NO. 6 2003

SGT NEWS

Compiled and published by dmg world media (uk) ltd on behalf of the Society of Glass Technology

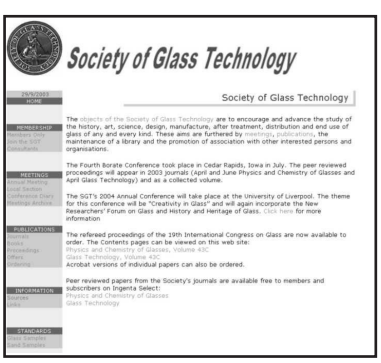
The Society website - www.sgt.org

A secure web-based trading facility and a 'members only' area are amongst the features of the Society of Glass Technology's website. Over the last year several new features on the site have begun to take shape, which provide additional services to members.

The homepage of the SGT website provides summaries and quick links to the most important activities taking place. Sometimes this is news, sometimes it is a new publication or an announcement for a conference, and sometimes it can be a change to the meeting programme.

The homepage includes links to the main areas of activity of the Society:

- Membership: with links to details on membership, the members only area, a listing of members offering consulting services, and a membership form.
- Meetings: with links to details on the Annual Meeting, Local Section meetings, a Conference Diary, and a Meetings Archive.
- Publications: this section has links to books and proceedings with further links to buy them securely online. It also has journals, SGT News and Glass Newsletter archives, the searchable 1952 issue of the Journal of the Society of Glass Technology and contents pages of all publications going back to volume one, published in 1917. There will also soon be an opportunity to order reprints from the whole of the last 86 years worth of publications.
- Information: this has links to useful glass sites and resources, the Glass Information Group's listing of Information Sources and the 2001 report from the International Congress on Glass.
- Standards: a listing of the SGT's glass and sand standard samples with a link to a secure transaction area to enable you to order them.



▲ *The Society of Glass Technology homepage.*

MEMBERS ONLY AREA

An area of the website has been set aside to offer additional services, free products and reports of general and more specialised interest to members. There are edited minutes of the Technical Committees available to view with the opportunity for members to contribute to the activities of these Committees.

This offers the international membership of the Society an opportunity to interact with committees, thereby increasing their breadth of coverage, and provides a greater pool of knowledge for everyone to benefit from.

There will be areas set aside for Special Interest Groups allowing non-members to contribute to their own specialised areas of interest. These will all be open for members to view and contribute their own comments.

A number of publications will be available for free viewing by members only. The first of these are the three Topical Issues in Glass series:

- Volume 1 - Advances in amorphous state chemistry
- Volume 2 - Reactions at glass surfaces
- Volume 3 - Photons, glasses and coatings.

Acrobat versions of the papers presented in these volumes will be available to view and keep. The area will also contain an archive of author submissions to Local Section meetings. The North West Section has led this initiative by persuading many of its guest speakers to present viewable versions of their talks. These will be available for a limited period after the time of their presentation to members and non-members alike before they are made available only to members.

The benefits from this are twofold: the speaker has a much wider audience beyond the Local Section, and the member has access to a new area of shared knowledge.

The members only area aims to be responsive to members' needs - if there is support for a particular new initiative we will try to introduce this as a future additional member service.

SECURE TRANSACTIONS

The website offers a shopping cart facility for anyone wishing to purchase books, conference proceedings, standard sands and glasses. Anyone wishing to pay by credit or debit card can now do so in the knowledge that the transaction takes place in a secure area and that any information being transmitted will be securely encrypted.

All of the Society's product catalogue is available to order online, conferences can also be booked in this way and membership fees will soon be able to be paid by this method.

JOURNAL SUBSCRIPTION RATES

The subscription rates for next year for two of the Society's publications are shown below. The rates for overseas subscriptions are also shown:

Glass Technology (ISSN 0017-1050):
UK inland: £185; overseas: £206
Physics and Chemistry of Glasses (ISSN 0031-9090):
UK inland: £204 overseas: £225

Surface mail is included in the price.

Electronic subscription is now available. This service is provided through Ingenta, incorporating CatchWord, and is available from this website: www.ingenta.com. Additionally, the volumes from 1998 are now also available online.

ELECTRONIC JOURNALS

The refereed papers from *Glass Technology* and *Physics and Chemistry of Glasses* are available over the internet via the Society of Glass Technology website. This is a new feature and is available to members and non-member subscribers of the journals.

The Society is working with Ingenta, the leading host of professional and academic publishers on the web, to provide this service. The issues that can be viewed online will be from the 1998 volumes onwards. The 2002 volumes onwards will also have hyperlinks from their references to other online publications and reciprocal links will be built up with other electronic journals. It is hoped that this will provide a better service for authors and researchers alike, cross-linking the mass of information available on the web.

Since its launch in May 1998, Ingenta has grown to become a leading web infomediary, empowering the exchange of academic and professional content online. With the acquisition of another major provider, Catchword, Ingenta supplies access to more than 5400 full-text online publications and to over 26,000 other publications. The company serves a growing global audience of academic and professional publishers, and in excess of 10,000 academic, research and corporate libraries and institutions, incorporating 25 million users worldwide. It records around three million monthly user sessions.

The title, author and abstract details of other journals can be viewed online, and a pay-per-view facility can be offered for anyone wanting full access to the publication.

Members with more than three years service will have full access to the available issues. More recent members will have graduated rights to view the volumes: two years for a new member, an additional two for those renewing for the second year, and full rights for subsequent renewals.

The December 2000 issue of *Glass Technology* and the June 2001 issues of *Physics and Chemistry of Glasses* will be freely viewable as sample publications.

For further information view either the links from www.sgt.org or from www.ingenta.com ■

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STANDARD SAMPLES

The Analysis & Properties Committee of the Society of Glass Technology has completed its analysis of two new certified reference materials (CRM) for amber and green coloured glasses. The standard samples were approved by the Council of the Society of Glass Technology in November 2000.

The laboratories involved in the process have all followed ISO guidelines for the production and traceability of analytical data.

INTENDED USE AND STABILITY

The samples are available in the form of glass pieces and also as 40 mm diameter discs.

They are intended for the verification of analytical methods, such as those used by the participating laboratories, for the calibration of analytical instruments in cases where the calibration of primary substances (pure stoichiometric compounds) is not possible and for establishing secondary reference materials.

The solid disc is intended for establishing and checking the calibration of x-ray spectrometers for the analysis of similar materials. The "as received" surface should be ground and polished.

The traceability of this CRM is ensured by the use of either stoichiometric analytical techniques or methods that are calibrated against pure compounds.

There are also values for ZrO_2 and Mn_3O_4.

These add to the existing range of standard sand and glass samples for analysis and calibration purposes.

SGT10 Amber soda–lime–silica container glass (mass%)

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	BaO	Na_2O	K_2O	TiO_2	SO_3	Cr_2O_3
72.8	1.62	0.325	10.6-	1.82	0.02	12.2	0.35	0.09	0.05	0.020

SGT11 Green soda–lime–silica container glass (mass%)

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	BaO	Na_2O	K_2O	TiO_2	SO_3	Cr_2O_3
70.7	1.83	0.342	10.3	2.14	0.031	13.6	0.69	0.068	0.06	0.205

GLASSES

Standard Glass No. 4. **Fluoride Opal Glass**
Also available as 6 mm thick sheets to special order, price on application.
Standard Glass No. 5. **Soda–Lime–Magnesia–Silica Glass**
Standard Glass No. 6. **Soda–Lime–Silica Glass**
Standard Glass No. 7. **Soda–Lime–Silica Glass**
Two lead glasses were received by the Analysis & Properties Committee but because of time limitations Glass No. 9 was not analysed by all of the collaborating laboratories. This glass has a lower lead oxide content, about 28% PbO, than Glass No. 8 and although it cannot be offered as a certified material, it could be useful as a subsidiary calibration check.
Standard Glass No. 8. **Lead oxide–potassium oxide–silica glass (30·59 wt% PbO)**
Standard Glass No. 9. **Probable composition available.**

SANDS

Standard Sand No. 1. **200 g packs at £20.00 plus postage (Al_2O_3 0·061, Fe_2O_3 0·014, TiO_2 0·026).**
Standard Sand No. 6. **(Al_2O_3 0·06, Fe_2O_3 0·032, TiO_2 0·024)**
Standard Sand No. 8. **(Al_2O_3 2·07, Fe_2O_3 0·26, TiO_2 0·073, K_2O 1·06)**
Standard Sand No. 9. **(Al_2O_3 1·35, Fe_2O_3 0·103, TiO_2 0·044, K_2O 0·82)** ■

SGT NEWS

"YOU'LL NEVER DO THAT" – PLANS FOR THE CONSTRUCTION OF A 42 INCH REFLECTING TELESCOPE BY AMATEURS

How can a group of enthusiasts build an observatory in the Pennines? There is the weather to contend with first, but it is not that bad! How about making your own reflecting telescope from a 42in diameter 3in thick mirror blank? The North West Section of the Society of Glass Technology hosted a joint meeting with the Institute of Measurement and Control at Pilkington Technology Centre, Lathom to hear from Steve Taylor about how this was done.

A BRIEF HISTORY

We were founded by Peter Drew 21 years ago, to provide professional grade equipment to amateur astronomers in a "good" viewing location.

The Amateur Astronomy Centre Todmorden is situated midway between the small north western England towns of Bacup and Todmorden and sits 1300ft above sea level, on the site of a former clay pipe works. Clear skies are surprisingly common, but there are often ferocious winds and driving rain.

▲ *The telescope site on top of the Pennines.*

After a few years enthusiasm and membership peaked and we had close to 2300 members. This was when I originally joined and then left the project, around 1985. The long slow slog began, and enthusiasm waned.

At this time, the astronomy centre had a few small telescopes, and a massive 30in diameter Dobsonian telescope.

Our original 2300 members dwindled over a 10 year period up until 1997, when we had a building, or half of one building. Fortunately the round bit, which is useful for an observatory - but without a roof. The building had been financed from raffles and the generous bequest from the estate of one of our early members, Mr Emley, without which, it is fair to say, the Astronomy Centre would not exist.

Peter had single-handedly built one and a bit 30ft diameter domes to cap the building, but before they could be completed, one dome blew away in the winter winds, and another was critically damaged. By 1997 we were at the "make or break" point, or in astronomical terms, the Nadir, (which is the opposite of Zenith, in fact as far away from zenith as it is possible to be). Real membership stood at around 300 steadfast or possibly, even probably, mad supporters, doggedly paying the princely sum of £2.50/year membership (though in fairness, many made substantial additional donations). Clearly things needed to change.

When Peter made the decisive move to start again, and let some of the "doers" who had left over the previous years know, we rallied round to help our old friend, and a small team (about six or eight) came together to try and help.

For some reason I became de facto leader of the group. I will be quicker next time.

We started the dome in August 1999, and finished in January 2000, having worked every weekend in between, with some midweek evenings, and finishing after midnight, sustained by my company coffee machine and pizza in industrial quantities.

The dome was lifted into place in March 2000. Now we had a building with a roof.

The Membership by now getting over the shock of the subs increasing from £2.50 to £10, began to rally around themselves, and we began to gain members for the first time in many years.

WHAT ABOUT THE TELESCOPE?

Now we wanted a telescope, and a big one. While there are many "big mirrors" lying around in the UK today, most are kept as "historical artefacts", and not as the fantastic bits of engineering that they are, and certainly never used in instruments.

We also very soon realised that we could never afford to buy a ready made mirror, we would need well in excess of £50,000, possibly more. Even "cheap" Russian or Chinese mirrors were beyond our means.

So, in the spirit that had taken us so far, we said "stuff that - we'll make our own".

So where do you start? Firstly of course you need a big piece of glass. A VERY big piece of glass (well certainly to us it is). Actually, firstly you need to find a source for the mirror, which we did, in Canada. The price for a 42in diameter, three inch thick blank would be £5213.

Now bear in mind our theoretical maximum income at the time was only £3000, of which over £1500 went on rates, insurance and sending out newsletters telling people about the progress we were making with the other £1500, and you can see the problem.

So, at the annual meeting of the Astronomy Centre, we launched "The Mirror Fund" confidently expecting that we could accumulate the money over the next two or three years, while we finished the building for the instrument.

But our members did us proud - at the launch, we raised over £600 in cheques alone, with pledges taking it to over £2000! Within 6 months of launch,

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 M Holden,
BH-F (Engineering) Ltd,
4A Churchward,
Southmead Park, Didcot,
Oxon OX11 7HB.
Tel 01235 517202.

Midlands
– Mr R Nickels,
4 Boundary Way,
Compton, Wolverhampton,
West Midlands WV6 8DL.
Tel 01902 762070.

North East
– Mr W Brookes,
82 Whitfield Crescent,
Penshaw, Houghton Le Spring, Tyne & Wear
DH4 7QY.
Tel/Fax 0191 584 3100.

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.

NORTH AMERICA
– Dr A G Clare,
School of Ceramic Engineering and Sciences,
New York State College of Ceramics at Alfred University,
2 Pine Street, Alfred,
NY 4802-1296, USA.
Tel 607 871 2392.

INDIA
– Dr J Mukerji,
Central Glass and Ceramic Research Institute, PO Jadavpur University, Calcutta 777 032, India.
Tel 473 3496.

▲ ***The grinding machine used by the group.***

we had landed a £1000 of sponsorship from Zen Internet, who carry our website, and closed the funding gap.

Meanwhile, a new 30in scope was built and placed at the top of the building.

The order for the blank was placed in November 2000 and delivered in August 2001. In fact we ordered two blanks, one, an 18in test piece and the main 42in.

DESIGN

What are the fundamental choices when building a telescope? Our process is different from the professional method, for obvious reasons, but this is what we did.

Once the "headline" aperture is selected, on the basis of resolving power or light grasp we need to choose the focal length, largely fixed by the building that will house the scope

In our case, the longest focal length that would conveniently fit is only a relatively fast F4, by which I mean that the focal length is 4 times greater than the mirror diameter - any longer and the end would poke out of the building, any shorter and we would have difficulty grinding the mirror.

OPTICAL CONFIGURATION

There are literally dozens of possible optical systems: the classic Newtonian, the Cassegrain, the Naysmyth Cassegrain.

All share the same basic principles, the primary mirror collects light from the object, and reflects it to a focus, where an eyepiece magnifies the image. The mirror surface is on the front of the glass, unlike a conventional mirror.

PRIMARY/SECONDARY/TERTIARY

All use a basically parabolic section, the only shape that reflects what is essentially parallel light back to a single focus.

All primary mirrors start their lives as flat bits of circular glass. The art of course is to make them very, very precisely dish-shaped.

The precision required is astonishing. The whole surface must form a parabola to an accuracy of at the very worst $^{1}/_{4}$ of the wavelength of light, which for blood red light would be $^{633}/_{4}$ or 150nm. Or put another way, if we blow the mirror up to fit inside the M25, 125 miles around, the centre of the mirror would be 7 miles deep, $^{1}/_{4}$ wave would be a maximum ripple of 9.5mm.

In fact our error budget is $^{1}/_{16}$ of a wave.

The surface accuracy dictates the materials used. Only glass is considered stable enough, and for the best results a thermally stable glass, like Pyrex or other borosilicate was used. For the best results quartz or fused silica can be used.

Sadly fused silica is a more than a bit out of our price range - a 42in blank would cost considerably more than our lifetime earnings to date.

The material we have used is called Black Vitreous Ceramic. BVC has lots of things we want: low expansion, low thermal mass, moderately soft - and affordable.

We have cheated with the initial curving, that has been done with a diamond wheel, and has saved several weeks of grinding.

Our grinding machine is powered by two, 2 horsepower motors.

HOW DOES IT WORK?

The sequence of grinding takes the surface from roughly the same as a paving slab to a very finely frosted glass surface, as we work through the "grits" from 120 grit to 600 or 800 grit and beyond. Grit size relates to the number of meshes per inch that block the size you wish to use, so 80 grit will pass through a 80 mesh per inch grid, 120 grit 120 meshes, etc.

The further you go in "grits", the less polishing time you need.

The mirror itself is sat on a resilient mat that supports the back of the mirror evenly, while not distorting the surface.

By this stage the mirror is still a dull grey, the next stage is to polish the mirror, using the time honoured pitch lap.

The process of polishing is now fairly well understood. It is a combination of a chemical process, where water under high pressure dissolves the glass slightly, and where a chemical reaction occurs between the polishing compound (often cerium oxide) and the glass. The lap has to be in very good contact for the necessary magic to occur, and pitch has the necessary "give" to make intimate contact.

HOW DO WE MAKE THE SURFACE THE ONE AND ONLY "RIGHT" SHAPE?

This is very much a rough summary. Testing optical systems is science, art and black magic. Some people can look at the image from a star in the scope and tell you exactly what is wrong, and where in your telescope.

The classical method is called the Foucault knife edge test, after its brilliant inventor, Leon Foucault, who is also noted for the famous "Foucault's pendulum", a demonstration of the rotation of the earth beneath a swinging pendulum.

Before the invention of the Foucault test mirror making was often a hit and miss affair, with people like William Herschel spending years trying to figure their metal mirrors.

The knife edge test changed all that, and heralded the era of big telescopes introduced by people like William Lassels of Liverpool, one of the great Victorian astronomers.

The knife edge test is not what we call a null test for a parabola. The "right" parabola is one of a series of doughnut shapes that are hard to characterise accurately without a lot of skill and practice. The knife edge is a null test for a sphere - if its a sphere the image goes half illuminated evenly.

Without going into the exact details, it is possible to create a null test for the parabola with extra optics. The effect of the extra optics is that when tested with a knife edge, the parabola now looks perfectly flat, and the sphere would look like a parabola!

There are several methods to do the nulling, but all rely on exquisitely precisely manufactured lenses or mirrors. Which is where the Hubble mirrors went badly wrong.

Testing the 42in is quite tricky. The F4 primary is roughly 14ft from the mirror to the focus, and 28ft to the radius of curvature- where the testing happens. Unfortunately, the building isn't 28ft tall, and we want to test vertically, rather than horizontally, because it reduces distortion in the mirror, and it weighs close to 500lbs.

We will be using the refractive null test and anything else we feel we can trust. A very well respected optician is making our test optics, and, touch wood, we won't "do a Hubble" - but at least we don't have to fix it from the Shuttle. Our error budget is $^{1}/_{16}$th wave of red light.

Figuring is the hardest part of the job, and by the usual reckoning, it will take close to a year to get the figure right, with several hours of testing after every five minutes of lapping.

We will have probably the largest mirror manufactured in the UK in the last 25 years, and then the story will really begin.

All of this has been achieved by purely private means, not a single penny of grants has ever been received by the project. ■

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