATOIRE CHARLES COULOMB MONTPELLIER

Bernard Hehlen

Professor
Department of Physics
University Montpellier - France

Bio:

Pr. Dr. Bernard Hehlen (49) obtained a doctoral degree (Ph.D) from the University of Montpellier in 1995. His Ph.D work, initiated by K.A. Müller (Nobel laureate 1987), concerned the possibility of a novel coherent quantum state in the prototypical ferroelectric system $SrTiO_3$. He obtained an EC grant for a post-doctoral fellowship position in Oxford (UK) at the Clarendon Laboratory. He had to resign his contract in 1996 when he got a position of teacher and researcher at the 'Laboratory of Glasses' in Montpellier. He became Professor in Physics in 2004. His scientific activity concentrates on the structural and vibrational properties of disordered systems, including glasses, ferroelectrics and relaxor materials. He is an experimentalist, working on neutron and X-Ray scattering at large facilities and light scattering experiments.
He was member of the scientific board of the 'inelastic- scattering' group at the neutron scattering center in Grenoble (ILL, 2000-2004). Between 2007 and 2013 he was heading a regional platform gathering Brillouin, Raman, hyper-Raman, and Infrared absorption spectrometers. He is currently chairman of TC26 'Vibrations and Glass Structure' at the International Commission on Glass (ICG), coordinator of the cluster "Basic Science", and member of the TC23 'Education'. From 2005 to 2014 he was responsible of a Master degree in 'condensed matter Physics' then "Nanophysics" at the University of Montpellier.
His scientific achievements have been published in 56 articles in peer-revue journals and books, and give rise to 59 oral communications including 18 on invitation by the organization committee. In 2004 he has been laureate of the Gottardi prize awarded by the ICG, for the construction of a hyper-Raman scattering spectrometer devoted to the study of glasses.

Abstract:

Atomic vibrations in glasses: basics & relations to glass structure

An introduction to the linear response theory will allow first to define the concepts of susceptibility, fluctuation spectra, auto-correlation functions, etc., and to link these quantities to the experimental data through the fluctuation-dissipation theorem. In a second step, we will treat the origin of the light scattering giving rise to the Raman and Brillouin selection rules. The latter will be exploited to relate the experimental observations to the local and medium range structure of oxide glasses taken in the family of silicates, borates and aluminosilicates.

Robert Hill

Chair of Dental Physical Sciences
Barts and the London QMUL
And
Research Director BioMin Technologies Ltd

Bio:

Professor Robert Hill obtained his PhD under the direction of Dame Julia Higgins FRS at Imperial College in 1984. His PhD was on Spinodal Decomposition in Polymer Mixtures. After completing his Ph.D he worked with Dr Alan Wilson at the Government Chemist on Glass Ionomer Cements where he developed an interest in Glass. He moved from Imperial College where he was Professor of Biomaterials to QMUL in 2009. He has published over 260 refereed papers of which more than 70 are on bioactive glass. He has filed over 20 patents. He is the inventor of Serenocem® a cement for sticking Cochlear impants in place as well as a number of bioactive glass based toothpastes including BiominF, Hydent Pro®, Elsenz®, BioMinC® see www.biomin.co.uk as well as a nano hydroxyapatite toothpaste. He won the Queens Award for Technological Achievement in 1988, the Alan Wilson Award for Dental Materials in 2013 and the Amourers and Brasiers Venture Award in 2013. In the last ten years the focus of his research has ben on structure-property relationships in bioactive glass, with a particular focus on high phosphate fluoride containing glasses.

Abstract :

Bioglass I: Structure Property Relationships

This presentation will deal with the structure of bioactive glasses (BGs) and the relationship to properties. This will include Network Connectivity as a predictor of bioactivity. The use of solid state NMR for exploring the structure of BGs will be reviewed. This will be then followed by how phosphate magnesium, strontium fluorine and chlorine influence the structure and how this influences the properties of the BG. The final part of the talk will focus on how a knowledge of glass structure and properties can be used to design BGs for different specific applications.

Bioglass II: Dental Applications

This talk will briefly outline tooth structure and the causes of tooth decay periodontal disease and dentine hypersensitivity. The use of Perioglass for the treatment of Periodontal disease and the use of BGs for filling aveolar sockets after tooth extraction will be covered. However the main focus of applications of BGs in dentistry will be in regard to their use in toothpastes for remineralization and treating dentine hypersensitivity.
The final part of the talk will deal with BGs for cutting and polishing teeth and their use in composite tooth fillings with which to replace traditional dental amalgam.

Leena Hupa

Åbo Akademi University
Turku, Finland

Bio:

Dr. Leena Hupa obtained her Ph.D. in Chemical Engineering at Åbo Akademi University in 1987. Her Ph.D. thesis was on aluminous raw materials in glass melting. At present, she works as Professor of Inorganic Chemistry and Leader of the Combustion and Materials Chemistry group in the Johan Gadolin Process Chemistry Centre at Åbo Akademi University. Her research deals with high-temperature processes and properties of high-temperature materials for biomedicine, bioenergy, and circular economy applications. She is co-author of more than 150 scientific papers and several book chapters dealing with bioactive glasses.

Abstract:

Clinical applications of bioactive glasses

This lecture focuses on the utilization of bioactive glass particles to heal bone defects and to treat chronic infections in orthopedic surgery. Several present commercial applications of bioactive glasses have been based on the ability of the glasses to form an apatite-like surface layer, bond to bone and to induce antibacterial effect around the dissolving glass. This lecture discusses the choice of bioactive glasses for various applications and introduces some long-term clinical findings of various bioactive glass containing products used in orthopedics and cranial surgery.

Hiroyuki Inoue

Professor
Institute of Industrial Science,
The University of Tokyo
Tokyo, Japan

Bio:

Academic education:

1982	Applied Chemistry (Diploma)
1987	Industrial Chemistry (Doctor of Engineering)

Professional life:

1987-1989	Research Assistant, Metropolitan University, Tokyo
1989 - 1993	Research Assistant, The University of Tokyo
1993 - 1997	Lecture, The University of Tokyo
1997 - 2005	Associate Professor, The University of Tokyo
since 2005	Professor, Department of Materials and Environmental Science, Institute of Industrial Science, The University of Tokyo

Miscellaneous:
2007 - 2015 Member of TC23 "Education", ICG
Since 2011 Member of TC27 "Atomistic Modeling and Simulation of Glass", ICG
2016 Chair of Coordinator Technical Committee (CTC)
2017 Chair of Glass Division of Ceramic Society of Japan.

Abstract:

Glasses prepared by containerless processing

By using containerless processing, we can obtain glasses in a wider range than the conventional melting and quenching method. Among these glasses, glasses showing characteristic physical properties have been found. For example, some glasses show high refractive index, such as 2.3. The refractive index of glass is related to the packing density and the electronic polarizability of the atoms in the glass. Let’s obtain these parameters and compare them with those in the conventional glasses. Also, some glasses show high young’s modulus, such as 160 GPa. Young’s modulus of glass is related to the packing density and dissociation energy of the constituents. Let us consider these physical properties and the fundamental physical properties of the glasses.

John Parker

Emeritus Professor
Department of Material Science and Engineering
University of Sheffield - UK

Bio:

Emeritus Professor Parker began his University Education at the University of Cambridge in 1964 where he studied for 8 years, obtaining an MA in Natural Sciences, a PhD in Earth Sciences and 2 years post-doctoral experience. From there he moved to the University of Sheffield to teach Glass Technology (1971-2009). His teaching and research interests have covered a wide spectrum but specifically have included optical fibres, dental cements, defects in glass making, structure and optical absorption. Although now formally retired he still teaches in Sheffield. He is also heavily involved in the Society of Glass Technology and in ICG, particularly its Coordinating Technical Committee, Web site, and Winter/Summer Schools. He writes a monthly article for Glass International on History of Glass Making and is Curator of the Turner Museum of Glass, giving frequent talks on the collection, its history and art.

Abstract:

Transport properties

Diffusion underpins the kinetics of many glass making processes. This talk will look at mathematical descriptions of diffusion and how experimental results can be obtained and interpreted. We will also examine the factors affecting diffusion coefficients and what happens when more than one species is mobile. Finally we will examine in greater depth ion exchange processes used in generating toughened glasses and optical waveguides.

Colour and redox processes

This talk will give an overview of the generation and control of colour in glass, including measurement techniques. The effect of the interaction between active ions and the local structural environment will be considered. Many of the transition metal ions used in colouring glass have more than one oxidation state and the importance of redox reactions in glass making will be stressed.

Shou Peng

President of China Triumph International Engineering Co., Ltd.

Director of China National Key Laboratory of New Technologies for Float Glass and China Glass Development Center – China

Bio:

Peng Shou, professor-level senior engineer and doctoral supervisor, born in 1960 in Tongcheng, Anhui Province, is the State Council Expert for Special Allowances in China. He has been devoted to the development of glass industry for more than 30 years, since graduating from Silicate Materials Science and Engineering Department of Wuhan University of Technology in 1982. He is president of Advisory Committee and Steering Committee member of the International Commission on Glass, director of China National Key Laboratory of New Technologies for Float Glass and China Glass Development Center, board chairman and president of China Triumph International Engineering Co., Ltd.

In China, Prof. Peng is widely known as the leader of Chinese float glass industry and the pioneer of photoelectric glass engineering. He has won many honors and titles which include the 2016 Presidents Award of the International Commission on Glass which recognizes outstanding lifetime contributions to the international glass community, two China National Scientific and Technological Progress Awards, four Scientific and Technological Progress Awards of Shanghai, China National Guanghua Engineering Science and Technology Award, Gold Prize of National Excellent Engineering Design Award, National Engineering Survey & Design Master Title, The First Group of National Candidates of “New Century Talents Project” Rated by Seven National Ministries, China Outstanding Scientific and Technological Worker etc. He presided over the development of a series of major innovation accomplishments with independent intellectual property rights. He compiled three monographs and published more than 50 papers.

Jean-Christophe Sangleboeuf

Professor of Mechanical Engineering
Mechanics and Glasses Department
Institute of Physics of Rennes
University of Rennes – France

Bio :

Pr. Dr. Jean-Christophe Sangleboeuf obtained his PhD in Mechanics of Materials from Ecole Polytechnique in 1998. His PhD was on the multiscale approach of the mechanical behavior of Ceramic Matrix Composites. He got the same year a teacher and researcher position at the « Glass and Ceramics Laboratory » in the « Mechanics of Brittle Materials » group - Rennes. With Tanguy Rouxel he established the « Applied Mechanics Laboratory of Rennes – LARMAUR » in 2000 and became Professor in Mechanical Engineering in 2006. After being director of the LARMAUR from 2010 to 2013, he transformed this laboratory into the « Mechanics and Glasses Department » of the Institute of Physics of Rennes – IPR in 2014. He is the director of the IPR since 2017.
His research interests are focussed on mechanical properties of glasses and in particular surface damage of glasses in connection with their composition, residual stresses and environmental conditions. He developped several scratching devices and also numerical modelling. During the past ten years he did a lot on photoinduced effects on chalcogenide glasses and above all photofluidity. He is now studying dynamical behavior of glasses under impact or shock under very high strain rate (from 10^3 to $10^7.s^{-1}$).
He has been member of the scientific comitee of the national research network on glasses during 8 years and he is member of the Executive Board of the « Union pour la Science et la Techonologie Verrières - USTV ».

Abstract :

Mechanical properties of glasses

Glass is a brittle material with a fracture behavior governed by surface flaws. Basic concets will be given on mechanical properties such as elasticity, « plasticity » and viscosity. Strength will be an issue after having discussed about Linear Elastic Fracture Mechanics, toughness, scratching, effects of environment and loading rate. The implication of flow of glass under point loading will be discuss in terms of densification and shear behavior, experimental or numerical approches. A focus will be done on how increase strength playing with composition/microstructure or residual stresses superimposition.

Akira Takada

Asahi Glass Company
Yokohama - Japan

Bio:

After graduating from Tokyo University at which I studied applied mathematics, I joined Asahi Glass Company. I have been performing a variety of computer simulations of macroscopic and microscopic phenomena on glass. My recent major concern is to construct a bridge between microscopic (glass structure) and microscopic phenomena (glass properties) on glass. I am joining the activities of TC-3 (Glass Structure) and TC-27 (Atomistic modelling and Simulation) under ICG. In addition, I have a research project at University College London as a visiting professor.I served as a president at the Japan Society of Industrial and Applied Mathematics (JSAM; a number of member is about 1,700) in 2013-2015. I am a member of Science Council of Japan. I am Fellow of JSIAM and Fellow of SGT (Society of Glass Technology).

Abstract:

Bridging between macroscopic and microscopic phenomena

For the former half of career, I undertook the task of modeling macroscopic phenomena such as heat exchanger, glass melt flow and vico-elastic deformation of glass. In those days no commercial software codes were available and I had to develop my own codes. Appropriate mathematical modelling is essential, however, it is also important to presume appropriate initial and boundary conditions as well as material properties for simulation. More challenging aspect is that material properties are non-linearly depenant on chemical conposition, temperature profile and etc.
.For the latter half of my career, I have devoted to microscopic phenomena in order to design glass materials. Microscopic simulation techniques such as molecular dynamics simulation and ab initio simulation have well-founded theories, but only small space-scale and short time-scale behaviors of material can be tackled with due to the requirement of a huge computation time. Several approaches to bride between macroscopic and microscopic phenomena are discussed in my lecture.I believe numerical modeling will contribute to discover wonderful treasure islands in the field of glass science and technology!

International Commission on Glass

LABORATOIRE CHARLES COULOMB MONTPELLIER

René Vacher

Emeritus Professor
Department of Physics
University Montpellier - France

Bio:

René Vacher was born in 1943. He is Emeritus Director of Research at the French « Centre National de la Recherche Scientifique (CNRS) ». He has been working in the field of Physics of glasses for more than 40 years. His main research activities concern the structure, the vibrational dynamics, and the elastic properties of glasses. He is also well known for his contributions to the Brillouin spectroscopy of light in solids, to the inelastic neutron spectroscopy of glasses, and to the structure and dynamics of aerogels.

He is (co-)author of 150 papers in journals with peer review and chapters in books, and 70 articles in conference proceedings. He has directed 15 PhD. Students.

He was director of the « Laboratory of glasses » in Montpellier, France, from 1982 to 1998, Head of Physics department from 1999 to 2002 at the University of Montpellier. From 1992 to 1999, he was director of the CNRS « Groupement de Recherche Physique des Verres ».

He was chairman of the conference « Glass Odyssey », annual meeting of the International Commission of Glasses (ICG) in 2002 and of the « Third European Conference on Neutron Scattering » in 2003, in Montpellier. He chaired the scientific committee of the Internal Congress on Glass held in 2007 in Strasbourg, France. From 2009 to 2016, he was chairman of the Coordinating Technical Committee of the International Commission on Glass.

ICG International Commission on Glass

LABORATOIRE CHARLES COULOMB MONTPELLIER

Daniele Zuccato

Core Team Leader – Scientific Research Management
Nuova Ompi a Stevanato Group Company
Piombino Dese, Padova - Italy

Daniele Zuccato achieved his Master Degree in Industrial Chemistry at Venice Cà' Foscari University in the framework of a collaboration project with the National Research Council Institute on the speciation of heavy metals in foodstuffs with HPLC-ICP-MS hyphenated techniques.
In 2009, he joined the R&D Glass Division of the Stevanato Group as project leader of the investigation studies on the migration of trace elements from the glass surface, following and coordinating from the very beginning the startup of the SGlab and assuming the position of Core Team Leader, in charge of the physicochemical improvement of pharmaceutical glass primary packaging.
Dr Zuccato is member of ISO TC76/WG2 and secretary/ member of TC 12 “Glasses for Pharma” of the International Commission on Glass.
To contact Daniele Zuccato you can email him at daniele.zuccato@stevanatogroup.com

Abstracts

Production Processes

This lecture will focus on the current glass production processes of glass containers for pharmaceutical use.
An overview of the available containers formats, and the relative market trends, will be presented together with the Pharmacopeial requirements of glasses for pharmaceutical use. Then the lecture will focus deep in details on the production processes needed to produce containers in compliance with both market and regulatory requirements.

Chemical Properties of glasses for pharma use

In this lecture the significant chemical interactions between the container inner surface and the enclosed therapeutic agents will be reviewed, with some considerations from the perspective of glass manufacturers. The surface interactions with the most advanced Pharmaceutical products will be also covered in order to provide some perspectives on the future of glass containers for pharma use.

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