

# SGT NEWS



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## BORATE GLASSES, CRYSTALS AND MELTS

An international conference solely dedicated to borate glasses, crystals and melts was held for only the second time in 20 years at Abingdon, UK, from 22 to 26 July 1996. The meeting reported on the progress being made in understanding the structure-property relations of borates, novel glasses and industrial and technical applications. Over 100 delegates from around the world contributed to the proceedings.

The four day conference on borates featured a Plenary Lecture by Professor Philip Bray, 11 invited papers, 45 conference papers and 12 posters. The meeting is the first since June 1977 when 36 papers were presented over four days at Alfred, New York. The subjects covered included: NMR spectroscopy; paradoxes of the vitreous state; structure, homogeneity and phase separation; spectroscopic techniques; thermodynamics of borate systems; ternary systems; non-oxide and mixed glasses; superionic and related systems; industrial and technological applications; relaxation and the glass transition; optical spectroscopy and defects; and modelling and computer simulation.

Relating property changes to the structure of glasses has been a major driving force for research for many years. Nuclear magnetic resonance (NMR) spectra of  $^{11}\text{B}$  can be used to distinguish between three and four co-ordinated boron within a glass. Professor Philip Bray of Brown

University introduced the use of this method in a paper published with Silver in 1958. In recognition of this outstanding and continuing contribution to the science of borates, the Second International Conference on Borate Glasses, Crystals and Melts was held in his honour.

Professor Bray was present to deliver the plenary lecture on NMR and nuclear quadrupole resonance (NQR) studies of borates. He described how advances in experimental techniques and theory have allowed a clear distinction between the NMR spectra of symmetric and asymmetric  $\text{BO}_3$  structural units. Bridging and non-bridging structures can therefore be identified. Recently, major improvements have been made in the resolution of responses from the various boron-oxygen bonding



The conference on borate glasses was held in honour of Professor Bray who delivered the plenary lecture.

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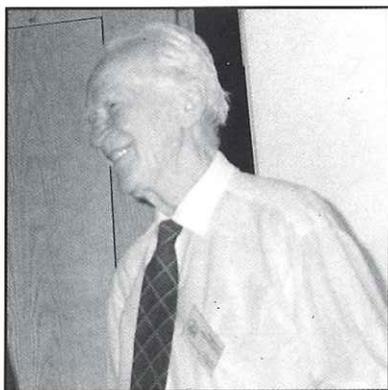
The December issue of *Physics and Chemistry of Glasses* features papers on: The influence of fluorine ions on EPR and optical absorption spectra of  $\text{Cu}^{2+}$  in lithium bismuthate glasses; kinetics of  $\text{AlF}_3$ -based glass by differential scanning calorimetry; crystal nucleation kinetics of a metastable phase on cordierite glass surfaces; spectroscopic properties of  $\text{Er}^{3+}$  and  $\text{Tm}^{3+}$  in tellurite glasses; influence of oxide additions on the oxidation states of polyvalent dopants in ZBLAN glasses; optical spectroscopy of a soda-lime glass exchanged with silver; effect of hydrostatic pressure on the ionic conductivity of glassy silver metaphosphate; low melting  $\text{PbO-SnO-P}_2\text{O}_5$  glasses; and determination of the nucleation rate curve for lead titanate glass by differential thermal analysis.

*Glass Technology* in December has papers on: the vaporisation of  $\text{ZrF}_4$  during the melting of ZBLAN glass; characterisation of tin oxide films by complimentary techniques (Technical Committee 19 of the ICG); and the 12th Turner memorial lecture - The future of glass research. There are also papers from the Spring Meeting on the pilot scale furnace for the demonstration of transferred arc melting and the options for large scale glass melting under EPA '90.

Both issues include abstracts from scientific, technical and business sources as well as the annual indexes for the conclusion of the 1996 volumes.



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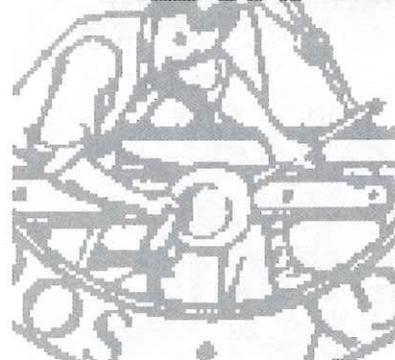
*Professor Porai-Koshits discussed some of the paradoxes associated with borate glasses.*

configurations. This has been combined with improvements by two and three significant figures in the parameters of the quadrupole interaction. With these changes structural groupings of more than a dozen atoms can clearly be identified within the glasses.

## SELECTED PAPERS FROM THE FIRST DAY

Later on the first day Professor Eugenii Porai-Koshits of the Institute of Silicate Chemistry, St Petersburg explored some of the paradoxes of borate glasses. Regions of inhomogeneity in binary systems such as  $B_2O_3-SiO_2$  have shown up some mysterious X-ray diffraction results. Small angle X-ray scattering has determined the size of such regions which can be measured in nanometres. It has proved that they are not regions of metastable immiscibility.

A second paradox is the proof in 1971 of the absence of metastable immiscibility in alkali borate glass systems (except lithium borate). This absence was proved by X-ray scattering but leaves electron microscopy observations unexplained.



The third mystery is the experimental observation of fluctuations in X-ray scattering intensity curves with changes of thermal density for alkali borate melts. This phenomenon may be explained by rearrangements of Krogh-Moe complexes and boroxol rings.

The borate glass anomaly, the unusual extrema in plots of physical properties such as thermal expansion with alkali oxide content in alkali borate glasses was questioned by Professor Don Uhlmann of University of Arizona. Different investigators have observed quite disparate thermal expansion behaviour, such variance was compared with theoretical explanations of the anomaly. The nature of bonding in borates as well as the behaviour of other physical properties as a function of composition was explored. New experiments which could help explain the nature of the borate anomaly were disclosed.

Dr Philip Gaskell of University of Cambridge has used X-ray and neutron diffraction measurements at low scattering angles to examine similarities in the medium range structure of borate glasses and crystals. In many cases, large 'superstructural' units were seen as intrinsic features of the structures of the glasses and their packing reflects in that observed in crystalline phases.

The use of crystallography to interpret the intermediate range order in borate glasses was extended by Dr Adrian Wright of Reading University and Drs Natalia Vedishcheva and Boris Shakhmatkin of the Institute of Silicate Chemistry of the Russian Academy of Sciences. Topological criteria were proposed for the formation of vitreous borate networks.

## SPONSORSHIP

Borax Consolidated Ltd, Corning Inc, Pilkington plc, US Borax Inc and the US Air Force European Office of Aerospace Research and Development all contributed financial support to the conference. Each organisation was thanked by the organising committee for their most valuable support. ■



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# OXY-FUEL BOOSTING AND GLASS TEMPERATURE CONDITIONING

**An evening seminar on oxy-fuel boosting and glass temperature conditioning was held in Bangalore to coincide with the executive council meeting of the All India Glass Manufacturers' Federation at Hotel Windsor Manor Sheraton and Towers. The seminar was chaired by Shri Sushil Jhunjunwala, chairman of the SGT's Indian section and Mr P R Kibe, president of the AIGMF, was the chief guest.**

The lecture 'oxygen boosting of glass tank furnaces' was delivered by Dr N Bandyopadhyay, general manager, BOC India Ltd, Calcutta. His address focused on oxy-fuel boosting rather than conversion to 100% oxy-fuel melting.

Oxy-fuel boosting can replace electric boosting and give better results. The uses of oxygen in the glass furnace, general enrichment, under flame lancing and oxy-fuel burners were all covered. Dr Bandyopadhyay used some typical installations to illustrate his talk including those at Lax & Shaw, UK

and at KL Glass, Malaysia. He discussed the special features of the flat jet lance system developed by BOC. In particular, he emphasised the retrofitting of oxygen lancing and oxy-fuel burners to glass furnaces to combat the effect of ageing, which results in reduced throughput capacity during the progressive recuperator failure or regenerator blockage.

Glass temperature conditioning was discussed by P J Deb of Incorporated Engineers Ltd, Baroda. In his lecture he talked about the development of forehearth and the most recent changes in their design. In particular he made reference to the use of thermocouples in place of radiometric infrared detectors and using integrated systems in preference to pneumatic devices. He also looked at the division of the forehearth and automatic heating and cooling control. The lectures were followed by an active question and answer session. The seminar ended with a vote of thanks proposed by the secretary of the Indian section. ■

# SGT NEWS



## THE RAINBOW COLOURS PRODUCED BY IRON AND MANGANESE

The iron-manganese system has been used since the Roman era to produce various colours from chemically identical glasses. Peter Howard, freelance glass technologist, has collaborated with researchers at the Natural History Museum and University of Manchester to recreate and analyse the rainbow of colours available. He described the discoveries to a joint meeting of the North West Section and the IoM NW Ceramics Group held at Pilkington Glass Museum, St Helens on 17 September.

The origin of colour in ancient and medieval glasses is of great interest to archaeologists. The significance of chemical composition, in particular the addition of colorants, has been used throughout the history of glassmaking. However, other factors such as redox reactions, glass structure and oxidation states, although perhaps poorly understood, were used by ancient glassmakers.

Theophilus, the medieval monk responsible for many of the

glassmaker's arts, described in particular the varying of colour in glasses containing iron and manganese. The technique used beech wood ash as the source of alkali, as it advantageously contains trace amounts of iron and manganese. The adaptation of furnaces in central and northern Europe to allow for more controlled air flow and dense local supplies of beech trees resulted in the domination of the central/northern European glass houses in medieval times and led to the rapid spread of the use of coloured glass.

Any colour from blue through green, yellow and brown to pink could be produced in glass containing iron and manganese, depending on the partial pressure of oxygen in the furnace atmosphere. Control of the interaction of Mn and Fe has been vital to the development of glass making over the last 1000 years.

By the late medieval era the Venetians were also deliberately adding small quantities of

manganese to their batches. In their case, however, it was used to counteract the colour imparted by iron impurities in their raw materials, enabling the production of near water clear glass.

### MODERN ANALYSIS

Researchers at the University of Manchester and the Natural History Museum used the Daresbury Laboratory synchrotron source to investigate the valency state of transition metal ions in glasses. They approached Peter Howard at the 1993 *Science and Art in Glass* meeting held at the Royal Institution of Great Britain after seeing his small pot furnace amongst the posters on display. The furnace design allowed good control of the redox conditions and Peter was asked to produce a range of glasses with different Fe-Mn oxidation states.

Using covered pots and stoichiometric reduction of the batch by silicon, the glasses produced ranged from blue through light green, dark green and yellow to sepia with a hint of a red due to colloidal metal precipitating out into the glass.

When these glasses were placed under the powerful X-ray source at Daresbury the researchers found the iron oxidation state varied systematically with colour while the proportion of manganese present as  $Mn^{3+}$  remained constant throughout.

The European success of producing coloured glass was not emulated in Britain. The lack of large quantities of beech forest meant that English glass makers were left to make strong iron green glass throughout medieval times. ■



**LOCAL SECTION CONTACTS**  
For details of forthcoming local section events in your area, contact the following.  
All SGT members and non-members welcome.

**London**  
– Mr P West,  
United Glass Ltd,  
Porters Wood,  
St Albans,  
Herts AL3 6NY.  
Tel 01727 59261.

**Midlands**  
– Mr C Baldwin,  
Stein Atkinson  
Stordy Ltd,  
Midland House,  
Ounsdale Road,  
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Nr Wolverhampton  
WV5 8BY.  
Tel 01902 324000.

**North East**  
– Mr J Henderson,  
44 Woodside Ave,  
Throckley,  
Newcastle upon  
Tyne NE15 9BE.  
Tel 0191 264 4775.

**North West**  
– Dr D Martlew,  
Pilkington  
Technology Centre,  
Hall Lane, Lathom,  
Ormskirk, Lancs.  
Tel 01695 54210.

**Scottish**  
– Mr D A Rennie,  
United Glass Ltd,  
Glasshouse Loan,  
Alloa FK20 1PD.  
Tel 01259 218822.

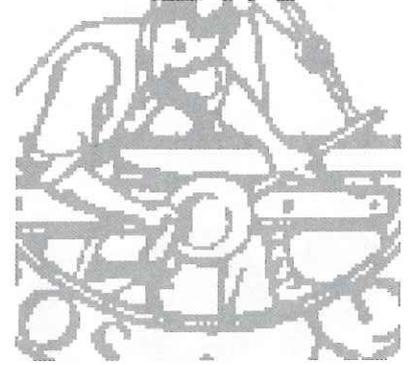
**Yorkshire**  
– Miss R M Sales,  
20 Blackbrook  
Drive, Sheffield  
S10 4LS.  
Tel 0114 2306179.

### IN PRINT

The February 1997 issue of *Physics and Chemistry of Glasses* contains papers on: The effect of ion exchange and heat treatment conditions on the diffusion of silver into soda-lime-silica glass; switching characteristics of barium vanadate glasses doped with iron oxide; diffusion studies in radial GRIN glass; vibration spectra of rings in continuous silicon-oxygen networks; effect of glass composition and basicity on reduction of metal ions to the metallic state in melts; 1, 2 and 3-dimensional FT-EPR spectroscopy measurements in the  $B_2O_3$ -Li<sub>2</sub>O system; the structural role of  $Bi^{3+}$  in  $Na_2O$ - $Al_2O_3$ - $Bi_2O_3$ - $P_2O_5$  glasses; an hypothesis on the nature of Griffith's cracks in alkali silicate

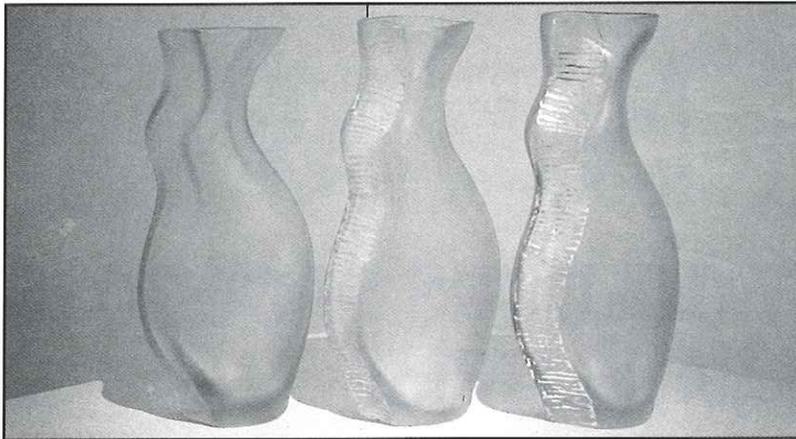
glasses; viscosity of  $Na_2O$ - $2SiO_2$ - $Na_2O$ - $2TiO_2$  glasses; crystal morphologies on a cordierite glass surface; and spectra of  $Nd^{3+}$  doped borotellurite glasses.

The February 1997 issue of *Glass Technology* contains papers on: The reaction between water and lead crystal glass (24% PbO); air flow patterns in the optical fibre drawing furnace; and comparative investigations on the polishing performance of optical glass using various polishers. Features on hand made glass manufacture include a look at environmental regulations, pollution control and studio practices across Europe. A new list of members offering consultancy services will also be featured.



## 1997 AWARD FOR INNOVATION IN TECHNOLOGY

Applications or nominations are now invited for the 1997 award for innovation in technology and/or science. The Glass Sellers are seeking an invention, process or system, developed within the last two years, which has commercial potential and has contributed or could in future contribute towards new understanding or new methods of production. ■



*Belinda Hornsey won the 1996 Glass Sellers' student award for art and craft with 'Mama Vessels' pictured above.*

## 1996 GLASS SELLERS' AWARDS FOR ART AND CRAFT

There were 23 entries for the main Glass Sellers' award and 16 for the student award this year, ranging from bowls to sculptures.

The main award, worth £1000, was won by Gail Gill for her 52cm high pure sculpture 'The Cruel Machine', made of free-blown, cut, shaped and polished glass. It is intended to represent the cruel harshness of humanity towards itself.

After an art foundation course in York, Gail widened her experience as an exchange student at Temple University, Philadelphia

and a teaching assistant at the Pilchuck Glass School in Seattle. She gained her BA (Hons) at West Surrey College of Art & Design.

Gail worked with other artists, including Peter Layton, until 1991, when she set up her own studio. She has since sold her work all over the world, as well as having pieces in many international exhibitions. In the same year as founding her studio, she was presented with the Prince's Youth Business Trust gold medal by Prince Charles and won the Mercury Telecommunications Trust Fund award. Her most recent commission was to make five pieces for Giorgio Armani.

The student award, of £500, went to Belinda Hornsey for her 'Mama Vessels'. These are of blown glass with the concave side being textured using cold processes. She seeks to capture the 'dancing' qualities of hot glass by emphasising form and line and is inspired by nature and rural landscapes.

Belinda recently completed her BA (Hons) at Staffordshire University and, in 1994/5, was winner of the RSA/Dartington Crystal Attachment. She is also one of 15 designers selected to work with Habitat and has won a place on the New Designers programme, which teaches CAD, graphics and business techniques. Currently she is designing for Dartington Crystal.

Both winners are highly talented artists with excellent knowledge of glass, its properties and have the skill to put their visions into solid form.

## ROLE OF GLASS IN THE TRANSPORT INDUSTRY

The Society of Glass Technology has become co-sponsor of a mini-conference on the role of glass in automotive transport. The 30th International Symposium on Automotive Technology and Automation (ISATA) is the largest European automotive forum with 13 dedicated conferences running simultaneously. Materials for Energy Efficient Vehicles is one of the main conferences, with glass as one of its components.

Further details on the meeting can be obtained from Claire Farrugia, Materials Conference Co-ordinator, 30th ISATA, 32A Queen Street, Croydon, CR0 1SU, UK. Tel +44 181 681 3069, Fax +44 181 686 1490.

## EDITORIAL CHANGE

Professor Alan Owen has returned to the University of Edinburgh after a two year sabbatical at the University of Arizona and has taken on the role of Editor of *Physics and Chemistry of Glasses*. Dr John Parker, who has been Acting Editor for the duration of Professor Owen's time in America will continue as Abstracts Editor for both of the Society's journals.

Dr Parker has been appointed Secretary of the Coordinating Technical Committee of the International Commission on Glass and Chair of ICG TC1, the technical committee on information and communications. As well as its established role of providing technical publications, dictionaries and literature database, TC1 will address new areas of communication such as the World Wide Web.

### LOCAL SECTION MEETINGS

- 5 December Midlands section - Christmas buffet, with entertainment.
- 6 December Yorkshire section - Annual dinner and dance.
- 10 December North East section meeting
- 6 January Midlands section - Energy and the Environment  
What's in it For You?  
*D Batt-Rawden and P Stevenson, ETSU.*
- 14 January London section - The Role of the Independent Furnace Designer.  
*P Scully, Eurofusion.*
- 23 January North West section - Low NO<sub>x</sub> Burners for Regenerative Glass Furnaces.  
*Speaker from British Gas.*



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