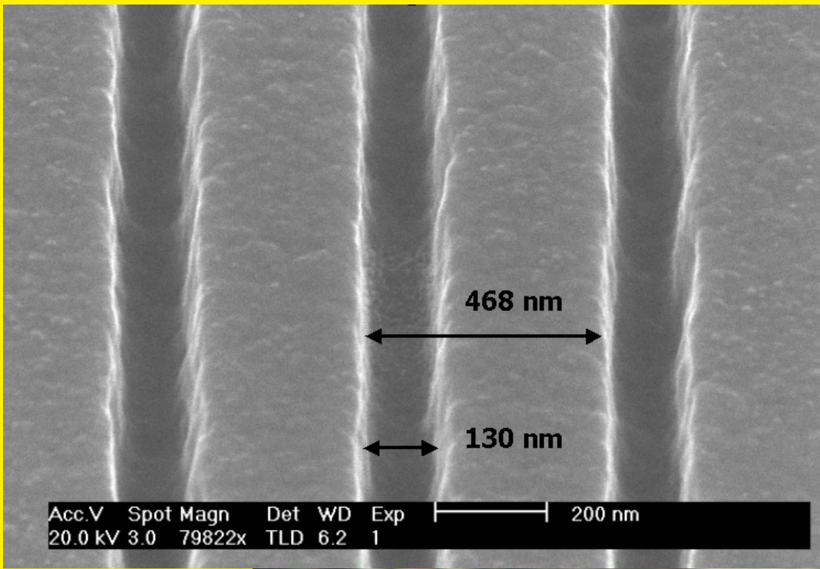
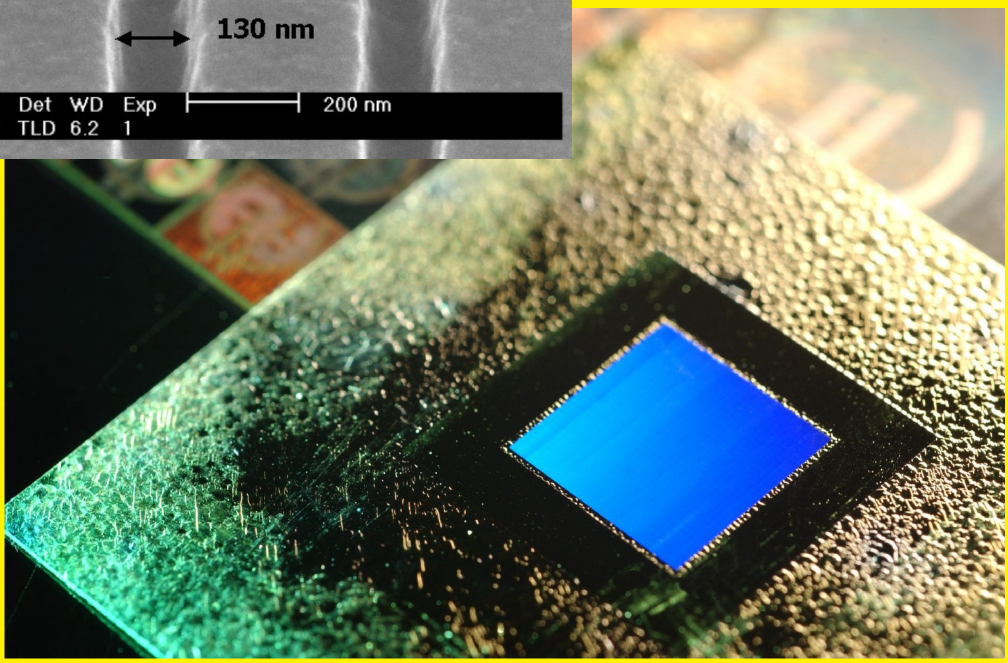
Australian Optical Society

NEWS





Volume 20 Issue 4
December 2006

ISSN 1832-4436

Registered by Australia Post
Publication No: 233066 / 00021

Contactless

PRECITEC

Measuring Technology

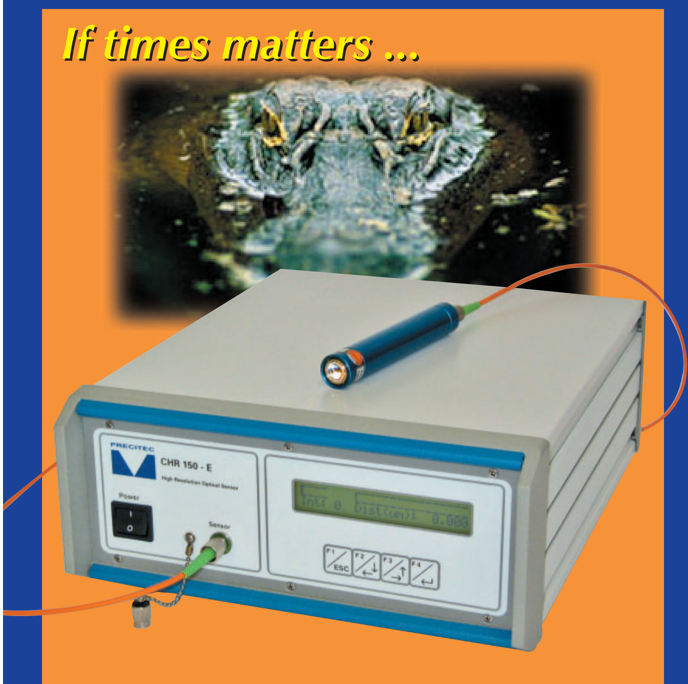
Measure distance and thickness – Scan all surfaces

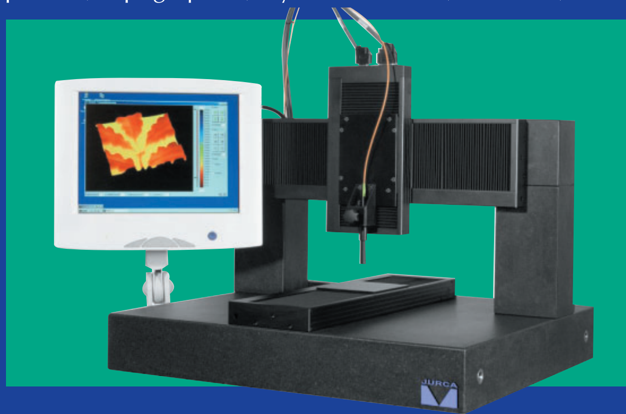
CHROCODILE:

Delivers contactless measurement of distances and layer thicknesses with up to 10nm resolution.

NEMESIS:

High resolution 3D contactless measurement of profiles, topographies, layer thicknesses, contours, etc.





LASTEK

Lastek Pty Ltd
Thebarton Campus, University of Adelaide,
10 Reid Street, Thebarton SA 5031 Australia
Ph (08) 8443 8668 Fax (08) 8443 8427
Email: sales@lastek.com.au Lastek website: www.lastek.com.au

www.precitec-optronik.de

LTWAM4529/R

AUSTRALIAN OPTICAL SOCIETY

ABN 63 009 548 387

AOS News is the official news magazine of the Australian Optical Society. Formed in 1983, the Society is a non-profit organisation for the advancement of optics in Australia. Membership is open to all persons contributing to, or interested in, optics in the widest sense. See the back page (or the AOS website) for details on joining the Society.

AOS News - Editorial Board

Submission guidelines

The *AOS News* is always looking for contributions, especially from AOS members. Here is a short summary of how to make a submission.

What can you submit?

* ***Scientific Article***

A scientific paper in any area of optics.

* ***Review Article***

Simply give a run down of the work conducted at your laboratory, or some aspect of this work.

* ***Conference Report***

* ***News Item***

* ***Book Review***

* ***Cartoon or drawing***

Reviewing of papers

On submission of a scientific or review article you may request that the paper be refereed, and if subsequently accepted it will be identified as a refereed paper in the contents page. The refereeing process will be the same as for any of the regular peer reviewed scientific journals. Please bear in mind that refereeing takes time and the article should therefore be submitted well in advance of the publication date.

How can you submit?

The easiest way is by email. We accept nearly all file formats. (Famous last words!).

Submitted articles will be imported into an Adobe Pagemaker file. It is best if the diagrams and other graphics are submitted as separate files. All common graphics formats are acceptable, but the resolution must be in excess of 300d.p.i.. Be aware that all colour diagrams will be rendered in grayscale, so if you do use colours, choose colours that show up well in grayscale.

When using Greek letters and mathematical symbols, use font sets such as Symbol or MT Extra. Please avoid using symbols that are in Roman fonts, where the Option or Alt key is used; e.g. Opt-m in Times font on the Mac for the Greek letter mu.

If using TeX, use a style file similar to that for Phys Rev. Letters (one column for the title, author and by-line, and two for the main body). The top and bottom margins must be at least 20mm and the side margins 25mm. Submit a pdf file with the diagrams included, as well as copies of the diagrams in their original format in separate files.

If using a word processor, use a single column. If you do include the graphics in the main document, they should be placed in-line rather than with anchors, but

SUBMISSION OF COPY:
Contributions on any topic of interest to the Australian optics community are solicited, and should be sent to the editor, or a member of the editorial board. Use of electronic mail is strongly encouraged, although submission of hard copy together with a text file on CD will be considered.

ADVERTISING:
Potential advertisers in *AOS News* are welcomed, and should contact the editor.
Rates:
Colour A4 adverts, $250 +GST per issue,

Page 1 Black and White $100 + GST,

Black and White in main body of newsletter - free to corporate members.

Conference announcements are free.

COPY DEADLINE
Copy for the next issue (Mar 07) should be with the editor no later than 21 Feb 2007.

EDITOR (acting)
Murray Hamilton
The University of Adelaide
Physics Department
Adelaide SA. 5005
Tel: (08) 8303 3994
Fax: (08) 8303 4380
murray.hamilton@adelaide.edu.au

Australian Optical Society website
http://aos.physics.mq.edu.au

- News
- Membership
- Optics links
- Prizes/awards
- Conferences
- Jobs/Scholarships
- Affiliated societies
- ...and more

December 2006 **Volume 20 Number 4**

AOS NEWS

ARTICLES

DEPARTMENTS

Cover Picture: An array of 130 nm wide channels with a period of 468 nm, 240 nm deep and 10 mm long (!) in a silver film. Incident light excites plasmons in the channels that propagate to the bottom, reflect back to the top and reradiate creating interference with the incoming light. This is being used to study the interaction of light with subwavelength optical structures created using electron beam lithography at CSIRO. The aim is to create an optical antenna and opto-electronic detectors, in direct analogy with those used for radio waves. The B&W picture shows a SEM picture of the channels. This work appeared in Optical absorption by surface plasmons in deep sub-wavelength channels Optics Communications Volume: 267, Issue: 1, November 1, 2006, pp.253-259 Davis, T.J.; Mayo, S.C.; Sexton, B.A. (Photo courtesy of Tim Davis)

AUSTRALIAN OPTICAL SOCIETY

ABN 63 009 548 387

AOS EXECUTIVE

PRESIDENT
Hans-A Bachor
ARC Centre of Excellence for Quantum-Atom Optics, Building 38
The Australian National University,
Canberra ACT 0200
Tel: 02 6125 2811
Fax: 02 6125 0741
hans.bachor@anu.edu.au

VICE-PRESIDENT
Ben Eggleton
CUDOS
School of Physics,
University of Sydney
Sydney NSW 2006
Tel: 0401 055 494
Fax: (02) 9351-7726
cwalsh@physics.usyd.edu.au

SECRETARY
John Holdsworth,
School of Mathematical and Physical Sciences, University of Newcastle,
Callaghan 2308 NSW
Australia
Tel: (02) 4921 5436
Fax: (02) 4921 6907
John.Holdsworth@newcastle.edu.au

HONORARY TREASURER
Stephen Collins
Optical Technology Research Lab
Victoria University
PO Box 14428, Melbourne, VIC 8001
Tel: (03) 9919 4283
Fax: (03) 9919 4698
stephen.collins@vu.edu.au

PAST PRESIDENT
Murray Hamilton
Department of Physics, University of Adelaide, Adelaide, SA 5005
Tel: (08) 8303 3994
Fax: (08) 8303 4380
murray.hamilton@adelaide.edu.au

AOS COUNCILLORS

Chris Chantler
School of Physics,
University of Melbourne
VIC 3010
Tel: (03) 8344 5437
Fax: (03) 9347 3732
chantler@physics.unimelb.edu.au

John Love
Optical Sciences Centre,
Research School of Physical Sciences and Engineering
The Australian National University
Canberra ACT 0200
Tel: (02) 6249 4691
Fax: (02) 6279 8588
jd1124@rsphysse.anu.edu.au

Halina Rubinsztein-Dunlop
Department of Physics,
University of Queensland,
St Lucia, QLD 4072
Tel: (07) 3365 3139
Fax: (07) 3365 1242
halina@kelvin.physics.uq.oz.au

Martijn de Sterke
School of Physics
University of Sydney NSW 2006
Tel: (02) 9351 2906
Fax: (02) 9351 7726
desterke@physics.usyd.edu.au

John Harvey
Department of Physics,
University of Auckland,
Private Bag 92019,
Auckland, New Zealand
Tel: (+64 9) 373 7599 X88831
Fax: (+64 9) 373 7445
j.harvey@auckland.ac.nz

Ann Roberts
School of Physics,
University of Melbourne
VIC 3010
Tel: (03) 8344 5038
Fax: (03) 9439 4912
a.roberts @physics.unimelb.edu.au

Ken Baldwin
Laser Physics Centre
ANU, RSPSE
Canberra ACT 0200
Tel. (02) 6125 4702
Fax. (02) 6125 2452
kenneth.baldwin@anu.edu.au

Adam Weigold
Photon Engineering Pty Ltd
PO Box 122 Rundle Mall, Adelaide, SA, 5000, Australia
Tel: + 61 - 8 - 8232 3444
Fax: + 61 - 8 - 8232 9333
Email: aweigold@ozemail.com.au

AFFILIATES
OSA
(Optical Society of America)
SPIE
(International Society for Optical Engineering)

CORPORATE MEMBERS

ARC COE for Quantum-Atom Optics
Australian Fibre Works
Bandwidth Foundry
Bitline System
Coherent Scientific
CUDOS
Francis Lord Optics (Avtronics)
Lambda Scientific
Laserex
Lastek
NewSpec
Optiscan
Photon Engineering
Raymax Applications
Warsash Scientific
Wavelab Scientific

President's Report

Dear AOS members

Scientific meetings, conferences and workshops are one of the major ways of communication in science. The personal interaction, the talk or poster are an important way to spreads the information about new results and to learn what the colleagues have discovered. The most important part in my experience however are the discussions after the lecture or at the posterboard. To make this possible one of our main activities at the AOS is to help with the organisation of optics conferences.

Next month you will have another great opportunity to meet your colleagues and see new science, and equipment, during the AOS meeting as part of the AIP Congress in Brisbane. This combination is very popular and after the exciting AIP Congress in Canberra in the year of Physics we are looking forward to another big congress which brings together optics people from across Australia. AOS has a set of talks in every time slot and posters on two evenings. You will not have a shortage of topics to study. In addition we have a great lineup of plenary speakers, including Jan Hall on his first visit since he received the Nobel prize in 2005, Anton Zeilinger and Debbi Jin who excel in studying quantum system of photons and atoms and many others. At the same time many students will have the opportunity to show their results and the Congress is a very good way to young people who excel in research in optics. We are looking forward to many exciting presentations - and the AOS will again reward the best student presentation with prizes.

The AOS is planning already further national and international meetings in many areas of Optics. If you want to be involved in organising such a meeting in a few years time please contact us. It can be a rewarding experience.

Enjoy the congress

Hans Bachor, AOS president

CALL FOR NOMINATIONS

IUPAP Young Scientist Prize

in Atomic, Molecular and Optical Physics 2007

Nominations are being sought for the Young Scientist Prize in Atomic, Molecular and Optical (AMO) Physics which will be awarded by the International Union of Pure and Applied Physics through the Commission C15 (AMO Physics) for the first time in 2007. The prize will be awarded during the XXV International Conference on Photonic, Electronic and Atomic Collisions (XXV ICPEAC) to be held in Freiburg, Germany, July 25 – 31, 2007. The Prize includes a medal, a $1000 award and an invited presentation at XXV ICPEAC.

The nominee is expected to have made original and outstanding contributions to the field of AMO physics. The leading personal contribution of the recipient to the achievement must be clearly indentifiable when the work was performed in collaboration. Nominees for the prize should have a maximum of 8 years of research experience (excluding career interruption) following the PhD on January 1, 2007.

Nominations should include:

- A letter of not more than 1.000 words evaluating the nominee's achievements and identifying the specific work to be recognized.
- A curriculum vitae including all publications.
- A brief biographical sketch not exceeding two pages

Self-nominations will not be considered. Nominations should be sent to the chair of IUPAP- C15:

Prof. J. Burgdörfer, Institute for Theoretical Physics, Vienna University of Technology, Wiedner Hauptstraße 8-10/ E136, 1040 Vienna, Austria, EU or iupap@tuwien.ac.at. **Deadline is February 1, 2007**.

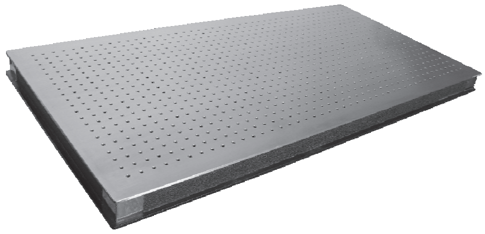
Two little snippets of gossip; Prof Min Gu, Swinburne University, has recently been elected to the Australian Academy of Technological Sciences and Engineering, and Dr Ken Baldwin, AOS Council and ANU, has just been elected to the post of President Elect of the Federation of Australian Scientific and Technological Societies. Warmest congratulations to both!

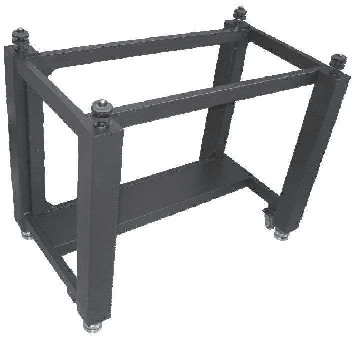
Optical Breadboards and Supports

Optical Breadboards

Specifications

- **Top plate**: Magnetic stainless steel, 5mm thick
- **Bottom plate**: Magnetic stainless steel, 5mm thick
- **Thickness**: 60mm or 100mm
- **Mounting holes**: M6 on top on 25mm grid
- **Flatness**: ± 0.1mm over 600 × 600mm area
- **Distance of fist hole to edge**: 50mm
- **Weight density**: 60mm thick, approx. 95kg/m^2
  100mm thick, approx. 105kg/m^2





Rigid Support Frame

Rigid support frames are used to mount optical bread-boards. The breadboard bottom surface rests on four heavy-duty bolts on the top of the support frame

- Four adjustable legs at the bottom
- Leveling on frame top to support breadboard
- Four heavy-duty precision castor wheels

Standard Metric Breadboards (mm)

300 × 300 × 60	900 × 600 × 100
600 × 300 × 60	900 × 900 × 100
600 × 450 × 60	1200 × 600 × 100
900 × 600 × 60	1200 × 900 × 100
900 × 900 × 60	1500 × 900 × 100
1200 × 600 × 60	1800 × 900 × 100
1200 × 900 × 60	
1500 × 900 × 60	

900 × 600 × 60 Plus support frame with casters

Optica Promota
James Gregory,
translated by Ian Bruce, University of Adelaide

(James Greogory (1638 - 1675), Regius Professor of Mathematics at The University of St Andrews, is best know in the optics community as one of the inventors of the reflecting telescope. Many of his ideas in optics were put down in a book called the Optica Promota. What follows is an excerpt from the recent first translation from Latin to English, which shows how Gregory arrived at his version of the law of refraction. More of the translation can be found at http://www.17centurymaths.com/ . *Ed*)

§1.1. Synopsis Proposition 1.

In the first proposition the rationale behind the refraction method is explained. There is to be a correspondence set up between reflection and refraction by surfaces derived from conic sections. The former is already well known geometrically at this time, and Gregory intends showing that the latter can also be derives geometrically for surfaces of the same form. The opening premise is the refraction of a light ray towards or away from the normal in entering a more/less dense medium He borrows heavily from Kepler's *Optics* in considering limiting situations where the degree of refraction is extreme. Thus, a transparent sphere with an infinite density will refract a parallel beam in the air through the centre of the sphere: in a less extreme situation the parallel beam can be refracted to pass through a focus of an ellipsoid, which has an ellipse as cross-section. The far focus must be used in order that physically meaningful angles of refraction occur. In a similar manner, a parallel beam in the infinitely dense transparent medium can come to a focus in the air outside a plane bounding the dense medium: in a less extreme situation the parallel beam in the dense medium can be refracted by the surface of a hyperboloid through the focus of the other branch; in this case the cross-section is a hyperbola. The case of the paraboloid corresponds to no refraction. Hence, lenses with parabolic cross-sections will not occur in this work.

§1.2. Proposition 1.

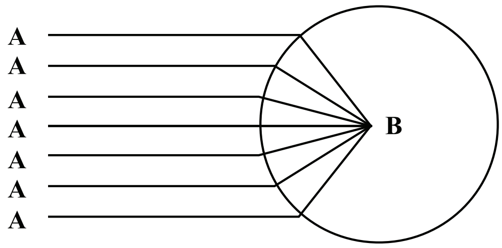
The Proposition shall be to examine: which pray shall be the surface which measures refractions?[1]

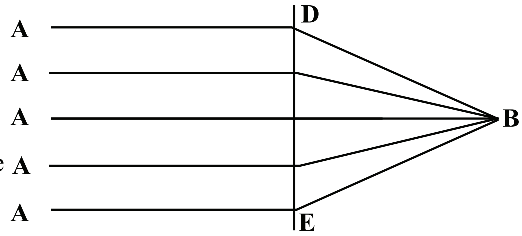
It has been commonly observed by those involved in Mathematics, whatever the truth of what else they may say, that light rays passing through a less dense transparent medium and incident obliquely on another denser medium, are refracted at the surface of the second medium, and bend towards the perpendicular, excited by the points of incidence. Conversely, rays crossing the denser medium and incident obliquely on the rarer medium, are refracted by the surface of the second medium, and bend away from the before-mentioned perpendicular. It is not for us to set forth here the origins of this refraction : indeed *Alhazen, Vittellio, Kepler,* and many others have discussed these causes at length; moreover, since the measurements of these effects as set forth by these authors are revealed to be less than reliable, we shall attempt on that account to exert a little influence in the midst of all this confusion - which perhaps will be of some use to mathematicians. But concerning these things which are to be the subject of deeper considerations, it may be permitted to argue a little by analogy, before we approach the subject with geometrical rigor.

It is clear enough from the elements of Optics that much of Reflection [Catoptrics] and Refraction [Dioptrics] have properties in common; therefore perhaps some common property will remain in the measurement of both reflection and refraction. But all the mystery of reflection that lies hidden in conic sections has been demonstrated - as will be shown in turn - and hence perhaps also a measure of refraction will be concealed therein. For the following cases considered, regular reflection cannot occur unless the reflecting surface is a conic section, and perhaps there may not be a rule for refraction either unless the refracting surface is a conic section also.

If in truth the reflecting surface is the concavity of a parabola, and the incident rays are parallel to the axis, then they are reflected into the focus. It can be asked therefore, for a given surface of refraction: is it the case that all the rays incident on this surface parallel to a certain specific line can be refracted into any one assigned point ? From the preceding it is probable - if such a surface can be made - that it shall be a conic section. But our search for such a surface making use of analogies may be undertaken by examining extreme situations. Thus, we may consider the medium in which the rays are incident to be the densest possible[2]: in which case the refracted rays will be perpendicular to the surface of the medium (see *Kepler. Ast. Opt. fo. 113*). The conic section is sought therefore for which all the perpendiculars are themselves concurrent in one point: the circle is such a section [Figure 1]. For the second case, the parallel rays are considered to be passing through the densest medium [*i.e.* to the left of DE]. The bundle of rays [Gregory calls this the form or shape] leaves along the same lines by which it enters; but the bundle enters with the lines perpendicular to the surface, as hitherto said, and so [tracing the rays backwards] the bundle of rays emerges from the densest medium turned away from the perpendicular lines[3]. Therefore the conic section is sought to which all the perpendiculars are parallel: but the straight line is such a section [Figure 2].

Some parallel rays A, A, A, etc. lying in one plane therefore are supposed to be refracted by the surface of the densest medium, where the refracting surface is a circle; in which case the refracted rays concur to the centre of the circle B. The single point [*i.e.* the focus] from an extreme point of view therefore is satisfactory. Also to be supposed, a number of rays arising from a single point B advancing in the rare medium, are to be refracted by the densest medium - the refracting surface of which is taken as the straight line DE - in which case all the refracted lines emerge parallel in the densest medium. Conversely, if these parallel rays lying in a single plane of the densest medium are considered to be refracted into the more rare medium by the surface DE, (because the same bundle of rays leaves which enter) all the rays A, A, A, etc., are concurrent in the point B; thus the converse situation is satisfactory from this extreme point of view. If truly, everything is examined carefully, then it will be seem - on account of the aforementioned reasons - that all the rays, either parallel or non-parallel, which are incident on the circular surface of the densest medium for refraction, are concurrent in the centre of the circle. Now we ask: how does this come about? The answer is :- Well, however the line is drawn incident on the circle, (provided they are co-planar) an axis can be drawn parallel to it, and without doubt the circle can be considered as a kind of ellipse, so that any diameter can be called the axis, from which it appears that the special line sought is the axis of a conic section.





[Figures 1and 2.]

For the other case, from observation it will also be apparent that all the parallel rays in a single plane of the densest medium are not so much assigned to a single fixed point, but to any point you wish beyond the line DE, and the component parts concur in B. Also we ask : how does this come about? The reply is :- Well, (supposing the straight line to be the branch of a hyperbola) any point outside the densest medium can be accepted as the location of the focus, from which it can be seen that the focus is the required point of concurrence. But of the two foci of the hyperbola, either real or imaginary [depending on whether we have a real hyperbola or this degenerate straight line case], it will be the point of concurrence which stands furthest from the point of incidence of the rays, otherwise the angle of refraction would be greater than a right angle, which cannot happen [*i.e.* the focus of the far branch of the hyperbola is used].

From these pre-tests of the medium using extreme values, we may attempt to answer the following questions :- By considering rays passing either from the rare medium into the densest, or from the densest into the outermost rare medium, by necessity it follows that the rays from one medium incident on another of the same density, to be the mean between the two aforementioned extremes ; but in this case there shall be no refraction. For the parabola, therefore, (which is the mean between the circle and the straight line) all the lines parallel to the axis and co-planer with it coincident on it, ought to be concurrent in the focus by refraction. These are incident from points at the greatest distance, and so the focus shall be at an infinite distance from the vertex of the parabola. Therefore all the rays incident on the parabola, and drawn from the aforementioned imaginary focus, are parallel to the axis. If truly they are parallel to the axis both before and after incidence, then in general they are free from refraction, as is the proposition.

We may therefore conclude from the analogy that one is able to find a surface of refraction for all different kinds of transparent media, which shall be a conic section, in which coplanar parallel rays in one medium are refracted by another medium to concur at a point. Now when the rays are parallel in the denser medium and they concur in the rarer medium, then the surface of refraction approaches almost to the most obtuse of hyperbolas, *i.e.* a straight line. On the contrary, when the rays are parallel in the less dense medium and they concur in the denser medium then the surface of refraction approaches almost to the most obtuse of ellipses, *i.e.* a circle. Truly from these discarded analogous trifles we may come close to more reliable evidence for establishing the scientific origin of refraction.

§1.3. Notes on Proposition 1:

1 The author is unaware of the now customary form of Snell's Law of refraction : he intends to relate the 'optical

density' to the focal property of a conic section, which we show below in modern terms for a medium of refractive index *n*. Initially he argues by analogy, assuming that an unknown law of refraction can be applied to conic sections just as the law of reflection can be applied, which certainly is the case as reflecting surfaces can bring parallel rays to a focus. In this matter, he follows the lead of Kepler in considering extreme cases, a ploy still used in understanding new physical phenomena.

2 That is, consider an infinite refractive index. This at least has the effect of changing a parallel beam into a focused beam; and conversely, by making use of a circular cross-section and a plane surface respectively. See the *James Gregory Tercentenary Volume*. Page 454 onwards. See also, p. 127 of Kepler's *Optics*, translated by W. Donahue, Green Lion Press, 2000.

3 Thus showing the principle of reversibility of a light ray.

§1.4. Propositio 1.

Propositum sit inquirere, quaenam sit superficies quae metitur refractiones.

Omnibus in Mathesi vel leviter veratis, vulgo notum est, radios luminosos per diaphanum rarius transeuntes, & in aliud diaphamum densius obliquè incidentes, refringi in superficie secundi diaphani, & ad perpendiculares vergere ab incidentiae punctis excitatas ; & è contrario radios per diaphanam densius transeuntes, & in aliud diaphanum tenuius obliq ; incidentes, refringi in superficie secundi diaphani, & a praedictis perpendicularibus divergere. Cujus refractionis causus & elementa non nostrum est hic explicare, abunde enim de his disputarunt *Alkazanus, Vitellio, Keplerus, & mulit alii*: Quoniamve: ob quae de earum mensurâ ab authoribus profaeruntur minus solida videntur, paucula quaedam de hac re (Mathematicis forsan non inutilia) in medium adducere conabimur. De his autem quae altioris sunt considerationis, liceat paululum analogicè disputare, priusquam ad αχριβειαν geometricam accedamus.

Satis patet ex Opticis elementis, multa Catoptricae, & Dioptricae esse communia ; forsan igitur; & in reflectionum, & in refractionum mensuris, aliquid commune haerebit : Totum autem reflectionem mysterium, in sectionibus conicus latere compertum est; (ut deinceps patebit) forte igitur & refractionum mensura illic latebit. Secundo non fit regularis reflectio, nisi superficies reflectionis sit sectio conica ; fortassis ergo nec regularis refractio, nisi refractionis superficies sit sectio etiam conica.

Si vero superficies reflectionis sit concavitas parabolae, & radii incidentes axi paralleli, omnes reflectuntur in focum : Quaeritur ergo num possit dati superficies refractionis, ita ut omni radii in eam incidentes, speciali cuidam lineae paralleli, refringantur in unum aliquod punctum determinatum? ex praedictis probabile est (si talis detur) hanc superficiem esse conicam sectionem : ut autem talem superficiem analogicè inquiramur, ab extremis incipiatur ; & concipiamus medium in quod incidunt radii esse densissimum ; radii refracti, ad superficiem medii perpendiculares erunt. (*Keplerus Ast. Opt. fo. 113*) Quaeritur igitur sectio Conica, cuius omnes perpendiculares ad sui lineam, in unum punctum concurrant ? talis autem est circulus. Secundo concipiatur illud medium densissimum, per quod transeunt radii paralleli ; & quoniam eisdem lineis egreditur forma quibus ingreditur ; ingreditur autem forma, lineis superficiei perpendicularibus, ut hactenus dictum ; ergo egrediuntur radii, sive forma, e medio densissimo lineis perpendicularibus : Quaeritur igitur sectio conica cujus omnes perpendiculares ad sui lineam sint paralleli ? talis autem est linea recta. Supponendo igitur, radios parallelos quotcunq; A, A, A, &c. in uno plano, refringi in superficie medii densissimi, & superficiem refractionis esse circulum ; radii refracti concurrent in centrum circuli B: uni igitur ex extremis est satisfactum. Supponendo etiam radios quotcunq,; ex puncto B existente in medio raro prodeuntes, refringi in medio densissimo cujus superficies refractionis comprehendetur linea recta DE, omnes lineae refractae evadent parallelae in medio densissimo. Si vero hi radii paralleli in uno plano medii densissimi, concipiantur in medii rarioris superficie DE refringi, (quoniam iisdem lineis egreditur forma quibus ingreditur) concurrent omnes radii A, A, A, &c. in punctum B; atq; ita altera ex extremis est satisfactum. Si vero, rem diligenter quis intueatur, videbit (propter praedictas rationes) omnes radios, sive parallelos, sive non parallelos, in superficiem refractionis circularem medii densissimi incidentes, in circuli centrum concurrere. Quaeritur autem unde hoc proveniat ? Respondetur ; videtur hoc provenire ex eo, quod quomodocunq ducatur linea in circulum incidens, (dummodo cum circulo in eodem sit plano) axis ipsi parallelus duci possit ; concipiendo nimirum, circulum esse ellipseps speciem, quaevis illius diameter potest dici axis ; unde videtur ; axem sectionum conicarum, esse lineam specialem quaesitam. Animadverdenti quoque patebit, omnes radios, in uno plano medii densissimi parallelos, non in unum tantum, sed in quodlibet punctum assignatum, extra lineam DE, ad partes B concurrere : Quaeritur etiam unde hoc proveniat ? Respondetur; hoc vedetur provenire ex eo quod, (supponens lineam rectam esse hyperbolam) quodlibet punctum extra ipsam possit sumi loco foci ; unde videtur focum esse punctum concursus quaesitum. E duobus autem focis, vel realibus, vel imaginariis, is erit punctum concursus, qui longissime a radiorum incidentia distat, alioquin angulus refractionis esset major recto, quod fieri non potest. Hisce de extremis praelibatis medium tentemus : Si autem radios provenientes e diaphano raro in densissimum, & e diaphano densissimo in rarum extrema concipiamus ; necessario sequitur radios ex uno diaphano, in aliud ejusdem densitatis incidentes, esse medium inter praedicta duo extrema ; in hoc autem casu nulla sit refractio ; In parabola ergo (quae media est inter circulum & lineam rectam) omnes lineae axi parallelae, & in eodem cum parabolâ plano, in ipsam incidentes, debent per refractionem concurrere in focum, a punctis incidentiae maximè remotum : at focus iste a vertice parabolae infinitè distat ; omnes igitur radii in parabolam incidentes, & ad praedictum focum imaginatium ducti, sunt axi paralleli : si vero & ante, & post incidentiam, sint axi paralleli, a refractione omnino sunt liberi, quod est propositum. Concludimus igitur analogicè pro omni diaphanorum diversitate, inverniri posse superficiem refractionis (quae sit sectio conica) in quâ lineae parallelae in plano unius diaphani, in altero refractae concurrant in punctum : quo autem densius fuerit diaphanum in quo radii sunt paralleli, & quo rarius diaphanum in quo concurrunt ; eo propius accedit superficies refractionis ad hyperbolarum obtusissimum, id est lineam rectam : & e contra; quo rarius fuerit diaphanum, in quo radii sunt paralleli, & quo densius fuerit diaphanum, in quo concurrunt, eo propius accedit superficies refractionis ad ellipsium obtussimam, id est circulum. Verùm relictis hisce analogiae nugis, ad experientiae scientiarum originis certiora testimonia accedamus.

§2. Synopsis Propositions 2 - 6: The Law of Refraction for Dense Ellipsoids and Hyperboloids.

According to Gregory, for a ray with a given angle of incidence *i* at a plane boundary separating two media, the angle of deviation *d* of the ray as it passes from one medium to the other is a measure of the refraction between the surfaces.

In *Prop. 2*, an experiment is described in which the angles labeled *i* and *d* are measured.

Prop. 3 shows how to construct an ellipse in which the incident ray is parallel to the principle axis at some point on the ellipse, with an angle *i* to the normal of the tangent at that point, while the refracted ray at an angle $r = i - d$ passes through the far focus. Note that new ideas introduced are called *Theorems*, while applications of given material are called *Problems*.

Prop. 4 demonstrates that the ratio sin *i* : sin *r* reduces to the ratio axis length : inter-focal distance.

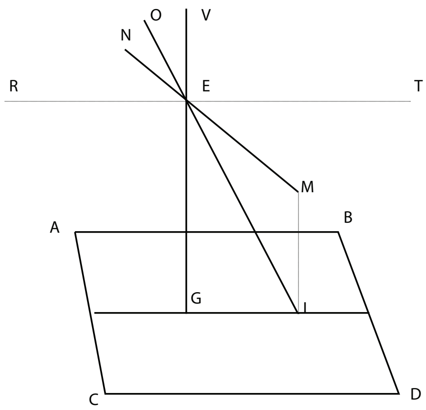
Prop. 5 extends the result of Prop. 4 to the case of many rays parallel to the axis, which all pass through the far focus of the dense ellipsoid. There are subsequently some tables for refraction through water, glass, etc, taken from the works of Witelo, Kercher, which he compares with his own measurements. Gregory appears to have conducted very precise experiments of his own. Of interest to the modern reader is the practice of comparing all the measurements to those of a particular angle, rather than taking an average, for the actual idea of a refractive index was not yet in use. (*This proposition not included here - Ed.*)

Prop. 6 introduces the other kind of refracting surface - related to the hyperbola. In the ellipsoidal case, rays parallel to the axis are sent through the far focus by refraction at the elliptic interface. In this case, rays diverging in air from the far focus are rendered parallel on refraction at the hyperbolic interface of the dense medium. (*This proposition not included here - Ed.*)

§2. Prop.2.1 Prop. 2. Problem.

To find the refraction of any medium with air.

Let some plane ABCD be set up parallel to the horizontal or close to it ; and let some other point be fixed at a higher position E, and through E a perpendicular VEG may be considered to be drawn to the horizontal, and the angle of incidence in the medium (of which the refraction of the angle in the medium is required) is GEL, which is measured with an astrolabe or quadrant. Finally the whole space between the plane ABCD and the point E is filled up a medium; the smooth surface of which shall be accurately parallel to the horizontal at the point E. By viewing with the eye placed at E, a small body placed at L shining brightly will appear to be shining brightly at M. Therefore, by measuring the angle NEV, [or GEM], the difference between that angle and the first angle OEV, [or GEL] will give the angle of refraction NEO sought, coming together with the angle of incidence NEV in air at E : [the task] which had to be accomplished. Anyone who wishes to find the angles of refraction by other means, may consult Witelo, Kepler, and the other dioptrics authorities.



Prop.2-Figure 1.

§2. Prop.2.2. Note on Prop. 2.

The Law of Refraction as we know it, had first been established experimentally by Thomas Harriot in the summer of 1601, but he had not communicated his discovery beyond a close circle of friends that included Aylesbury and Warner. [*vide* J. Lohne, *Essays on Thomas Harriot*, J. Arch. Exact Sciences, p.275,(1979)]: the law was to be rediscovered by Snell in 1624, but was not published by him. Descartes (1637) had independently discovered the law experimentally, while Fermat had applied his principle of least time to give the first theoretical explanation of the phenomena of refraction and reflection. Thus the scientific community, such as it was at the time, was familiar with Snell's Law when Gregory produced his book. Gregory however did not have the law of refraction as a ratio of sines, though he measured refraction with a ratio that can be reduced to this form for the case of conoidal surfaces. The method adopted by Gregory to measure the angle of refraction of a ray, say through a flat glass slab, appears to be as follows:

1. A small light source at L is observed in air initially through a small opening at E with the eye placed at O.

2. The medium is placed in position with E on or very close to the smooth horizontal surface, and again the image of the light from L is observed - now refracted at the surface, and passing through E along EN. The observer considers the image to lie at M, which can be found using the parallax method, [by simultaneously viewing a small object placed outside the medium, and adjusting to give the same height ML, when there is no relative motion on moving the eye slightly]. Gregory regards the angle of deviation NEO as a measure of the refraction: the same experiment survives to this day, where one measures the true depth and the apparent depth of an object, from which the refractive index of the medium can be extracted.

§2. Prop.2.3. Prop. 2. Problema.

Refractiones cujuscunq; diaphani aere invenire.

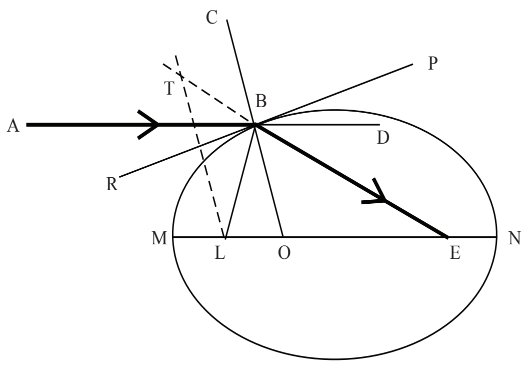
Sit planum aliquod ABCD stabilitum, & horizonti parallelum, vel eo circiter; sitq; punctum aliquod firmissimè stabilitum in sublimi positum E, & per punctum E concipiatur duci perpendicularis ad horizontem VEG, sitque angulus incidentiae in diaphano (cujus anguli refractio requiritur) GEL, qui faci è mensuratur astrolabio, vel quadrante: & in puncto L, figatur corpusculum resplendens, & tandem impleatur totum illud spatium inter planum ABCD, & punctum E, diaphano optimè polito, cujus superficies ad E punctum, horizonti sit exquisitè parallela, & aspicienti per punctum E, apparebit resplendens in M; explorato igitur angulo NEV, seu GEM; differentia inter illum, & priorem angulum OEV, seu GEL dabit angulum refractionis quaesitum NEO, competentem angulo incidentiae NEV in aere, quod faciendum erat. Qui alios, refractionum angulos inveniendi, modos desiderat Vitellionem, Keplerum, alioque dioptrices auctores consulat.

§2. Prop.3.1. Prop. 3. Problem.

With two acute angles given, [*i.e. i* and *d* with $i > d$] *to find an ellipse such that the line parallel to the axis, incident on this ellipse, shall make an angle with the tangent, equal to the complement of the larger angle*, *and the line from the point of incidence to the focus at the greater distance shall make an equal angle with the axis to the smaller angle.*

Let the two angles be given, ABC the larger and DBE the smaller, and the tangent line RBP of the ellipse shall be found perpendicular to CB at the point B, the line AB shall be parallel to the axis of this ellipse, and the line BE shall cross through the further focus. Through any point of the line EB [*i.e.* the actual size of the ellipse is not important], without doubt E, EO is drawn parallel to the line AB, to which the other line CB is produced in O, and the angle OBL is made equal to the angle OBE, and MN shall be equal to the sum of EB and BL. This shall be equal to the axis of the ellipse sought, with the positions of the foci at L and E and the axes MN. The ellipse MBN can be described which necessarily will cross through the point B.

Conversely, since LB and BE together are equal to the axis MN (by the converse of [*Prop*.] 48, *Book* 3, *Apollonius*), and since the angles OBE and OBL are equal, if they are taken from the right angles RBO and OBP, then the equal angles EBP and RBL are left; and therefore the line RBP is made to touch the ellipse in the point B (by the converse of [*Prop*.] 52, *Book* 3, *Apollonius*). With AB parallel to the axis MN, the angle RBA is the complement of the given larger angle ABC; and because the lines AD and MN are parallel, the angle to the further focus BEO is equal to the given smaller angle DBE, as required.



§2. Prop.3.2. Note on Prop. 3.

Angle ABC is the angle of incidence *i*, while Gregory has taken the angle of deviation DBE or *d*, as a measure of the refraction by the medium. Thus, the experimental procedure of Prop. 2 for measuring refraction is adopted for the curved surfaces of the lenses to be subsequently discussed.

§2. Prop.3.3. Prop.3. Problema.

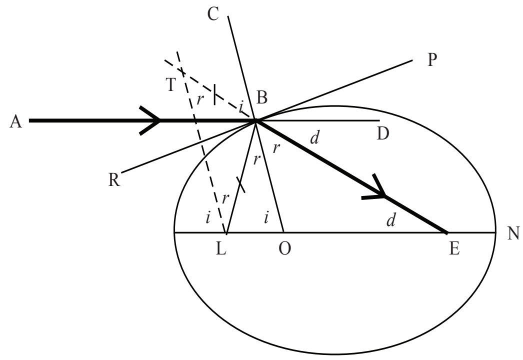
Datis duobus angulis, non obtusis, invenire ellipsin, ut linea axi parallela, in eam incidens, efficiat cum tangente angulum, equalem complemento majoris, & recta a puncta incidentiae ad focum maxime distantem, efficiat cum axe angulum aequalem minori.

Sint dati duo anguli, ABC major, DBE minor, sitque invenienda ellipsis tangens lineam RBP ad CB perpendicularem in puncto B, cujus axis rectae AB sit parallelus, & linea BE per focum maxime distantem transeat. Per punctum quodlibet lineae EB, nimirum E, ducatur lineae AB parallela, EO, quae utrinque producatur : producatur CB in O, & fit angulus OBL aequalis angulo OBE, fitque MN aequalis EB & BL simul; quam dico esse axem ellipseos quaesitae, positis focis L & E: axe MN, & focis L, E, describatur ellipsis MBN quae necessario transibit per punctum B; quoniam LB, BE simul sint aequales axi MN (per conversum [*Prop*.] 48, *lib* 3, *Apoll.*), & quoniam anguli OBE, OBL sunt aequales, si a rectis RBO, OBP auferantur, relinquuntur anguli EBP, RBL aequales; tangit igitur linea RBP ellipsin in puncto B (per conversum [*Prop*.] 52, *lib* 3, *Apoll.*); facitq; cum AB, axi MN parallela, angula RBA aequalem complemento anguli dati majoris ABC; & ob parallelisimum linearum AD, MN, angulus ad focum remotiorem BEO, aequalis est angulo dato minori DBE, quod erat faciendum.

§2. Prop.4.1. Prop. 4. Theorem.

With the same situation, I say that the sine of the difference of the given angles shall be to the sine of the larger angle, as the separation the foci to the ellipse axis.

For the line EB [see Prop.3 -Fig.1] may be produced to T, and BT made equal to BL, and TL drawn. Therefore the angles BTL and BLT are equal, and also the angle LBE is equal to the sum of both, and therefore EBO, or half the angle EBL, is equal to the angle BTL, therefore the triangles EBO are ETL are similar. But the angle BOL is equal to the larger given [*i*] ABC, on account of the parallel lines AB and MO, and the angle BEO is equal to the smaller given angle DBE [*d*]. But BEO and OBE added together are equal to the angle BOL, and therefore the angle OBE, or LTE is equal to that angle, and this is the difference of the given angles ABC and DBE; and also the angle TLM is equal to the angle BOL, or to the given larger angle ABC. As a consequence we conclude the sine of the difference of the angles given, that is the sine of the angle LTE is to the sine of the larger angle given TLM, as the separation of the foci LE is to the length of the axis of the ellipse TE. Q.E.D.



§2. Prop.4.2. Note on Prop. 4.

Gregory has independently discovered a form of the familiar law of refraction $\sin i/\sin r = n$, where i is the angle of incidence ABC, r the angle of refraction OBE, and n the index of refraction of the medium relative to air. For the angle of deviation d used by Gregory is given by $d = i - r$, while n is related to the eccentricity e of the ellipse of major diameter $2a$ by $n = 1/e$. Thus, $\sin i/\sin(i - d) = 2a/2ae$, or $\sin i/\sin r = 1/e$, where e is the eccentricity of the ellipse in modern terms, though this particular terminology was not in use at the time. Indeed, the focus/directrix property of conic sections was not discovered until the beginning of the 19th century by the two Belgian mathematicians Quatelet and Dandelin - see e.g. Eves: *An Introduction to the History of Mathematics,* p. 169.

§2. Prop.4.3. Prop. 4. Theorema.

Iisdem positis, dico sinum differentiae angulorum datorum, esse ad sinum anguli majoris, ut focorum distantia, ad axem ellipseos.

Producator enim linea EB in T; fitq BT aequalis BL, & ducatur TL ; erunt igitur anguli BTL, BLT aequales, & LBE aequales ambobus simul, ergo & EBO semissis anguli EBL, aequalis erit anglulo BTL, triangula igitur EBO, ETL sunt equiangula ; est autem angulus BOL aequalis majori dato ABC, ob parallelismum linearum AB, MO, estque angulus BEO aequalis minori angulo dato DBE: BEO autem & OBE sunt aequales angulo BOL; igitur angulus OBE, vel illi aequalis LTE, est differentia angulorum datorum ABC, DBE; est quoq; angulus TLM aequalis angulo BOL, vel majori dato ABC. Concludimus ergo, sinum differentae angulorum datorum, hoc est angluli LTE, esse ad sinum anguli majoris dati nimirum TLM, ut distantia focorum LE, ad axem ellipseos TE, quod erat demonstrandum.

lambda scientific

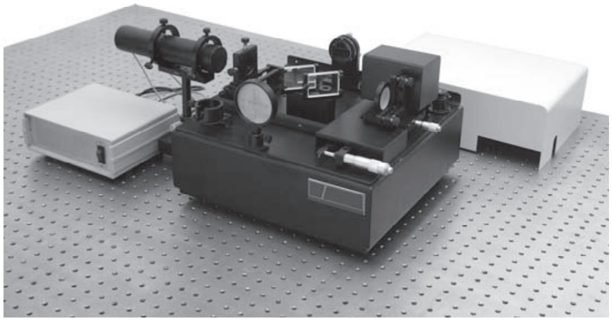
Optics Education

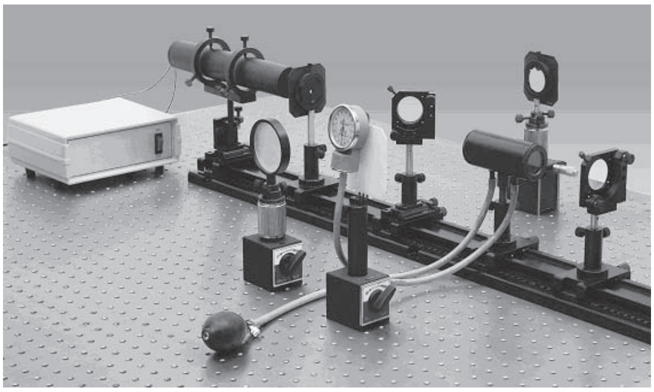
LEOI– 21 Universal Interferometer

LEOI-21 provides precision Interferometry for both Michelson and Fabry-Perot interferometers.

Michelson interferometer is for observing interference phenomena such as equal inclination, equal thickness, white light interference, precise wavelength comparison and measuring the refractive index of transparent slice or air .

Fabry-perot interferometer is for observing multiple-beam interference and measuring fine structure of spectrum.





LEOK-3 Optics Experiment Kit

LEOK-3 allows users to construct most of the optics experiments required in general physics education. It provides a complete set of optical, mechanical parts and light sources and can construct 26 experiments in below categories.

- Lens measurement
- Optical instruments
- Interference phenomena
- Diffraction phenomena
- Polarization analysis
- Fourier optics and holography

LEOK-21 Fibre Optics Experiment Kit

LEOK-21 enables users to understand the principle of fibre optics and develop practical skills on optoelectronics. It can construct below experiments

- Fundamental of fibre optics
- Coupling method between fibre optics and light source
- Multimode fibre numerical aperture measurement
- Fibre optics transmission loss measurement
- M-Z fibre optics interference experiment
- Fibre optics thermal sensing principle
- Fibre optics pressure sensing principle
- Fibre optics beam splitter parameter measurement
- Adjustable optical attenuator parameter measurement
- Fibre optics isolator and parameter measurement

www.lambdasci.com

Lambda Scientific Pty Ltd
2/147, Buxton Street, North Adelaide SA 5006 Australia
Phone: +61 8 8267 2686
Fax: +61 8 8267 2689
E-mail: sales@lambdasci.com

SPIE The International Society for Optical Engineering

SPIE was formed in 1955 as the Society for Photo-optical Instrumentation Engineers, and has been dedicated to providing the best possible service to the optical engineering community. SPIE is an international technical society dedicated to promoting the engineering and scientific applications of optical, photonic, imaging and optoelectronic technologies through its education and communications programs, meetings and publications.

SPIE offers

International Networking

Today SPIE is the largest international professional engineering society serving the practicing engineer and scientist in the field of optics and photonics. The Society serves the global technical and business communities, with over 14,000 individual, 320 corporate, and 3,000 technical group members in more than 75 countries worldwide. Advance professionally through networking and visibility among your peers. Learn from others and gain access to the voices, ideas, and the energy of a global community.

Meetings

Among the many services the Society offers are the sponsorship, planning, and execution of technical conferences, product exhibitions, and symposia. SPIE's technical meetings and symposia are internationally-acclaimed gatherings of engineers and scientists working in optics, optoelectronics, and many related fields. They take place in large and small venues, from specialised topics to cross-disciplinary information exchanges, complete with extensive programs including short courses, workshops, and other special activities.

Publications

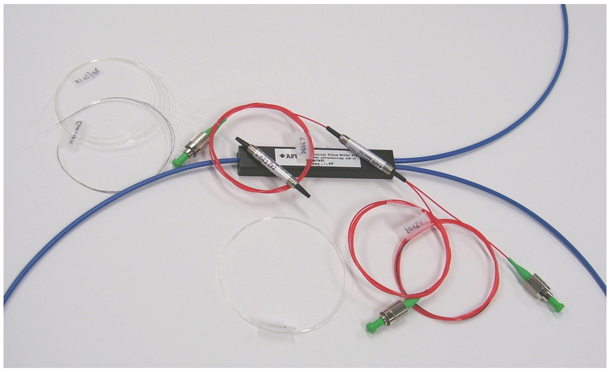
A major activity of SPIE is the publication and distribution of archival professional journals, full-manuscript conference proceedings, newsletters, and optics-related texts and monographs. SPIE publications deliver timely, high-quality technical information to the optics, imaging, and photonics communities worldwide. Membership includes a subscription to
OE Reports, a monthly newspaper that provides news and commentary on cutting-edge technology.

and More

In addition, SPIE provides numerous services to its members, including on-line electronic databases, electronic bulletin board and networking services, and employment assistance. To further serve the public good, the Society sponsors a number of awards, scholarships, and educational grants every year, and publishes a comprehensive catalogue of educational resources in the optics field,
Optics Education.

To join SPIE: Complete the online membership form at *www.spie.org/membership_form.html*, print and fax it to SPIE along with a copy of your AOS dues receipt. (Be sure to indicate that you are eligible for the US$20 discount as an AOS member). Any queries can be directed to Mr Paul Giusts at *membership@spie.org*

SPIE International Headquarters
Tel: +1 360 676 3290 *Fax*: +1 360 647 1445 *email:* spie@spie.org
web: http://spie.org
PO Box 10, Bellingham WA 98227-0010 USA

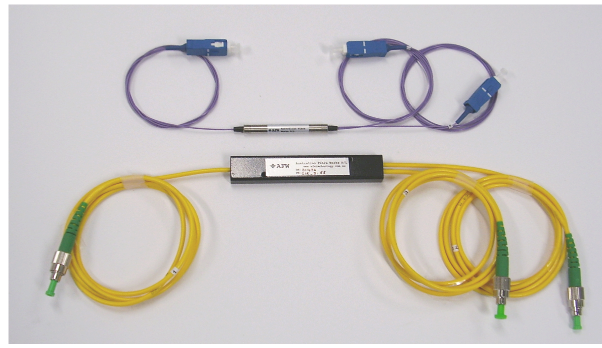


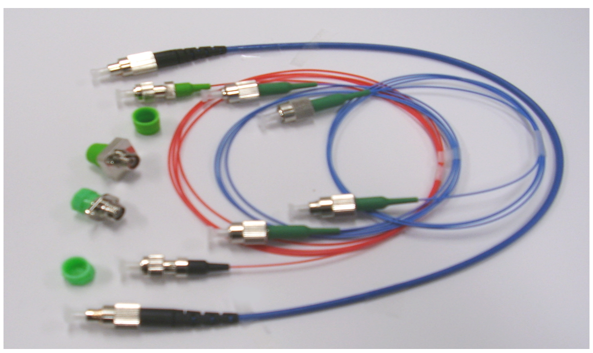
Polarization Maintaining Filter Coupler

- 1x2 or 2x2 port configuration
- Optical signal splitting while preserving polarization.
- Available in 250um, 900um or 3mm cable types
- High ER, high RL, low access loss, high power
- 1030nm, 1064nm, 1310nm and 1550nm
- Range of coupling ratio 1/99, 5/95, 10/90, 50/50 etc
- For communication systems, amplifiers and lab research
- Customer specified coupling ratios and wavelengths

Optical Circulator

- 3 port or 4 port version
- SMF fiber or PM panda fiber
- Available in 250um, 900um or 3mm cable types
- High extinction ratio, high RL, high power
- 1030nm, 1064nm, 1310nm and 1550nm
- High isolation between ports
- With connector or without connector



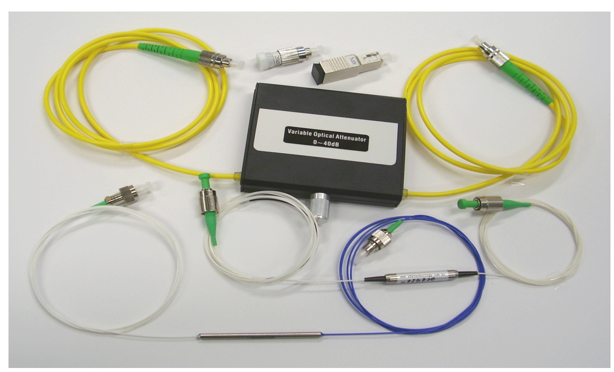


Polarization Maintaining patch cords and pigtails

- Available in 250um, 900um or 3mm cable types
- High extinction ratio up to 28dB
- 980nm, 1064nm, 1310nm and 1550nm
- Slow axis or fast axis aligned to connector key
- FC or FC/APC connector types
- Narrow key 2.02mm or wide key 2.14mm connector
- SMF, Hi1060, MMF fiber also available

Optical Attenuator- PM and non-PM version

- Variable and fixed type for SM fiber
- Fixed attenuator for PM panda fiber
- High attenuation precision
- Fibre coupled attenuator with or without connector
- 20dB min extinction ratio, high RL
- For communication systems, sensors and lab research
- Available in customer specified attenuation values



AFW

Australian Fibre Works Pty Ltd

Suite15, 88-90 Walker street
Dandenong, VIC 3175
Tel: +613 9702 4402
Fax: +613 9708 6883
Email:sales@afwtechnology.com.au
Web:www.afwtechnology.com.au

Laser Accessories

Vibration Isolation Tables, Platforms & Workstations

Kinetic Systems offers a comprehensive range of passive or active vibration isolated optical tables, workstations & platforms offering:

- Large Range of Sizes & Performance Levels
- SPILLPRUF Spill Management System
- Variety of TableTop Materials
- Optional Accessories Including Casters, Guard Rails, Armrest, Faraday Cages, Enclosures, Additional Shelves & Many More
- Custom Designs Available

Nano Positioning Systems

- 1 to 6-axis Systems Available
- Travel up to 1mm
- Sub-nanometre Resolution
- Sub-nanometre Repeatability
- Analogue or Digital Control Electronics
- New Integrated PIMCA Ceramics Offer Greatest MTBF
- Control Options include Patented Input Processing for Shortest Step & Settle Time.

Micro Positioning Systems

- Systems with 1 to 6+ Degrees of Freedom
- Travel up to 300 mm
- Nanometre Resolution
- Sub-micron Repeatability
- Complete with Labview drivers (+ others)
- Standalone or PC Based Controllers
- National Instruments Interface Available

Laser Power & Energy Meters

- Dual Channel Power/Energy Meter
- Variety of Power & Energy Heads Available
- Simultaneous Power & Energy Readings
- USB Interface with Remote Control to LabVIEW
- SD Card for Data Logging
- Digital, Analogue Bar & Graphic Options
- Hand Held Power Probes Also Available

Detectors

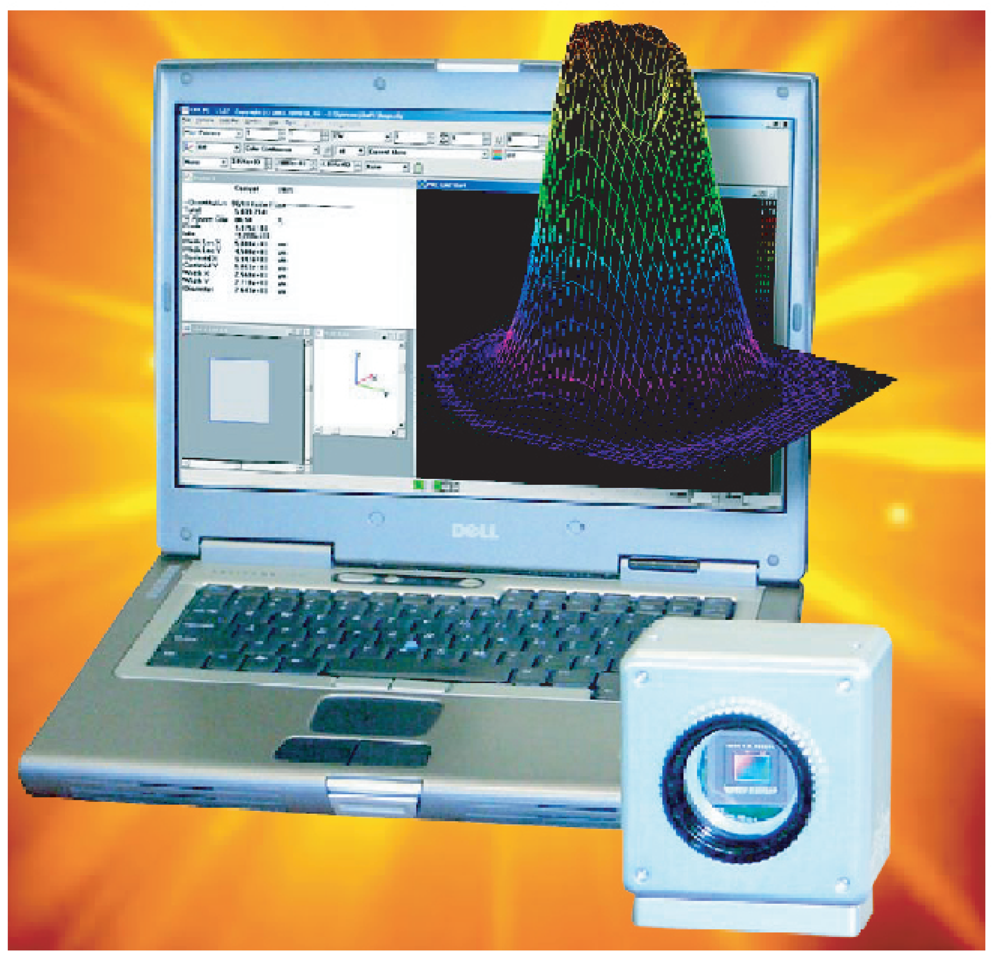
Warsash offers a comprehensive range of detectors from the UV to the far IR including:
- Silicon PN, PIN & APD Detectors (Including Photon Counting Modules)
- InGaAs PIN & APD Detectors (Extended Versions Available)
- HgCdTe Detectors (Photoconductive & Photovoltaic Available)
- Full range of Ge, PbSe, PbS, InSb & InAs Detectors
- Channel Photomultipliers (Including Photon Counting Modules)
- Comprehensive Range of Controllers, Amplifiers, Voltage Supplies, Coolers etc

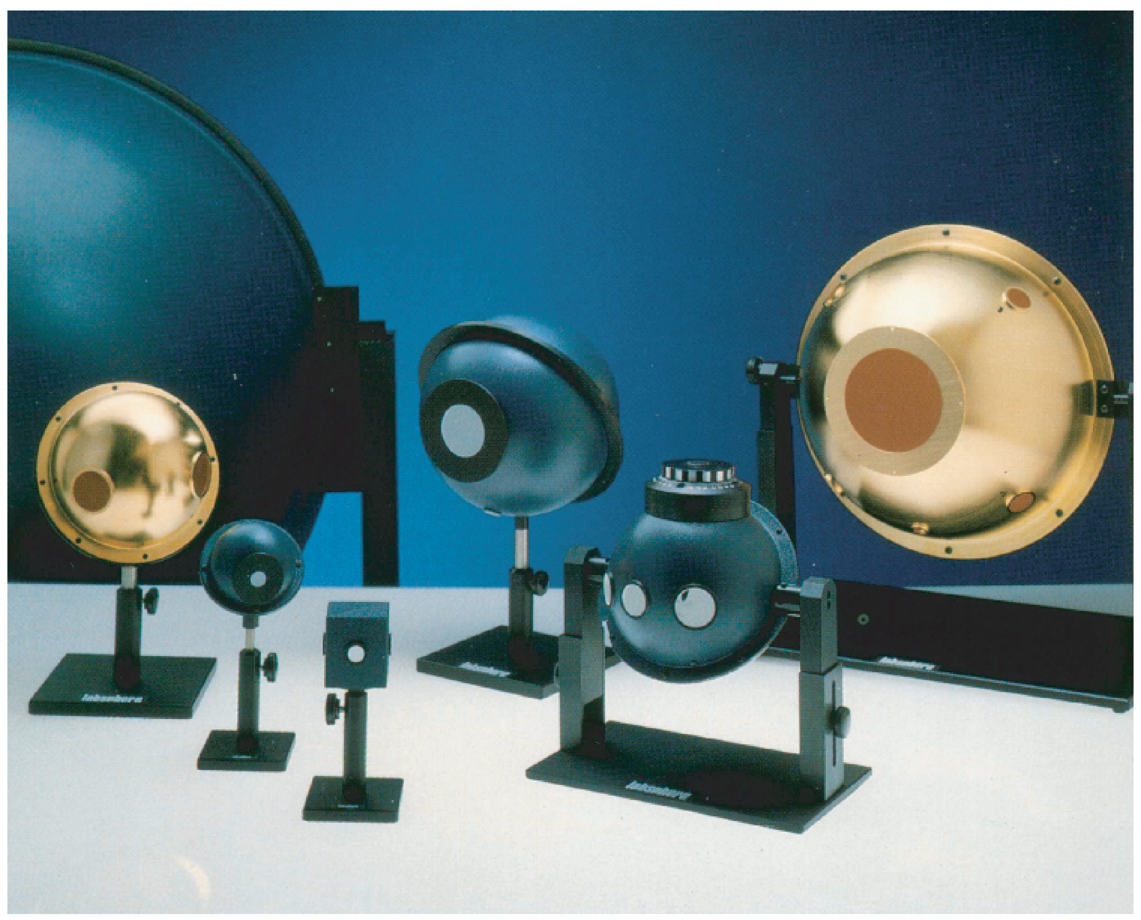
Laser Safety Products

Warsash can supply a complete range of Laser Safety products including:
- A Comprehensive Range of Protective Eyewear Frames & Filters (Including Prescription Lenses & CE Certified)
- Laser Barriers & Screens
- Laser Safety Windows
- Interlock Systems & Warning Signs
- Advise on Suitable Protective Measures

Laser Beam Analyser Systems

With Spiricon's range of laser beam analyser systems you can accurately analyse your laser beam in real time. The Spiricon systems offer the following advantages:
- Compatible with Nearly all Commercially Available CCD Cameras
- UV to IR Systems Available (Including Cost Effective 1550nm Systems)
- Analogue (8 to 14 bit), Digital (auto 8 to 16 bit) & FireWire versions Available
- Patented UltraCal Technology Accurately Measures the Baseline
- M² & Hartmann Wavefront Analysers Available





Integrating Sphere Systems & Reflectance Material

Warsash offers a full range of Integrating Spheres & reflectance materials including:
- 2" to > 2m Diameter Spheres
- >99% Reflectance Material from the UV to IR
- Uniform Source Systems
- Calibrated Measurement Sphere Systems
- Reflectance Standards & Targets
- Custom Reflectance Coating & Machining Service

WARSASH Scientific
Advanced Instruments for Research & Industry

Sydney
PO Box 1685
Strawberry Hills
NSW 2012
Tel: (02) 9319 0122
Fax: (02) 9318 2192
sales@warsash.com.au
www.warsash.com.au

CUDOS

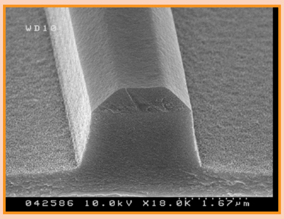
Centre for Ultrahigh bandwidth Devices for Optical Systems

An Australian Research Council Centre of Excellence

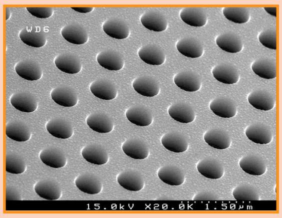
Chalcogenide materials platform

Switching, regeneration, wavelength conversion etc require nonlinear optical response. Our approach: use waveguides of chalcogenide glass (fibre or etched in planar thin films), combining high material nonlinearity (n2) and tight confinement to produce nonlinear response at low threshold.

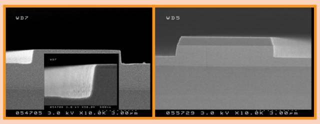
Gratings and photonic crystals can also be written into the planar films using focused ion beam or phase mask interferometry.



Chalcogenide Waveguide

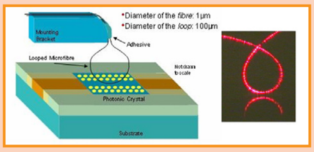


An image of a 2-D photonic crystal lattice milled into a 300nm thick AMTIR-1 chalcogenide glass membrane supported on a silicon nitride window.



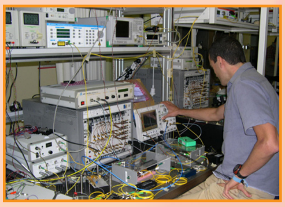
(Left) Profile of reactive ion-etched As_2S_3 waveguide; (Right) Similar rib waveguide structure in AMTIR-1 glass.

Light can be coupled from fibres into planar resonant cavities in photonic crystals using looped tapered fibre for experiments in switching and filtering.



Schematic of a looped taper used for high efficiency coupling to photonic crystal waveguides, with an illuminated looped taper (at right).

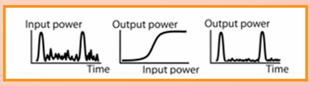
Devices can be evaluated using short pulse lasers with FROG analysis for detailed physical studies of pulse propagation through to 160 Gb/s BERT systems for evaluating network performance.



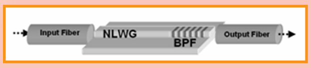
Mark Pelusi tests a component in the 40 Gb/s BERT system at Sydney University.

Applications

Here is an example of a simple integrated photonic regenerator. High intensity pulses are broadened enough in the waveguide to pass through the offset Bragg filter. No broadening occurs at low intensities. The power transfer curve can be tailored to have the correct nonlinear response.



This nonlinear power transfer curve results in both signal to noise and bit error rate improvement.

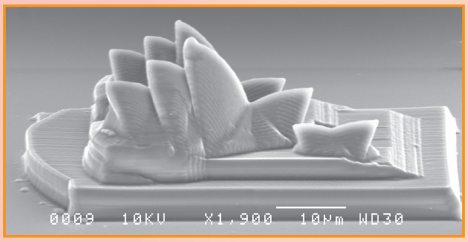


The optical regenerator consists of a 5cm long nonlinear As_2S_3 rib waveguide where spectral broadening occurs due to intensity-dependent phase modulation, followed by an integrated Bragg grating band pass filter, offset from the signal frequency, near the exit facet.

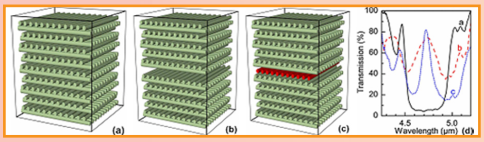
Similar phase modulation techniques produce wavelength converters and pulse compressors.

Three dimensional photonic crystals

We use photo-polymerisation and micro-explosion techniques to create three dimensional photonic crystals. Photo-polymerisation allows all kinds of microscopic objects to be sculpted



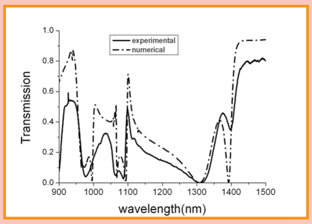
while the micro-explosion approach allows regular structures like "woodpiles" to be micro-machined.



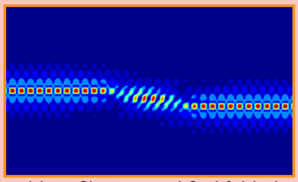
(a) Schematic of a woodpile lattice in which the void channels are represented within a bulk polymer material;
(b) a planar defect embedded within a woodpile lattice;
(c) a one-dimensional lattice is embedded within a planar defect;
(d) infrared transmission measurements of a simple woodpile lattice (solid black), with planar defect (dashed red) and embedded one-dimensional lattice (dotted blue).

Device modelling

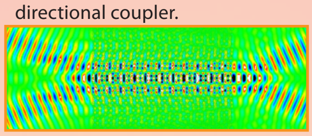
Semi-analytic and fully numerical codes are used to develop, explore and optimise photonic device concepts.



Experimental and theoretical transmission spectra (3D FDTD) compared on a linear scale. Radius r=250 nm; the lattice period was 1000nm.



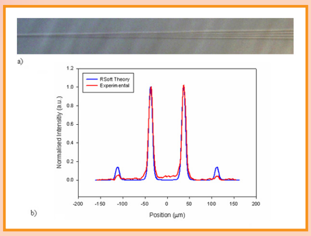
Field profile in a modified folded directional coupler.



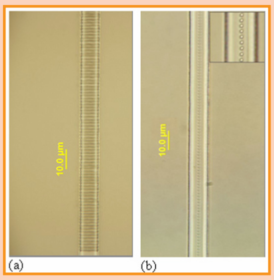
Field plot in an autocollimating beam combiner relyin on highly efficient coupling.

Femtosecond laser machining

Allows waveguides, gratings, couplers to be written directly into active glasses and other bulk materials.



a) Phase contrast micrograph of a femtosecond laser-written conventional 1.4 splitter;
b) the experimental and modelled output in the 4 arms.



Gratings formed in rib waveguides using (a) the scribe methods and (b) the single-pulse method (close-up of features shown in the inset).

For more information please visit http://www.cudos.org.au or email cudos@physics.usyd.edu.au

CUDOS Student competion

The ARC Centre of Excellence CUDOS recently ran a student competition where students had to describe their research in terms accessible to lay-people. We published three of the entries in the last issue, and here we publish three more in this issue of the AOS News.

Gifted glasses to Lure Light: *The Age of Optics*

By Amrita Prasad

Australian National University

Harnessing the potential of new materials has revolutionized civilization. It took early man from the Stone Age to the Iron Age and it is now taking us into the Age of Optics. 'Lightening fast' communication characterizes this era and chalcogenide glasses are the building blocks. These glasses are used to harness and manipulate the fastest thing in the universe – light.

Electronic communication systems sufficed a few decades ago. However with the advent of the Internet, arguably the most significant technological development of the 20th century, electronic systems were pushed to their limit. Optical communication promised unlimited opportunity and expansion in terms of bandwidth and speed. The invention of the optical fibre in early 1980s saw bulky electric cables being replaced by their hair-thin counterparts. A single strand of optical fibre can carry more than half a million-telephone conversations and over thousands of computer connections and TV channels!

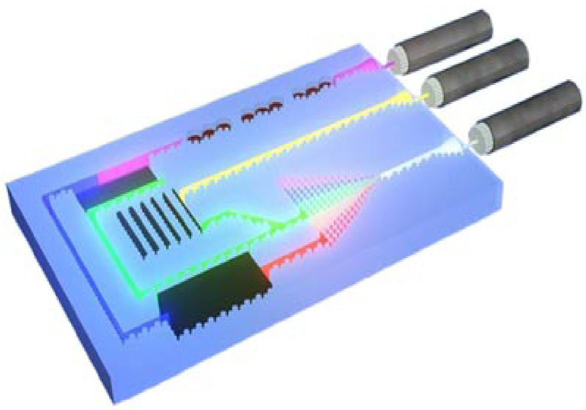
The science involving material processing and purity of optical fibres themselves has rapidly advanced. Silica fibres can carry signals for over 250 kilometres before any amplification is required. However, amplification in longer fibre links was initially done *electronically*. Optical signals had to be converted to electrical signals, amplified, converted back to optical signals and sent along their way. This brought the speed of communication to a screeching halt in the face of slower electrical components. Early 1990s heralded the breakthrough innovation of an optical amplifier. Researchers found a way to boost the optical signal by doping a part of the fibre with a special material (Erbium). Without this invention, it might have been impossible to keep up with the demands on communication, which we have realised today.

However, not all of the existing electronics can be replaced with optical components as yet. Switching, regeneration and routing of signals is still done electronically. This leads to those inconvenient delays on 'high speed' Internet and over long distance phone calls. Here at the Australian National University we say no to delay! The Laser Physics Centre, which is part of the Research School of Physical Sciences and Engineering, has research groups dedicated to studying the ways of light and its interaction with materials. This approach is fundamental - using materials themselves to manipulate light. At the heart of this study is a set of glass materials called the '*chalcogenides*'. Sulphur (S), Selenium (Se) and Tellurium (Te) are the '*chalcogen'* elements and we make these into glass form by adding Germanium (Ge) and Arsenic (As). The resultant glass has potentially remarkable properties.

Chalcogenides react to input light in a *non-linear* fashion. The refractive index (which determines the speed of light inside a material) is dependent on the intensity of incoming light. Non-linearity of the refractive index forms the basis of using these materials for optical communications as it aids manageability of the light path and routing. *Chalcogenides* are also intrinsically low loss at the telecom wavelengths (1310 and 1550 nm), which means they can be comfortably integrated into existing fibre networks. Such control opens up a wide range of possibilities – both scientific and economical.

Optical switching behaviour has been demonstrated for the very first time using these glasses. An optical signal is not sent not just from point A to point B in a 'straight path', it is switched on its way along a completely different path, without using any electronics! Progress has also been made towards developing an **all-optical regenerator**. This device basically receives the incoming optical signal, amplifies it and cleans it up (reshapes or retimes) before it continues along the system. In order to successfully implement optical components we study the material properties of *chalcogenides*. The quest is for an ideal composition with reasonably low loss and significantly high optical non-linearity.

Chalcogenides are diverse in their application areas – from medical surgery to military radar, understanding of these can lead to breakthroughs in all these fields. These materials have attracted global interest with research groups around the world striving in collaborative and competitive efforts. Our research will provide a simple and economical means to making all-optical communication a reality. Bandwidth limitations will be



Schematic of the All Optical Chip (picture courtesy Centre for Ultra High bandwidth Devices for Optical Systems (CUDOS), Australia) www.cudos.org.au a thing of the past and delays will no longer be an issue. Although this technology, in all its glory, will be fully functional over a decade hence, our research is working to lay solid foundations. Complex custom engineering and new and improved techniques will indeed welcome the Age of Optics.

Photons: young slaves of a technological society

Christian Rosberg

Australian National University

Many important scientific discoveries were made in the previous century, the first truly *technological* one in human history. One revolutionary achievement was the ability to understand and control the flow of electronic charges in various physical systems. Later on this knowledge was used to solve many complicated practical and technological problems.

We had already learned to make water, wind and steam work for us and for the advancement of society. To make them our slaves. Bending the free will of the electrons as well, and exploiting the poor creatures to our own advantage allowed for a whole new range of technological milestones to be achieved. In this way we eventually generated more freedom and prosperity than average human lives had ever seen throughout history.

Electrons first served as carriers of energy and information in simple metal cables, but soon the use of this cheap and reliable work force diversified tremendously. Advanced systems involving materials with special electronic conducting properties and increasingly complex circuits gave birth to the mighty electronics industry, and a true *electronic revolution* in society. Electrons are now the blood of most machines, flowing through all corners of our world and daily life. They brew our coffee, they vacuum our carpets, they run our computers and multiply huge numbers without making errors. And very reassuringly for their masters, it is unlikely that they will ever regain their lost freedom.

But why stop at electrons? Nature provides other useful creatures such as *photons*, the fundamental elements of *light* or *optical waves*. What if a success like that of the electronic revolution could be realised by a similar enslavement of the photon? A *photonic revolution?* The idea is not straight forward at all, but there is reason to be optimistic because the potential is huge, and a great deal of the work has already been done! Photons light our homes, they read and write our compact discs, they weld and cut through steel, they perform medical surgery, they scan and detect, and much more. However, although photons successfully find many natural and unique applications, they must often face competition with other technologies.

The development of an advanced photonics industry was triggered by the invention of the *laser* around fifty years ago. Through fundamental physical knowledge and clever engineering, lasers suddenly allowed for generating beams of very pure light in a highly controlled fashion. The evolution of modern *optical fibres* was another revolutionary landmark. An optical fibre is a

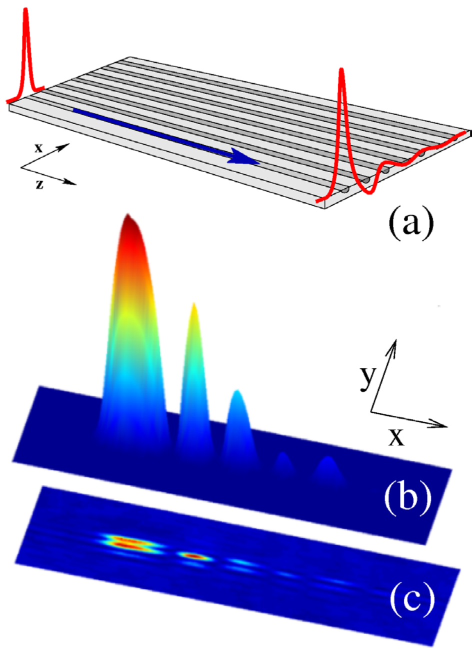


Fig. 1. (a) Schematic of a self-localized optical beam at the edge of a nonlinear waveguide array. (b) Measured intensity distribution of the output beam. (c) Interference fringes revealing a staggered phase structure.

thin cable made out of transparent material which can transmit photons or light signals. The material, usually glass, is arranged in a way as to confine light inside its core and guide it along the fibre. Optical fibres are therefore somewhat similar to electric cables, but transmitting photons rather than electrons.

With the laser being a superb photon source, and the optical fibre representing an elegant way to transmit light efficiently and over long distances, the road was paved for the extremely successful application of photons in signal transmission or *optical communications*. Over the past decades lasers and optical fibres have become the backbones of the global internet and telecommunication networks, in many cases replacing existing *electronic* technologies. Essential parts of the network systems still rely on electronics, but the ongoing sophistication and maturation of optical technologies gives hope for even more photonic territory in the future.

One of today's fundamental research challenges in photonics is the search for ways to control the propagation of light all-optically, i.e. *by means of light itself*. The main motivation for this is the need to modulate and switch light signals efficiently and at very high speeds in communication networks. Such signal processing is typically done electronically, and not all-optically.

Controlling light with light itself has some inherent advantages which, in principle, can improve system performance and reduce costs. But there are also many challenges associated with the realisation of all-optical control. One issue is that it is necessary to employ *nonlinear* optical materials. Nonlinearity means that photons can interact with a material and dynamically modify its properties. This in turn affects the way the photons themselves propagate through the medium, and thus self-control of light can be achieved. Unfortunately, only a limited number of suitable nonlinear materials are available, and to make practical use of even the best of them calls for a great deal of creativity and skills from scientists and engineers.

To overcome some of the limitations associated with the nonlinear materials, it is often possible to take advantage of the freedom in macroscopic design of the optical structures. Nonlinear effects can be explored in appropriately structured optical fibres, but also in carefully designed *waveguide arrays,* which essentially consist of properties of individual waveguides. By varying the intensity of the laser beam injected into the array, it is possible to either lock the light to a single waveguide (high intensity), or to let it escape (low intensity).

Such all-optical control of light propagation is illustrated in Fig. 1 which shows an experimentally observed self-localized beam at the edge of a nonlinear waveguide array. Several independent laser beams can be employed to realise switching of a number of passive low power beams by a high power control beam.

To integrate such beam switching schemes in complex systems requires more technical issues to be solved. However, each experiment as the one presented here improves our knowledge and skills and helps pushing the combined efforts further and further towards the fulfilment of the greater goals. History shows that it has been done several times before, and we know that history repeats itself. Revolutions happen all the time, in science and technology often bit by bit with help from all our little slaves.

Photons: lighting the path to electrons of the New Age

Cameron Smith
University of Sydney

Electronic transistors have been the key active 'building block' in practically all modern electronics since the 1960's. However, with growing interest in optical research, soon they may be replaced by components that operate not via electrons – but photons.

Since the first patent of the transistor was registered in Germany, 1928, by Julius Edgar Lilienfeld, technological advances have soared in the past 78 years, with scores of electronic devices pervading our daily lives. Medical, military, business and the home have all been radically affected by the invasion of electronics. And while progress continues near unabated, it is inevitable that our thirsts for ever greater speeds will demand above and beyond the limit of what electronic devices can provide.

The 1980's already saw optical technology begin to replace electronics, specifically for long distance telecommunications. Optical fibres are inherently much better at transporting data than their electronic (copper) counterpart, with a single fibre capable of transporting the same information flow as thousands of electrical links. However, the cost of electronic mass-produced components is still more economically viable for short distance, chip-to-chip type applications, with electronic speeds sufficient - for now.

Electronic transistors operate by using a controlling current or voltage to affect the conductivity of a semiconductor material. This can either allow electrical current to flow through (binary ON) or not (binary OFF). However, there is a limiting factor on their processing rate: size. The longer it takes the electrons to flow from one end of the component to the other determine how fast they operate. As such, there has been massive investment into the research and development of transistor miniaturisation, the result of which currently sees hundreds of millions of transistors on a single commercial microprocessor.

How small can they go, though? The more tightly packed the transistors are, the greater the power density, and thus heat, of the device. Heat affects semiconductor impedance, which in turn slows the flow of electrons. This means that as the transistors are reduced in size, thermal limitations become progressively more problematic. What next?

The intrinsic limits of transistor speeds are rapidly approaching while consumer wants continue to demand more and more. The development of optical components is a compelling solution, in which photons replace electrons as the carriers and processors of information signals.

Optical components possess a number of advantages in this endeavour, including low transmission loss, low powers, high data rates, and virtual imperviousness to electrical and thermal disturbances. Considering the fact that there are already optical links for long distance communications, it is feasible to imagine the simplistic integration of optical components into these systems. This would bypass the noisy, power-consuming process of converting the signal from one format (photonics) to another format (electronics), and back again.

One aspect of our research at CUDOS, the Centre for Ultrahigh-bandwidth Devices and Optical Systems, is investigating the 'building block' for optical components: the all-optical switch, or "photonic transistor". Instead of affecting the flow of electrons by electrons, we are researching ways to affect the flow of photons by photons.

We use *Photonic Crystals* (PhCs), a lattice array of air holes inside a glass structure, to confine the flow of photons within micron scale circuit-like geometries (see Fig. 1). PhCs can already realise various device components; indeed, a wealth of science is heavily devoted to optimising their design. Our work involves the use of a particular glass type for these structures, *chalcogenide*, which is interesting to us for its *nonlinear* properties.

All materials have a specific *refractive index*, which in a loose sense determines how photons propagate through them. Refractive indices also have a nonlinear aspect, in which their value may be changed by infusing them with intense light. Chalcogenide has a very high degree of nonlinearity, up to 1000 times that of silica, allowing this trait to be readily exploited.

Analogous to electronic circuitry and semiconductor transistors, PhC circuits made from chalcogenide glass can behave as an all-optical switch (see Fig. 2). The index of the glass is altered by a controlling set of photons, which in turn affects the signal flow of photons through it.

This principle has generated much interest across the globe, and it is not unfathomable to imagine such component concepts gradually phasing their way into everyday devices in the near future.

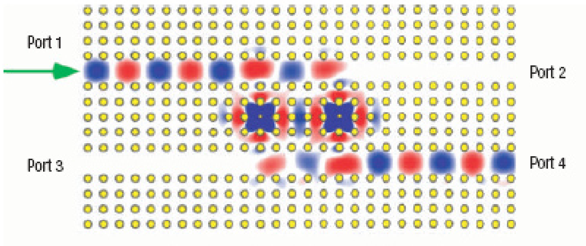


Figure 1. A typical PhC circuit design; in this case, a channel add/drop filter.

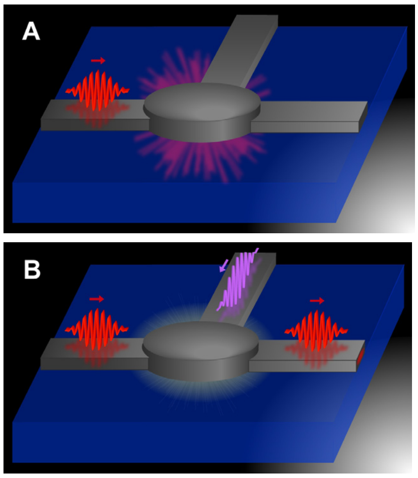


Figure 2. (A) an input signal does not penetrate the nonlinear glass when it is in the OFF state, (B) an input signal penetrates the nonlinear glass when a controlling signal of light infuses it to the ON state.

AOS Medal

The Australian Optical Society is seeking nominations for the next award of this medal, which is for an outstanding contribution or contributions to the field of optics in Australia by a member of the Australian Optical Society.

This Medal is the most prestigious award of the Australian Optical Society. It would normally be presented only to a nominee at an advanced stage of his or her professional career and with a strong and sustained record of authority, enterprise and innovation in the field of optics in Australia.

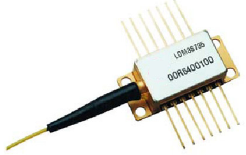
Nominations for the next AOS Medal should include brief personal details and a curriculum vitae emphasising the main contributions made by the nominee to Australian optics. Two letters of recommendation should also be provided. Nominations may be made either by or on behalf of any eligible candidate. The selection panel reserves the option to seek additional information about candidates for the award.

It is hoped that the person selected to receive the medal will be able to do so at the next AOS Conference.

Nominations close on the 15th of February each year, and should be sent to the secretary,

Dr John Holdsworth,
School of Mathematical and Physical Sciences, University of Newcastle,
Callaghan 2308 NSW
John.Holdsworth@newcastle.edu.au

Product News



High power 1310nm DFB Laser Diode from oemarket.com

This 1310nm laser is a specially designed for high performance analog optical transmission systems. It has high linearity, excellent CSO and CTB specifications, and high output power. It is ideal for applications in CATV optical systems, intensity modulation optical transmitters, etc.
MQW DFB laser diode, 14-pin butterfly package, built-in thermo-electric cooler (TEC), built-in isolator, output power from 4mW to 40mW

Wideband Optical Circulators from oemarket.com

This optical circulator covers the whole C and L bands from 1520 to 1625nm. It has ultra low insertion loss and high isolation.
Three or four ports, C+L bands, high isolation and low PDL, passed GR-1209-CORE and GR-1221-CORE tests.

New 1931-C/2931-C Series Optical Power Meters

For applications requiring measurement of low-power light sources, Newport's model 1931-C Single channel meter and 2931-C dual channel meter have broken the barrier of temporal measurement performance with calibrated results. This new series of power meters have the ability to handle repetition-rates of up to 20 kHz at a sampling rate of 250 kHz.
Peak-to-peak and DC source measurements can be displayed in units of W, dBm, dB, and A. Simultaneous measurements of a variety of light sources operating at different power levels and wavelengths can be performed with the dual channel 2931-C Optical Power Meter.
Low-power measurements, of pW to tens of Watts can be accomplished with any one of Newport's 918D or 918L Series Silicon (Si), Germanium (Ge) or Indium Gallium Arsenide (InGaAs) Detectors, covering 190–1800 nm wavelength range. All 918D and 918L Series Detectors have a built-in temperature sensor for active compensation of temperature-induced measurement fluctuations.
True Root-Mean-Square (rms) measurements, providing the most accurate rms value regardless of the shape of the input waveform.
Other advanced features include a 250,000 data point storage buffer, analog and digital filtering, programmable sample rates, moving statistics, plotting, and multiple user-configuration storage.
Features

- 5.7" Graphical TFT LCD, ¼ VGA provides excellent legibility from any angle, in any light condition or colored eyewear
- Data storage via internal memory or *USB Flash Drive*
- Color plotting, statistics and on-board data post-processing
- Analog and digital filtering
- USB and RS-232 computer interfaces
- Trigger in/out control with alarm levels
- Analog bar graph with 10X zoom
- Advanced Programming toolkit - .NET, LabVIEW, High-speed

For more information please contact Neil, Graeme or Dennis at: sales@newspec.com.au , www.newspec.com.au . Tel: 08 8273 3040

New Cylindrical Lens Mounts

The CYM-2R can hold and position cylindrical optics as large as 2-in in height. What makes this mount unique is its ability to rotate a cylindrical optic about its center. This feature eliminates unwanted translation during rotation of the power axis. 100-TPI adjustment screws provide ±5° roll adjustment range with a sensitivity of 6 arc seconds. The CYM-2R is post-mountable, with a mounting hole that accepts 8-32 or M4 screws. With the use of adapters (sold separately), other sizes of cylindrical optics can also be held. Adaptors are available to mount 1/4-in., 1/2-in., 1-in and 19-mm high cylindrical optics. Each one of these adaptors places the centre of the cylindrical lens at the axis of rotation and has a location pin for quick installation.
Features

- Rotates lens about its center
- ±5° rotation range
- 6 arc-sec sensitivity
- Adaptors for many lens sizes

For more information please contact Neil, Graeme or Dennis at: sales@newspec.com.au , www.newspec.com.au . Tel: 08 8273 3040

New Mini-Spectrometer

The Oriel IS-Series of Mini-spectrometers offer significant advantages over traditional mini-spectrometers. Newport took Oriel's 30+ years of designing and manufacturing spectroscopic instruments, combined with customer feedback, and designed a family of instruments that truly addresses the needs of both the Researcher, and the Systems Integrator.
Models are available to cover various spectral ranges from 190 to 1000 nm, in both fiber-coupled and free-space configurations (NIR spectral ranges may be available upon special request). After exhaustive testing of numerous arrays, Newport selected a Si NMOS photodiode array for the IS Series. These arrays have a broad spectral response, superior sensitivity in the ultraviolet, and lower cross talk than most other arrays. Because these PDAs have inherently good UV performance, they do not require a UV enhancement coating, which is often used on CCDs, and is prone to degradation over time.
Features

- Si NMOS array for superior UV sensitivity

- Spectral ranges from 190 to 1000 nm
- High resolution models: 0.45 nm
- Low stray light
- USB 2.0 communication to PC
- Options for order sorting filters
- Fibre coupled and free space models

For more information please contact Neil, Graeme or Dennis at: sales@newspec.com.au , www.newspec.com.au . Tel: 08 8273 3040

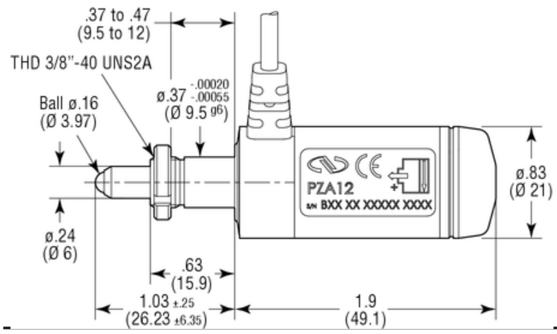
Compact, Ultra-high Resolution, Motorised Actuator

Newport's NanoPZ Ultra-High resolution actuator provides exceptional nanometer-scale resolution over an amazing 12.5 mm travel range. Newport's exclusive design and innovative piezo stepping motor results in a range of motion and stability that ensures 30 nm of motion sensitivity with no loss of position when power is removed. And unlike some other piezo-based devices, the NanoPZ design does not rely on varying static and dynamic friction forces, which can provide inconsistent performance and premature failure. The NanoPZ incorporates our exclusive piezo micro stepping motor and ergonomic controls that provide consistent results, superior reliability and unmatched ease-of-use. With all this, plus >0.2mm/s speed, 50 N load capacity and more quiet operation, it's easy to see why Newport's NanoPZ outperforms the rest.

NanoPZ is ideal for motorising manual-positioning stages and opto-mechanical components, especially those in hard to reach spaces or hazardous hands-off applications, such as high-power laser experiments. NanoPZ's non-rotating tip helps prevent contact surface wear and also allows for direct load attachments as well as push-and-pull applications.

Features

- Highly reliable operation with 30 nm motion sensitivity over 12.5 mm travel
- 10x faster speed (> 0.2mm/s) and 2x higher load capacity (50 N) than other piezo motor devices
- Non-rotating tip prevents from wear
- User-friendly and highly compatible
- No loss of position with removal of power; ideal for set-and-forget applications



For more information please contact Neil, Graeme or Dennis at: sales@newspec.com.au , www.newspec.com.au . Tel: 08 8273 3040, Fax: 08 8273 3050

NewSpec Pty Ltd
83 King William Road
Unley, South Australia, 5061
ABN 82 882 831 899

TMC Precision Vibration Isolation Systems

Unparalleled expertise in precision floor vibration control and a commitment to manufacturing.

TMC has almost 40 years of experience providing quiet work surfaces. They offer unparalleled expertise in precision floor vibration control and a commitment to manufacturing using the most advanced precision metal fabrication techniques. As a vertically integrated manufactured, they pride themselves on delivering products of superior quality, resulting from complete in-house manufacturing.

They have an extensive range of inexpensive vibration isolation products from simple, desktop isolated microscope bases, to high performance damping optical tables of virtually any size. Other products include:

- Raised and Solid Floor Platforms
- Magnetic Field Cancellation Systems
- Electric Field Shielding Systems
- Active Piezoelectric Vibration Control Systems
- Advanced Vibration Isolation Systems
- Acoustic Enclosures
- Precision Structures
- Custom Made Systems

Coherent Scientific is now supplying TMC products throughout Australia and New Zealand. Please contact us for more information; sales@coherent.com.au www.coherent.com.au

Sapphire OPSL for 488 nm Solid State:

Reliability For Your Instrumentation Application. Promised. Proven.

Coherent Inc. has been leading the way with its turnkey ptically pumped semiconductor laser technologies (OPSL) since 2001.

With more than 5,000 systems installed worldwide, the Sapphire has proven itself as a rugged, compact and versatile solid-state laser system for a variety of applications including spectroscopy, laser microscopy, general fluorescence applications and the graphic arts.

Coherent Inc. employs patented PermAlign technology, robotically assisted, permanently soldering the components into place for consistent quality and reliability. The system has no moving parts, does not suffer misalignment and does not use epoxies that can outgas and contaminate the cavity. The result is maximum performance and exceptional lifetimes (that is actual lifetimes, demonstrated in the field, not just statistically extrapolated) typically greater than 10,000 hours, with a number still continuing well beyond 30,000 hours.

The Sapphire 488 nm is available in 10 mW, 20 mW, 25 mW, 30 mW, 50 mW, 100 mW,

200 mW and 500 mW models to give you exactly what you need for your application at the right price. Sapphire is also available at 460 nm with a 10 mW output.

The Sapphire is also well complemented by Coherent Inc's range of compact solid-state laser products available in 375 nm, 405 nm, 440 nm, 460 nm, 532 nm, 561 nm, 635 nm, 660 nm and 785 nm.

Please contact Gerri Springfield or Paul Wardill for further information.

Coherent Scientific Pty Ltd
Ph: (08) 8150 5200
Fax: (08) 8352 2020
sales@coherent.com.au
www.coherent.com.au

Lastek are proud to be appointed the Australian distributor for FJW Optical Systems in Australia and New Zealand.

Established in 1945, FJW Optical Systems are manufacturers of the popular Infrared viewers, trade named FIND-R-SCOPE. The FIND-R-SCOPE is a handheld battery-operated rechargeable infrared camera with video output, which allows viewing through a camera viewfinder and a remote monitor simultaneously with spectral sensitivities from 400 to 2200 nm. Also available are UV viewers sensitive from 180 to 1550 nm.

Australian customers may have previously purchased FIND-R-SCOPE viewers from Lastek as an Edmund Optics item. Now not only can Lastek offer full FIND-R-SCOPE support with direct back-up from the manufacturer, we can now also offer the full FJW Optical Systems product range.

FJW Optical Systems product information can be found at www.findrscope.com

For further details please contact Lastek at sales@lastek.com.au

Nanonics appoints Lastek as its distributor in Australia and New Zealand.

Nanonics, a leading manufacturer of AFM Raman and SPM, Scanning Probe Microscopes, has appointed Lastek as their new distributor in Australia and New Zealand.

Nanonics pioneered commercial scanned probe microscopy systems with normal force probes associated with tuning fork feedback and now introduces the Integra Control System designed with all the unique capabilities tuning forks in mind, such a extreme stability and without any interference or lever excitation that are associated with beam bounce systems. It also eliminates feedback laser excitation, which is very important in applications such as electrical measurements of carrier concentration in semiconductors or in optical experiments such as simultaneous confocal imaging or near-field optical measurements. In all such experiments the tuning fork provided a zero background for monitoring the scanned probe microscopy parameters of interest.

The Tuning Fork Systems can use all of the probes available today for SPM, be they glass or silicon cantilevers, or the Akiyama probe, recently introduced by Nanonics.

With the unique features of the ultralow noise Integra Controller one has the ultimate in AFM feedback without mechanical or other alignment being required. Simply place the probe and you are ready for repeatable and ultimate resolution AFM scanning, even with samples such as highly oriented pyrolytic graphite, HOPG.

For further information please call Alex Stanco at Lastek on 1800 882215 or via email at alex.stanco@lastek.com.au

Lastek Pty Ltd
Adelaide University - Thebarton Campus
10 Reid St, Mile End, South Australia 5031
Phone: (08) 8443 8668
Toll Free: 1800 882 215 (NZ: 0800 441 005)
email: sales@lastek.com.au
web: www.lastek.com.au

PM panda fibre optical attenuator

Polarization maintaining fixed attenuator is based on micro-optics technology; it can achieve very high attenuation precision. The device is pigtailed and it can supply with 250um panda fiber or with connectors, 20dB Min extinction ratio and 55dB min return loss. The PM fiber attenuator is widely used in optical communication systems, lab research, sensors and receivers. The device can supply with customer specified attenuation values.

Email: sales@afwtechnology.com.au
Tel: 03 9702 4402

CLEO Pacific Rim 2007
August 26 - 31 2007, COEX, Seoul, Korea

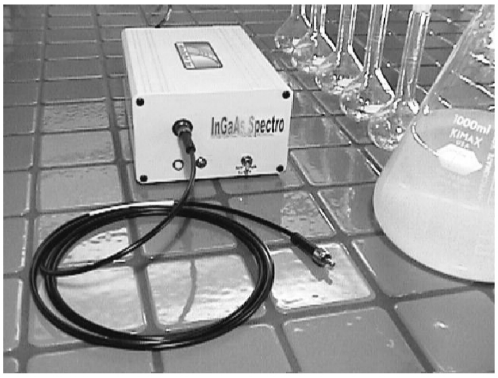
Important dates!
Deadline for Paper Submission : March 23, 2007
Notification of Acceptance : May 25, 2007
Pre-registration Due Date: July 6, 2007

Spectroscopy

Raman Spectroscopy Systems

Renishaw PLC is the world leader in high-throughput research grade non-contact Dispersive Raman Spectrometers.

- Chemical identification, stress, thickness, orientation and wear characterisation of materials down to <1µm
- New fast chemical point mapping and imaging techniques
- Interface compatible to SEM, CLSM, NSOM, AFM and FTIR
- Semiconductors, Materials, Ceramics, Polymers, Forensics Mineralogy, Coatings, Pharmaceuticals, Biological studies



Fibre Spectrometers

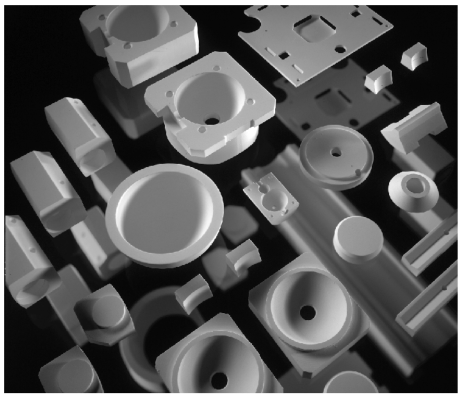
StellarNet Inc develops ruggedized miniature fiber optic spectrometers for Lab and Field measurements providing accurate and reliable instrumentation for a variety of applications in the UV-VIS-NIR ranges

- Superior Signal to noise
- FREE SpectraWiz Analysis Software
- Applications: Reflectance, Transmission, Absorbance, Colorimetry Emissions, Chromaticity, Lasers, Irradiance, Fluorescence, UV & Plasma monitoring, Laser Induced Elemental Analysis and much more

Spectroscopy Accessories

To complement the above instruments Warsash Scientific also offers a number of Spectroscopy accessories including:

- Reflectance spectroscopy accessories for the majority of commercially available UV-Vis & FTIR spectrometers.
- Custom High Reflectance PTFE Spectralon Laser cavities and Spectroscopy componants
- Calibrated reflectance standards & targets
- Lasers designed for especially for spectroscopy
- High QE cameras & detectors
- Polarisation maintaining Componants



WARSASH Scientific
Advanced Instruments for Research & Industry

Sydney
PO Box 1685
Strawberry Hills
NSW 2012
Tel: (02) 9319 0122
Fax: (02) 9318 2192
sales@warsash.com.au
www.warsash.com.au

Cobolt Solid State Laser Systems

Cobolt

Visible Single Wavelength DPSS Lasers

- Compact, rugged design
- 473nm, 591nm, 532nm & 561nm available
- Powers up to 150mW
- TEM00 beam with M2 < 1.1
- Single longitudinal mode
- Narrow spectral bandwidth
- Low noise <0.3% rms
- RS232 computer control

Visible Dual Wavelength DPSS Lasers

- Dual line diode-pumped solid state laser
- 20mW at 491 nm + 20 mW at 532 nm
- TEM00 beam with M2 < 1.1
- Wavelengths combined in a single beam
- Low noise <0.3% rms
- RS232 computer control

Eye-Safe Microchip Laser

- Compact pulsed eye-safe microchip lasers
- Wavelength 1535nm
- Peak power 1-2 kW
- Compact, rugged, industrial design
- Pulse width 3-5 ns; repetition rate 1-10 kHz
- Low power consumption
- Integrated photdiode

WARSASH Scientific
Advanced Instruments for Research & Industry

Sydney
PO Box 1685
Strawberry Hills
NSW 2012
Tel: (02) 9319 0122
Fax: (02) 9318 2192
sales@warsash.com.au
www.warsash.com.au

NEWSLETTER

Commission Internationale d'Optique ● International Commission for Optics

A proud past and a challenging future

This year's LFNM conference highlighted how physics and optics in Ukraine can benefit from international collaboration.

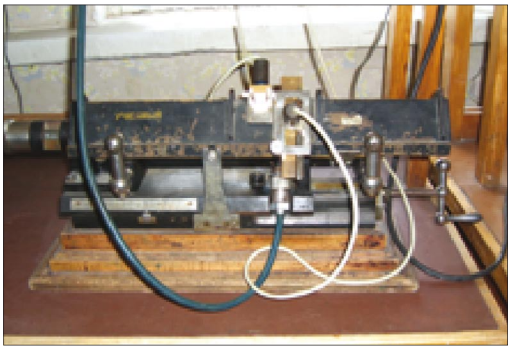
Professor Mauro F Pereira of Sheffield Hallam University, UK, gives a lecture presentation at the 2006 LFNM conference in Ukraine.

The 8th International Conference on Laser and Fiber-Optical Networks Modelling (LFNM) was held at Kharkiv National University (KhNU) and Kharkov University of National Electronics (KhNURE), Ukraine, on 29 June – 1 July 2006. About 140 papers were presented at plenary sessions, and as invited papers, oral and poster communications. Professor Mauro Pereira gave an invited talk and a longer introductory lecture on advanced microscopic methods for designing new materials and structures for optical devices. He also visited teaching, research and industrial labs and had meetings with key scientists in Kharkov to discuss possible topics and mechanisms for future collaboration.

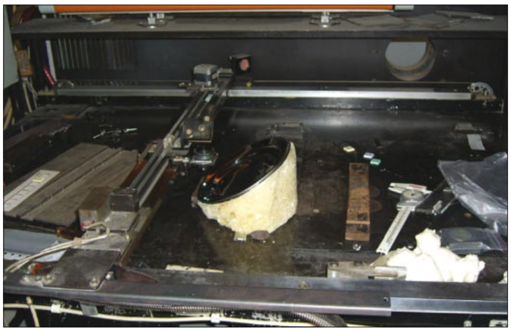
KhNURE is among the oldest and most widely recognized universities in Eastern Europe. Since its foundation in 1804 more than 100 000 students have graduated, and the university has hosted three Nobel Prize Laureates: L Landau, I Mechnikov and S Kuznets. It currently has around 12 000 students and employs 2000 lecturers, including 200 professors with habilitation (doctor degree) and more than 1000 professors with a PhD (candidate degree). However, the future of education and research in Ukraine is facing some uncertainty, since a typical professor's salary is only around $200 a month and living costs in Ukraine keep rising.

KhNURE was set up in 1930, and regardless of the difficulties mentioned above it is fighting to maintain good educational standards. As the photographs here show, some of its laboratories are undertaking joint projects with industry, e.g. ceramic cylinder construction and digital patterns for printing (in co-operation with BASF), and commercial laser engraving with different types of materials. Of particular interest is the theoretical modelling being developed at the Photonics Laboratory. New concepts for optoelectronic materials are also being created in collaboration with the University of Guanajuato in Mexico, and the LEOS Student Chapter has developed an interesting interactive teaching software suite for basic photonics studies. The main difficulty for immediate progress at present is access to electronic journals.

In summary, there is potential for future contributions to optics in Kharkov. International collaboration and partnerships should be supported. For example, the ICO Travelling Lecture Program aims to help visiting scientists lecture in scientific and academic institutions outside their country of origin, and to enhance mutual international co-operation.



This instrument for measuring electrical field distribution in microwave waveguides was originally developed more than 70 years ago, but is still in good working condition in one of the teaching labs at KhNURE.



One of KhNURE's current joint projects with industry: laser digital pattern printing in co-operation with BASF.

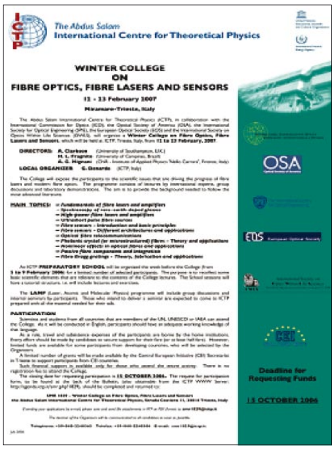
The Chair of the ICO Travelling Lecture Program is Professor Alexander A Sawchuk (USC, USA). Scientists or host groups interested in participating in this program should send a letter of application, by e-mail, to Prof. A Sawchuk at ico-treasurer@sipi.usc.edu, with details of the proposed lecture program and the ICO support needed. Official letters of invitation from local institutions or research centres are also required, along with a tentative calendar of activities supported by the host institution.

Application forms can be downloaded from: www.ico-optics.org/travlecture.html.

Mauro F Pereira

Winter College 2007 to focus on fibres

The 2007 Winter College will be hosted by the ICTP in Trieste, Italy, in February.



The ICTP announce details of the 2007 Winter College on Fibre Optics, Fibre Lasers and Sensors.

The Abdus Salam International Centre for Theoretical Physics (ICTP) has announced that the forthcoming Winter College on Fibre Optics, Fibre Lasers and Sensors will be held at the ICTP in Trieste, Italy, from 12 to 23 February 2007.

The Winter College is co-sponsored by ICO, EOS, OSA, OWLS and SPIE. The directors of this year's college will be: A Clarkson (University of Southampton, UK), H L Fragnito (University of Campinas, Brazil) and the local organizer G Denardo.

The college will expose participants to the scientific issues that are driving the progress of fibre lasers and modern fibre optics. The program will consist of lectures by international experts, group discussions and laboratory demonstrations. The aim is to provide the background needed to follow the most advanced literature on these subjects.

The main topics featured this year will be quite broad, and will focus on: fundamentals of fibre lasers and amplifiers; spectroscopy of rare-earth-doped glasses; high-power fibre lasers and amplifiers; ultrashort pulse generated in fibre lasers; fibre sensors; optical fibre communications; photonics crystals; non-linear effects on optical fibres and applications; and fibre Bragg gratings.

The ICTP Preparatory School on Mathematics, which was initiated last year, will again run before the college (from 5 to 9 February 2007), with the aim of recollecting some of the basic scientific elements that are relevant to the contents of the college lectures. In addition, the LAMP (laser, atomic and molecular physics) programme will include group discussions and seminars for the participants.

Students and scientists from all countries that are members of the United Nations, UNESCO or IAEA are welcome to attend and encouraged to submit application forms. The closing date for requesting to participate is 15 October 2006.

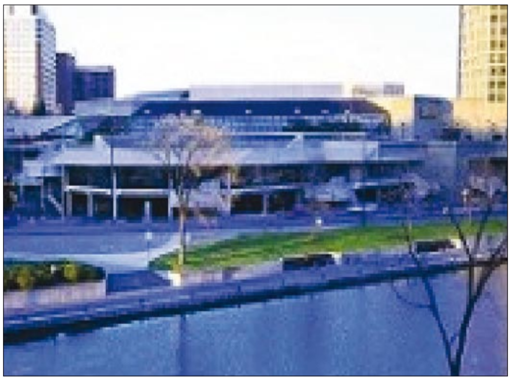
For more information about the college and how to apply, read the full announcement at: http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a06183.

Successful ETOP series heads to Canada

ETOP 2007 will be hosted by the Ontario Photonics Education and Training Association on 4–6 June.

The Ontario Photonics Education and Training Association (OPETA) has been announced as the host of the 2007 Education and Training in Optics and Photonics (ETOP) series of meetings. ETOP 2005, which was held in Marseille, France, was a big success (see *ICO Newsletter* January 2006), and the general principle is that ETOP is hosted in alternate continents each time, having been held in Tucson, Arizona, USA, in 2003. ETOP 2007 will be co-located with the Photonics North 2007 conference, and will be held at the Ottawa Convention Center in Ontario, Canada.

The ETOP 2007 chair will be Dr Marc Nantel. ETOP is co-sponsored by ICO, OSA and SPIE, and recently IEEE/LEOS has joined the ETOP Steering Committee for sponsorship, contributing to this unique joint venture.



The Ottawa Convention Centre in Ontario, Canada, where the ETOP 2007 meeting will be held on 4–6 June.

The Ontario region in Canada benefits from some impressive technological activity. Giants like Nortel Networks and JDS Uniphase associate closely with a growing number of very active small- and medium-sized photonics companies. The area therefore has enormous potential in offering photonics training to young researchers and engineers who are interested in orienting their careers towards emerging photonics technologies.

ETOP is devoted to participants at the pre-college, technician, two-year, four-year and graduate-equivalent levels. Typical session topics include: training and laboratory materials for demonstrations; training and continuing education in industry; education in geometrical optics, quantum optics, technologies for integrated diffractive optics; software for teaching; computer-assisted learning; curriculum development, and laboratories for optics and photonics education.

The proceedings from the ETOP series are now available online, as a facility from the SPIE digital library, at: www.spie.org/communityServices/StudentsAndEducators/etop/. For further information, please visit www.etoponline.org.

Tunisia granted full ICO membership

The ICO annual bureau meeting was held in September in Russia.

Professor Zohra Ben Lakhdar, president of the Tunisian Optical Society and the Tunisian Territorial Committee.

On 2 to 3 September 2006 the International Commission for Optics (ICO) Bureau had its annual meeting, which was held in Saint Petersburg, Russia, to coincide with the ICO Topical Meeting on Optoinformatics/Information Photonics 2006.

During the meeting the ICO Bureau had the great pleasure of receiving Tunisia's application for full ICO membership. Tunisia has been an associate member since 2003, and the application was unanimously approved by the bureau.

The president of the Tunisian Optical Society and the Territorial Committee is Professor Zohra Ben Lakhdar. She is currently professor of physics at Tunis El Manar University in Tunisia and director of the Department of Physics Laboratory of Atomic-Molecular Spectroscopy and Applications. Professor Ben Lakhdar is a member of the Islamic Academy of Sciences, and has been an associate member of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy, since 2001. In 2005 she was honoured by being named a winner of the L'OREAL–UNESCO Award for Women In Science.

The board of the Tunisian Committee for Optics (TCO) consists of: Zohra Ben Lakhdar (president), Souad Lahmar (vice-president), Hassen Ghalila (secretary), and Zoubeida Dhaouadi (treasurer).

Among the TCO's forthcoming activities is participation in and support of the "International Ibn Al-Haythem Day", which is organized by the Youth Science Association of Tunisia, and will be held on 26 to 28 December 2006 in Tunisia. The event is supported by the Tunisian Optical Society, the University of Gabès and UNESCO.

Professor Ben Lakhdar with her collaborators at the Physics Laboratory of Atomic-Molecular Spectroscopy and Applications at the University of Tunisia.

Professor Ben Lakhdar with her undergraduate students.

New member-at-large for ICO/US Advisory Committee

Arthur Guenther appointed to USAC/ICO National Advisory Committee for Optics.

Arthur H Guenther, research professor at the University of New Mexico, Center for High Technology Materials in the US has recently been appointed as a member-at-large of the US Advisory Committee for the International Commission for Optics (USAC/ICO), which represents the interests of the US optics community internationally.

The main purpose of USAC/ICO is to promote the advancement of optics and photonics in the United States and throughout the world, as well as to effect appropriate US participation in ICO through the national academies. USAC/ICO has been the official representation of the US as an ICO Territorial Committee since 1948.

Guenther is currently at the University of New Mexico after a career as chief scientist with the US Air Force, chief scientist for advanced defense technology at the Los Alamos National Laboratory, and science advisor for laboratory development and manager of alliances with Sandia National Laboratories.

He has been involved in many outstanding projects, including helping to found an industry association in New Mexico, and promoting optics education programmes; he constructed a career ladder for optical technicians and theorists at West Mesa High School, Central New Mexico Community College and the University of New Mexico.

Guenther was ICO president between 1999 and 2002, and was their official representative to the Education and Training in Optics and Photonics (ETOP) Conference. He is still very active within ETOP and will participate in the next ETOP Conference, which will be held in June 2007 in Ottawa, Canada. Arthur previously chaired this biannual meeting in Singapore.

Contacts

International Commission for Optics (www.ico-optics.org).

Bureau members (2005–2008)

President A T Friberg
Past-president R Dändliker
Treasurer A Sawchuk
Secretary M L Calvo, Departamento de Óptica, Universidad Complutense, 28040 Madrid, Spain. E-mail: mlcalvo@fis.ucm.es.
Associate secretary G von Bally
Vice-presidents, elected
S N Bagayev, A M Guzmán, G F Jin, B Y Kim, M Kujawinska, H Lefèvre, J Love, I Yamaguchi
Vice-presidents, appointed
J Braat, M Gu, I C Khoo, G Sincerbox, P Stahl, A Wagué
Senior adviser (ad personam)
P Chavel
IUPAP Council representative
Y Petroff

IOP

Forthcoming events with ICO participation

26–29 October 2006
7th International Young Scientists Conference "Optics and High Technology Material Science SPO 2006"
Kiev, Ukraine. Contact: Dr Viktor O Lysiuk, lysiuk@univ.kiev.ua

13–17 November 2006
I Andinean and Caribbean Conference on Optics and its Applications
Santiago de Cali, Colombia. Contact: Prof. E Solarte, esolarte@calima.univalle.edu.co

26–29 November 2006
9th International Conference on Optics Within Life Sciences (OWLS 9)
Taipei, Taiwan. Contact: Prof. Arthur Chiou, aechiou@ym.edu.tw

3–10 December 2006
8th LAM Workshop on Physics and Applications of Lasers
Addis Abeba, Etiopía. Contact: A Asfaw, araya@phys.aau.edu.et

6–8 December 2006
5th International Conference on Optics-Photonics Design and Fabrications-ODF'06
Nara, Japan. Contact: Prof. Tsuyoshi Hayashi, hayashi@pac.ne.jp, www.odf.jp/in.html

12–16 December 2006
8th International Conference on Optoelectronics, Fiber-optics and Photonics
Hyderabad, India. Contact: Prof. D N Rao, dnrsp@uohyd.ernet.in

17–19 April 2007
International Workshop Technolaser 2007
Havanna, Cuba. Contact: Dr J R Triana, tecnolaser@ceaden.edu.cu, www.ceaden.cu/tecnolaser/index.asp

5–7 September 2007
International Conference on Optics and Laser Applications-ICOLA
Yogyakarta, Indonesia. Contact: Dr Sar Sardy, sardy@eng.ui.ac.id

25–27 September 2007
ETOP 2007
Ottawa, Canada. Contact: Dr Marc Nantel, marc.nantel@oce-ontario.org

7–11 July 2008
21st Congress of ICO
Darling Harbour, Sydney, Australia. Contact: Prof. John Love, jdl124@rsphysse.anu.edu.au

For further information about events with ICO participation that are coming up in 2006–2008, see the events page of the ICO website at www.ico-optics.org/events.html.

Responsibility for the accuracy of this information rests with ICO. President: Ari T Friberg, Royal Institute of Technology, Optics, Electrum 229, SE-164 40 Kista, Sweden; e-mail: ari.friberg@imit.kth.se. Associate secretary: Gert von Bally, Laboratory of Biophysics, Medical Centre, University of Münster, Robert-Koch-Str. 45, D-48129 Münster, Germany; e-mail: lbiophys@uni-muenster.de.

OPTICS SHOP

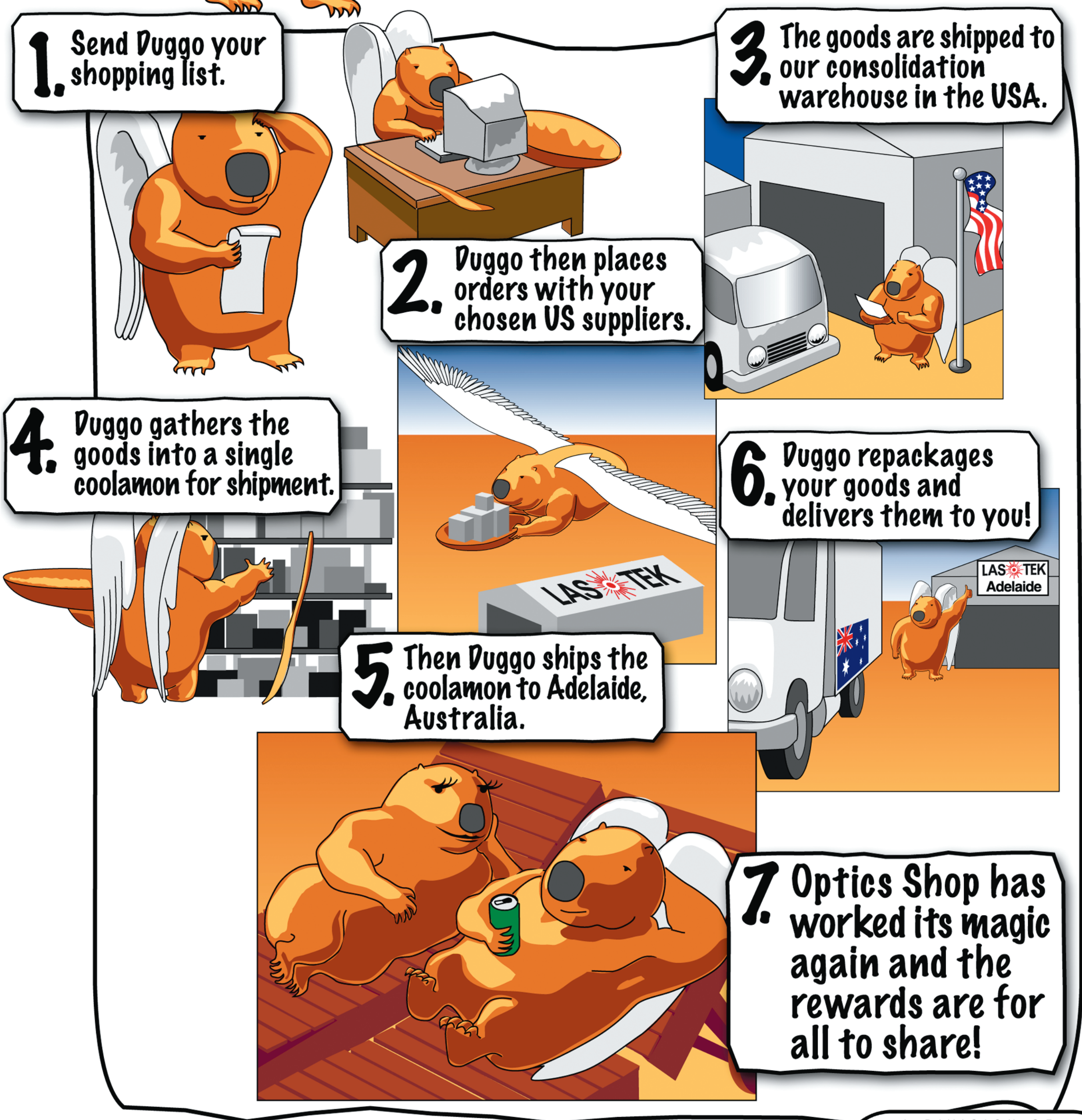
The OpticsShop Shipping Process

Meet Doug, OpticShop's high flying, goods routing wombat - Duggo to his mates!

Duggo will demonstrate how he can deliver small items from America, cheaper.

Duggo can even deliver books from Amazon to Australia cheaper than Amazon can.

Who can? Ya mate Duggo can!



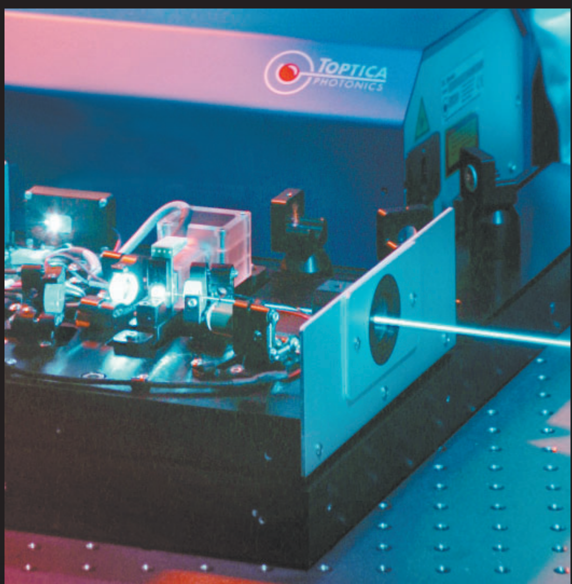
www.opticsshop.com.au

A DIVISION OF LASTEK

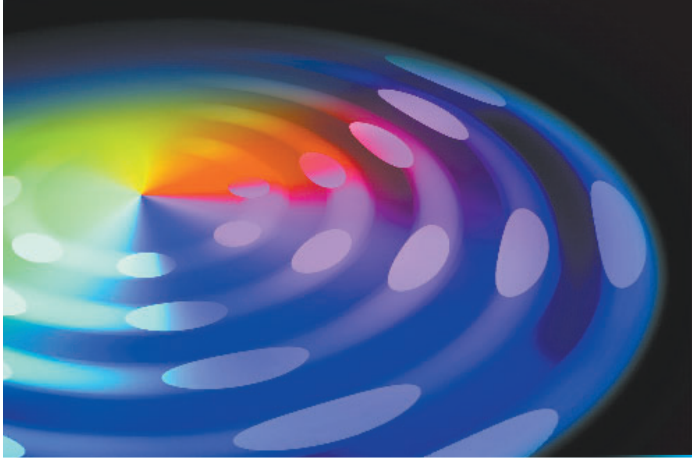
TOPTICA PHOTONICS

A Passion for Precision

- tunable stabilised laser diode systems
- DFB/DBR lasers
- iBeam/iPulse: DPSS lasers for gas laser replacement
- femtosecond fibre lasers
- optical media testing
- MOT optics
- and much more



Toptica Photonics represent the future of lasers and photonics: cutting edge technologies expertly designed and engineered. Now Toptica lasers are represented in Australia and New Zealand by Lastek. To receive a copy of the new Toptica literature pack, or for further information on any Toptica products, contact Lastek at the address below.



LASTEK

Lastek Pty Ltd
Thebarton Campus, University of Adelaide,
10 Reid Street, Thebarton SA 5031 Australia
Ph (08) 8443 8668 Fax (08) 8443 8427
Email: sales@lastek.com.au Lastek website: www.lastek.com.au

LTWAM4529

Index to Advertisers

Corporate Member Address List

ARC COE for Quantum-Atom Optics
Building 38A, Science Road,Australian National University,
Canberra ACT 0200
Tel: (02) 6125 2811
Fax: (02) 6125 0741
Hans.bachor@anu.edu.au, http://www.acqao.org

Australian Fibre Works
Suite 15, 88-90 Walker Street
Dandenong, Victoria 3175, Australia
Tel: +61 3 9702 4402
Fax: +61 3 9708 6883
Email:don@afwtechnology.com.au
Web: www.afwtechnology.com.au

Bandwidth Foundry Pty Ltd
Suite 102, National Innovation Centre,
Australian Technology Park, Eveleigh, NSW, 1430
Tel: (02) 8374 5300
Fax: (02) 8374 5301
info@bwfoundry.com
http://www.bwfoundry.com

Coherent Scientific Pty Ltd
116 Sir Donald Bradman Drive
Hilton, SA, 5033
Tel: (08) 8150 5200
Fax: (08) 8352 2020
scientific@coherent.com.au, http://www.coherent.com.au

CUDOS
School of Physics,
University of Sydney, NSW, 2006
Tel: (02) 9351 5897
Fax: (02) 9351 7726
cwalsh@physics.usyd.edu.au

Francis Lord Optics (Avtronics)
33 Higginbotham Rd, Gladesviile, NSW, 2111
Tel: (02) 9807 1444
Fax: (02) 9809 7136

Lambda Scientific Pty Ltd
2/147 Buxton St , North Adelaide, SA 5006, Australia
Tel.: +61 8 8267 2686
Fax: +61 8 8267 2689
email michaellee@lambdasci.com
http://www.lambdasci.com

Laserex Technologies Pty Ltd
5A Corbett Court, Export Park SA 5950, Australia
Tel. +61 8 8234 3199
Fax.+61 8 8234 3699

Lastek Pty Ltd
GPO Box 2212, Adelaide, SA, 5001
Tel: (08) 8443 8668
Fax: (08) 8443 8427
alex@lastek.com.au, http://www.lastek.com.au

NewSpec Pty Ltd
83 King William Rd, Unley, SA 5061
Freecall 1800 153 811
Tel: (08) 8273 3040
Fax: (08) 8273 3050
sales@newspec.com.au, http://www.newspec.com.au

oeMarket.com - Bitline System Pty Ltd
8 Princes St
BEXLEY NSW 2207
Tel:02 9597 2689
Fax:02 9597 1959
info@oemarket.com,http://www.oemarket.com/

OptiScan Pty Ltd
PO Box 1066, Mt. Waverley MDC, VIC 3149
Tel: (03) 9538 3333
Fax: (03) 9562 7742
rogerw@optiscan.com.au, http://www.optiscan.com.au

Photon Engineering
PO Box 122, Rundle Mall, Adelaide, SA 5000
Tel: (08) 8232 3444
Fax: (08) 8232 9333
info@photonengineering.com.au
www.photonengineering.com.au

Raymax Applications Pty Ltd
PO Box 958, Unit 1/303 Barrenjoey Road
Newport Beach, NSW, 2106
Tel: (02) 9979 7646
Fax: (02) 9979 8207
sales@raymax.com.au
http://www.raymax.com.au

Warsash Scientific Pty Ltd
PO Box 1685, Strawberry Hills, NSW, 2012
Tel: (02) 9319 0122
Fax: (02) 9318 2192
sales@warsash.com.au

WaveLab Scientific Pte Ltd
Blk 2, Bukit Batok St 24, #06-09 Skytech Building,
Singapore 659480
Tel: 65-65643659
Fax: 65-65649627
bob@wavelab-sci.com, http://www.wavelab-sci.com

AUSTRALIAN OPTICAL SOCIETY

ABN 63 009 548 387

2007

Subscription Renewal Form

Please check all details before returning completed form by 30 November 2006

Name & address

Title

Initials

First Name(s)

Surname

Employer/Institute/Company

Telephone Number

Fax Number

Email

URL

Affliliations AIP OSA SPIE

Main Activities (number up to three in order of importance)

First *Second* *Third*

1 astronomical optics	8 optical design	15 nonlinear optics
2 atmospheric optics	9 optical physics	16 teaching
3 communications and fibres	10 radiometry, photometry & colour	17 holography
4 electro-optics	11 spectroscopy	18 (.....................................)
5 fabrication and testing	12 thin films	19 (.....................................)
6 information processing	13 vision	20 (.....................................)
7 lasers	14 quantum optics	

Email Notices: Notices will be sent to the email address provided. Do you wish to receive posted notices as well? Yes ☐ No ☐

Date of joining:

Financial in:

Subscription Rate (includes GST): Corporate $290 p.a. Member $43 p.a. Student : $16 p.a.

PAYMENT METHOD *(Please tick box)*

*Cheque** ☐ *Mastercard* ☐

Money order ☐ *Visa* ☐

** Cheques payable to "THE AUSTRALIAN OPTICAL SOCIETY"*

Send payments to:

A/Prof Stephen Collins
Honorary Treasurer, AOS
OTRL (F119), Victoria University, PO Box 14428
Melbourne, VIC 8001, AUSTRALIA
Tel: (+61)(0)3 9919 4283; Fax: (+61)(0)3 9919 4698
Email: stephen.collins@vu.edu.au

If paying by credit card please <u>complete</u> ALL boxes in this authorization. Incomplete forms cannot be processed.

EXPIRY DATE /

CARD NUMBER

NAME ON CARD

AMOUNT **A$**

SIGNATURE

DATE

* Please do not staple cheques onto this form; use a paperclip instead.

Sapphire™

Reliability For Your Instrumentation Application

Proven

- Optically Pumped Semiconductor Laser (OPSL)
- Greater than 5 years of field proven reliability
- >5,000 units installed worldwide
- Permalign™ patented permanently bonded technology
- Negligible amplitude noise
- 488 nm: 10 mW, 20 mW, 25 mW, 30 mW, 50 mW, 100 mW, 200 mW & 500 mW
- 460 nm: 10 mW

Coherent Inc offers a complete range of laser solutions including low power, CW, solid-state lasers.

375 nm | 405 nm | 445 nm | 460 nm | 488 nm | 532 nm | 561 nm | 635 nm | 660 nm | 785 nm

116 Sir Donald Bradman Drive,
Hilton SA 5033
Phone (08) 8150 5200
Fax (08) 8352 2020
Freecall 1800 202 030
sales@coherent.com.au
www.coherent.com.au

Coherent
SCIENTIFIC
Established in 1989

Coherent Scientific Pty. Ltd., Inc. in South Australia, ABN 20 008 265 969