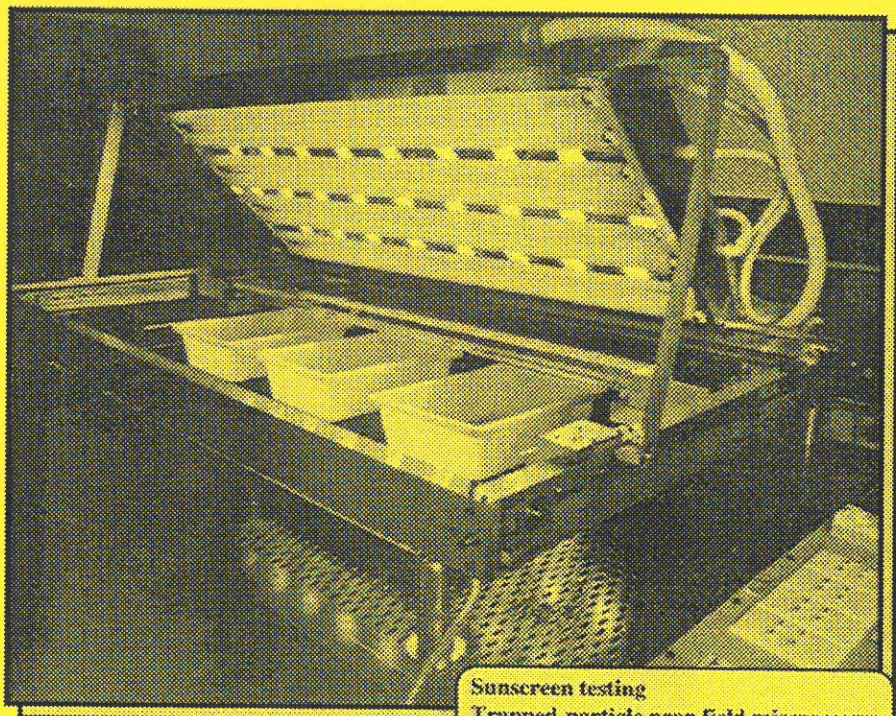


Australian Optical Society

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# NEWS

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Sunscreen testing  
Trapped-particle near-field microscopy  
AOS XII, Sydney 1999  
1998 membership list

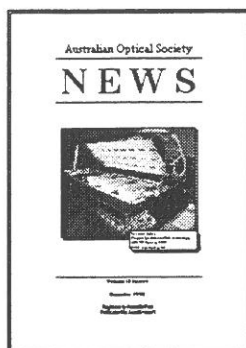
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**Volume 12 Issue 4**

**December 1998**

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# AOS NEWS

## ARTICLES

### COVER :

This issue's cover shows a solar simulator which was collaboratively designed and built for the University of Sydney Department of Veterinary Pathology by the CSIRO National Measurement Laboratory.

The simulator has a large area and reproduces the full spectrum of sunlight.

The simulator is used to investigate the effects of ultra-violet radiation on the skin of small animals. (See the article on sunscreen testing on p23).

### 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 encouraged, or else submission of hard copy together with an ASCII text file on floppy disk.



Where possible, diagrams should be contained within the document or sent as separate encapsulated post-script files. Figures on A4 paper will also be accepted.

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### DEADLINE FOR NEXT ISSUE :

1st March, 1999

### 9 Particle-trapped Near-field Scanning Optical Microscopy

Single-beam gradient-force laser trapping (the technique behind 'optical tweezers') is a promising technique for micromanipulation and microscopy. In this article, we review an imaging technique which combines laser trapping and near-field microscopy, and report our research on this topic.

- Min Gu and Pu Chun Ke

### 23 Sun screen testing

Sunscreens are rated for their ability to block the access of ultraviolet radiation from sunlight to our skin. The testing of this rating, or SPF, is no simple matter. For reasons to be discussed the most favoured methods use real human skin but an artificial source. The characteristics of this source have not been fully standardised, so significant differences between methods and ratings may occur. Some of the difficulties currently being considered will be outlined here.

- Frank Wilkinson

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**AOS News is the official news magazine of the Australian Optical Society. The views expressed in AOS News do not necessarily represent the policies of the Australian Optical Society.**

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SPIE

(The International Society for Optical  
Engineering)

## President's Report

The end of 1998 was marked by a very significant event for our optics and spectroscopic communities - the Australasian Conference on Optics Lasers and Spectroscopy, which was held in Christchurch in December. This was an extremely successful conference which attracted a large number of participants — over 250 including a substantial number of PhD students. A number of industry exhibitors were also present at this meeting displaying recent developments in equipment, and initiating many



important contacts. The venue at the University of Canterbury was ideal, with very well equipped lecture theatres and local technical help at hand. The area for the exhibits and poster display was spacious and well laid out. The scientific program of the conference was superb. The lectures, plenary, invited and contributed as well as the poster presentations were wide ranging and extremely interesting. I believe that the overall impact of this conference was that of a much larger event. Wednesday's Dan Walls Symposium was a fitting tribute to Dan's impact on the field of Quantum Optics. A number of his former students and collaborators presented excellent talks demonstrating a strong and impressive base for new and exciting developments in physics stemming from Dan's tutelage.

On behalf of all the attendees, I would like to thank Wes Sandle and his organizing team (Peter Manson, Rob Ballagh, John Harvey, Ken Ghiggino and R. Reeves) for the enormous amount of work that they put in to making the conference the success that it was. Two student prizes for the best poster presentations were given by AOS at the ACOLS conference. The prizes went to Robin Purchase from ANU and Winni Hensinger from the University of Queensland. These prizes were sponsored by Lastek. I would like to

express my thanks to Lastek for their generosity in sponsoring the prizes.

I am also pleased to be able to announce that the 1999 AOS Postgraduate Student Prize was awarded to Daniel Day from Victoria University. This prize will provide travel assistance for Daniel to attend an international conference on 3D imaging where he hopes to present a paper entitled "High Density Three-dimensional Optical Data Storage".

The AOS Council met on the Thursday evening of the conference week and an abbreviated set of minutes for that meeting is elsewhere in this News. The Council believes that the Society should have a much larger student membership than it has today. Possibly we are not informing new students sufficiently about the benefits of becoming members of our Society and about the work that the Society is doing to promote optics in Australasia.

As Brian Orr mentioned in his retiring President's report in the previous issue of *AOS News*, we have regular communications with the Federation of Australian Scientific and Technological Societies (FASTS) which is a lobby group for Australian Science and Technology in local political, social and economic circles. FASTS has now announced its Ten Top Policies for 1999. We have reproduced them here for you in this current issue of *AOS News*. These ten top policies are most important for all of us and should be considered very seriously by all of our members. In the near future the Government is going to define its position on research funding mechanisms for our Universities. I strongly support the view of FASTS, of the importance of a nationwide competitive, peer-review process which is part of a plurality of research funding mechanisms. It is important that the position of ARC is secured as an independent body and provided with an increased budget so that a larger number of top ranked science projects can be funded. Both Europe and America have sharply increased their spending on research. Australia should follow this lead.

Halina Rubinsztein-Dunlop  
18 January, 1999

<http://www.physics.mq.edu.au/~aos/>



# AOS MEDAL



AUSTRALIAN OPTICAL SOCIETY

The Australian Optical Society is seeking nominations for the fourth 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.

Previous winners of the medal have been:

- 1995: Mr Bill James  
James Optics, Melbourne;
- 1996: Dr Parameswaran Hariharan  
University of Sydney and CSIRO;
- 1997: Professor Jim Piper  
Macquarie University.

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 1999 AOS Medal Winner 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, which is planned for mid-1999.

The closing date for nominations is 15 February 1999. Nominations should be sent to the AOS Secretary:

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Citations to the journal will be as for any other journal, and it will be abstracted and indexed in the main secondary services, such as INSPEC. In addition, selected articles will have associated online commentaries. As executive summaries, these commentaries will provide even greater access and

visibility, offering a valuable entry point into the physics research literature. The publishers are also committed to maintaining unrestricted access to the archive at no charge.

Judging by the high level of interest already shown by libraries and physicists alike, we are sure that NJP will play a pivotal role in the future of scholarly communication.

Further information is available from <http://njp.org>. Alternatively, you can contact me at the address below.

Yours sincerely

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# OPTICS GRAPEVINE



*News from the World of Optics*



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Sunday July 4 to Friday July 9  
(see details p14)

### Online bookshops in Australia

For a list of Australian bookshops with online services, visit

<http://www.anatomy.su.oz.au/danny/books/shops/>

Several bookshops have searchable databases with prices (in Australian dollars), delivery times, etc.

### "Lightcraft" propulsion technology

The possibility of reducing the cost of US\$10,000/kg to launch a payload into low Earth orbit has driven efforts to develop laser-driven spacecraft — small vehicles propelled by a laser from the ground — which can achieve orbit. In models currently being developed, pulsed laser light is focussed underneath an annular rim, causing the air to break down and hence providing lift. Test flights so far have reached a height of 30 m, and a 100 kW CO<sub>2</sub> laser is under development which should provide lift to 30 km. If successful, the cost of reaching orbit could be lowered to as little as US\$200/kg. The

drawbacks would be the maximum payload size, and, without proper controls, the possibility of flooding orbits with debris. (*Optics and Photonics News*, January 1999, p23)

### OSA/SPIE Merger

The joint Task Force set up to investigate the possibility of a merger reported back to SPIE and the OSA in October, 1998. The task force recommended that the societies merge, but retain some of their current identities under the new organisation. The executive summary of the task force can be found in, for example, *OE Reports*, No. 179, November, 1998. Those who are interested in this issue can follow discussions of the proposed merger at

<http://www.spie.org/info/jtf/forum/home.html>

An interesting series of letters from past AOS presidents can be found in *Optics and Photonics News*, January 1999 p5-7.

### Quantum Teleportation of Light

The first demonstration of the teleportation of the entire quadrature phase amplitude of a beam of light was reported in *Science*, October 23, 1998. The researchers used squeezed-state entanglement to teleport the beam over a distance of 1m. While the teleportation was far from perfect, it was beyond classical limits and depended only on improved efficiency in the quantum entanglement to greatly increase the efficiency. The work is aimed at the future of communications and information processing. (from *Optics and Photonics News* Vol. 10 No 1.)

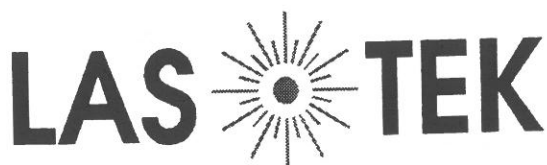
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The Optical Society of America now has a system whereby the Table of Contents for *Applied Optics Online*, *JOSA A Online*, *JOSA B Online*, *Optics Express*, and *Optics Letters Online* are mailed to a list of interested parties. To subscribe to this mailing list, and hence receive a timely e-mail of the latest issue's Table of Contents, visit the OSA home page

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A reminder that *Optics Express* is OSA's all-electronic, peer-reviewed journal reporting new developments in all fields of optical science and technology every two weeks. *Optics Express* is free to readers.





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# Particle-trapped Near-field Scanning Optical Microscopy

Min Gu and Pu Chun Ke

Optoelectronic Imaging Group, School of Communications and Informatics,  
Victoria University, P. O. Box 14428 MCMC, Victoria 8001

*Single-beam gradient-force laser trapping (the technique behind 'optical tweezers') is one of the most promising applications of laser technology. In this article, we review the latest development of laser trapping in near-field microscopy, and report our research on this topic.*

## 1. Introduction

For more than a decade, laser trapping has proved to be a useful tool in the manipulation of nano- and micron-sized objects [1]. This technology is particularly appropriate for analysing chemical components [2], investigating self-lasing micro-particles [3], and sorting biological samples such as blood cells, biomolecules and DNA chains [4-7].

For these applications, the trapping of a small object (usually a spherical particle) is achieved at the focus of a high numerical aperture (NA) objective. When a particle is illuminated under a highly focused laser beam, it is trapped in the potential well produced by the gradient force of the light in the focal region. (See reference 1 for a discussion of the origin of this force). The stability of the trap is mainly affected by: The spatial distribution of the laser beam in the focal region of the trapping objective; the absorption properties of the medium where particles are suspended; and the Brownian motion and composition of the trapped particle.

One of the recent applications of laser trapping technology is in near-field microscopy. Near-field microscopy is a new technique for high-resolution imaging [8]. It has provided new opportunities to study the nano-scale world optically, which cannot be done with conventional microscopy because of the diffraction limit [8]. The application of laser trapping in scanning force microscopy was first

demonstrated by W. Webb *et al.* in 1993. In their scheme, a laser-trapped glass stylus acts as a sensitive transducer of small fluctuating forces on the stylus due to its interaction with the sample [9]. In 1994, Kawata *et al.* demonstrated a particle-trapped near-field scanning optical microscope with the use of a laser-trapped polystyrene particle as the near-field probe [10]. An important feature of this approach is its non-invasive probing mechanism which is much desired in biological study. However, a problem associated with this method is that the signal-to-noise ratio, and therefore the image quality, is limited by the weak scattering properties of the dielectric particle. Recently we have successfully imaged a near-field interference pattern using laser-trapped metallic particles. We have shown that image contrast can be much more enhanced compared with images recorded with dielectric particles [11].

## 2. Principle of particle-trapped near-field scanning optical microscopy

The principle of particle-trapped near-field scanning optical microscopy (PTNSOM) is illustrated in figure 1. A particle is trapped on the surface of a sample by a

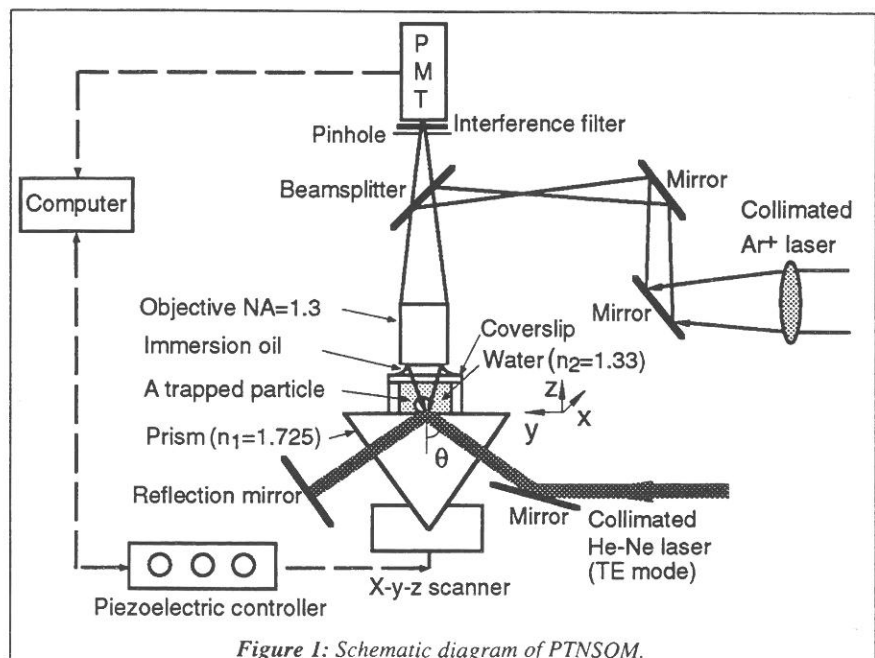


Figure 1: Schematic diagram of PTNSOM.



highly focused laser beam. The sample is illuminated by evanescent waves generated by a laser beam, of a different wavelength to the trapping beam, under the total-internal-reflection condition. The evanescent waves above the sample are scattered by the trapped particle and propagate into the far-field, where a detector is located. The detector is mounted at the conjugate point of the trapped particle with respect to the trapping objective. An infrared filter is used to block the trapping laser beam and let the illumination light pass through. A pinhole is inserted in front of the detector to remove stray light other than from the trapped particle. The strength of the detector signal is then a measure of the strength of the evanescent field at the particle, so that the field can be mapped by scanning the particle. In common with most near-field microscopes, the resolution of the image depends primarily on the particle size and not the illuminating wavelength.

In contrast with conventional near-field microscopes, such as the photon tunnelling scanning optical microscope or the shear-force microscope, no distance control is needed in this scheme because a particle remotely controlled by a laser beam stays in touch with

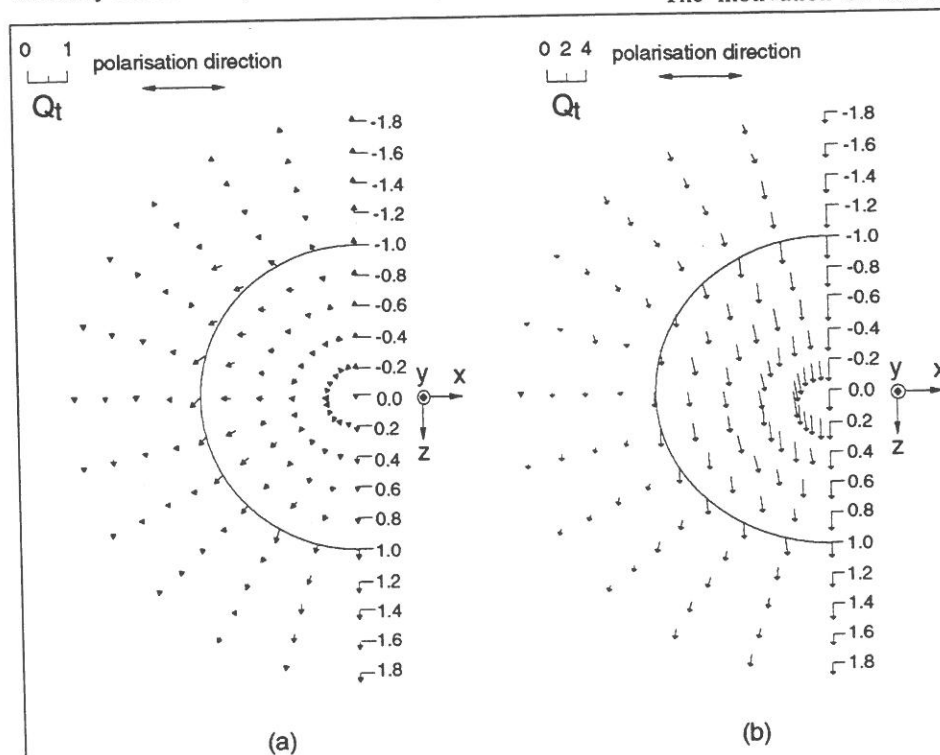
the surface of the sample.

In PTNSOM, if a dielectric particle is trapped as a scatterer, the trapping efficiency decreases with increasing NA of the objective lens [12]. The trapping efficiency determines the scanning speed, and hence the time required to acquire an image is longer for high NA lenses. However, a high NA is needed in order to increase the scattered signal. This conflict can be solved by using a laser-trapped metallic particle, for which the trapping efficiency increases with NA.

### 3. Research on PTNSOM at Victoria University

Research of PTNSOM at Victoria University started at the beginning of 1997 in the Optoelectronic Imaging Group within the School of Communications and Informatics. Since then, significant efforts have been devoted to the understanding of laser-trapping with dielectric and metallic particles [13,14], characterisation of trapping forces in the presence of spherical aberration [14,15], and PTNSOM with laser-trapped metallic particles [11]. In this section we report some of the results.

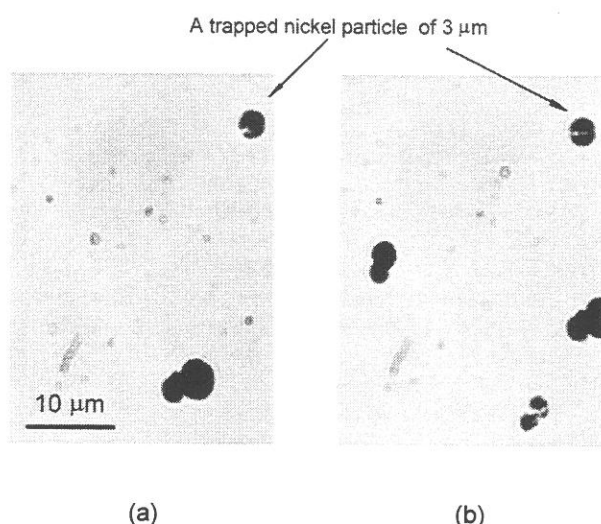
The motivation of our study of PTNSOM is to use



**Figure 2:** Calculated distribution of total trapping efficiency  $Q_t$  for (a) a polystyrene and (b) a gold particle. The total trapping efficiency is proportional to the total trapping force but normalised by the trapping power. The right half of the particle is omitted as the force distribution is symmetric about the beam axis ( $z$  axis). Each arrow starts from the focal position of a trapping laser beam, and points in the direction of total trapping force. The light distribution over the aperture of the trapping objective (oil-immersion, NA = 1.25) is uniform and linearly-polarised ( $\lambda = 488$  nm).

metallic particles as near-field probes to enhance the scattering efficiency, and therefore the image quality. However, our recent study has demonstrated some additional advantages of metallic over dielectric particles. As illustrated in figure 2, a metallic particle can be trapped in the transverse direction only if a laser beam is focused near the bottom and close to the edge of the particle, while a dielectric particle can be trapped at any off-axial position [12,14]. In the axial direction, a metallic particle experiences a push-out force along the optical axis while a dielectric particle can be either lifted or pushed depending on the focal position of a trapping laser beam [12,14]. In other words, a metallic particle can be trapped in two-dimensions and

pushed along the direction of the trapping laser beam (see the example in figure 3).



**Figure 3:** A trapped nickel particle of diameter  $3\ \mu\text{m}$  recorded using a CCD camera. Frames (a) and (b) were recorded at different times.

As previously noted, the principal advantage of using a metallic particle is that the maximum transverse trapping force on a metallic particle increases with the NA of the objective, while it decreases for a dielectric particle (see Table 1). As a result, using a metallic particle trapped by a high NA objective can increase not only the scattering efficiency, but also the scanning speed.

**Table 1** Experimental comparison of maximum transverse trapping efficiencies ( $Q$ ) of polystyrene and gold particles of  $2\ \mu\text{m}$  in diameter. The trapping wavelengths for polystyrene and gold particle were at  $633\ \text{nm}$  and  $488\ \text{nm}$ , respectively. The axial trapping position of a polystyrene particle was in the central equatorial plane while that was at the bottom of a gold particle. The transverse trapping position was on the edge of the particle in both cases.

NA	$Q_{\text{polystyrene}}$	$Q_{\text{gold}}$
0.8	-0.2300	-0.0102
0.9	-0.1732	-0.0179
1	-0.1414	-0.0276
1.1	-0.1267	-0.0305
1.25	-0.1020	-0.0407

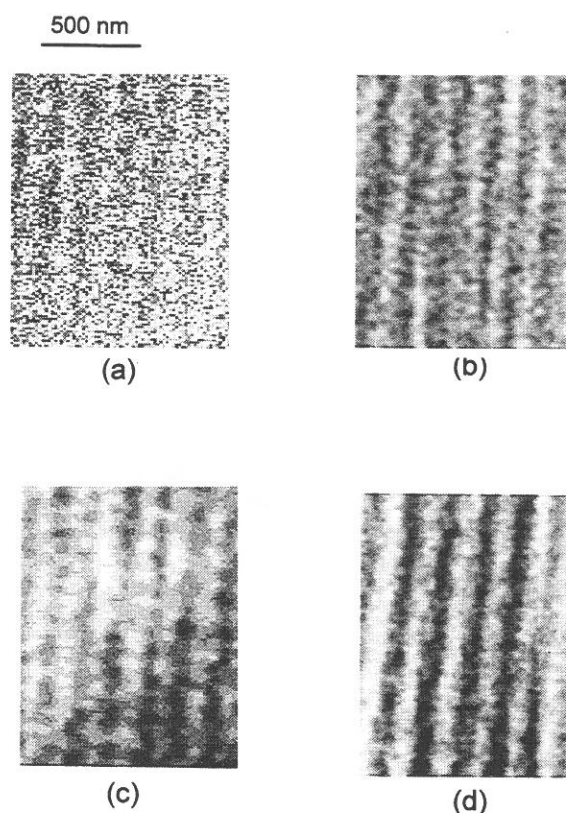
As shown in Table 2, scattered-signal strength measured from a metallic particle is far greater than that from a dielectric particle of the same size as a result of high reflection in the former case.

**Table 2** Averaged scattered signal strength by trapped polystyrene and gold particles with evanescent waves from the surface of a prism.

Particle diameter	$2\ \mu\text{m}$		$0.1\ \mu\text{m}$	
	polystyrene	gold	polystyrene	gold
Scattered signal (a.u.)	0.25	1.95	0.01	0.02
Image contrast	0.049	0.12	0.013	0.039

For a particle of  $2\ \mu\text{m}$  in diameter, the scattered signal from a gold particle is approximately 8 times stronger than that from a polystyrene particle. For polystyrene and gold particles, the scattered signal is increased by factors of approximately 24 and 96, respectively, when the particle size is increased from  $0.1$  to  $2\ \mu\text{m}$ . These results suggest that image quality can be enhanced if a trapped metallic particle is used as a near-field probe.

To demonstrate the image enhancement by a laser-trapped metallic particle, two evanescent waves were generated in opposite propagating directions on the surface of a prism. Figure 4 shows the images of the evanescent-wave interference pattern recorded with trapped polystyrene and gold particles of diameters of  $0.1$  and  $2\ \mu\text{m}$ .



**Figure 4:** Images of the evanescent-wave interference pattern recorded with a trapped particle: (a) a polystyrene particle of diameter  $0.1\ \mu\text{m}$ , (b) a gold particle of diameter  $0.1\ \mu\text{m}$ , (c) a



polystyrene particle of diameter 2  $\mu\text{m}$ , and (d) a gold particle of diameter 2  $\mu\text{m}$ .

The output power of the illumination He-Ne laser and the trapping  $\text{Ar}^+$  laser was 17 mW and 200 mW, respectively. The scanning speeds for trapped polystyrene and gold particles were 1 and 1.5  $\mu\text{m/s}$ , respectively, and the corresponding image acquisition times (70 pixels  $\times$  100 pixels) were 2.2 and 1.6 minutes. Compared with polystyrene particles, gold particles of diameters of 0.1 and 2  $\mu\text{m}$  exhibit improvement in image contrast by factors of 2 and 1.5, respectively, owing to the greater scattered-signal strength for gold. Figure 4 also confirms that, for a given material, image contrast is improved by the use of a large-sized particle. For example, image contrast is increased by factors of 2.8 and 2.1 for larger polystyrene and gold particles, respectively.

#### 4. Conclusion

We have shown that PTNSOM with metallic particles shows advantages over PTNSOM with dielectric particles. If PTNSOM is used to image a biological sample, the scanning speed should be increased further. One of the methods for solving this problem is the use of a trapping objective with a complex apodization property. Research on this topic is currently under way in the Optoelectronic Imaging Group at Victoria University.

#### References

- [1] S. Sato and H. Inaba, Optical and Quantum Electronics, 28 (1996), 1-16.
- [2] K. Sasaki, Z. Shi, R. Kopelman and H. Masuhara, Chem. Lett., (1996), 141-142.
- [3] K. Sasaki, H. Misawa, N. Kitamura, R. Fujisawa and H. Masuhara, Jpn. J. Appl. Phys., 32 (1993), L1144-L1147.
- [4] T. N. Buican, M. J. Smyth, H. A. Crissman, G. C. Salzman, C. C. Stewart, and J. C. Martin, Appl. Opt., 26 (1987), 5311-5316.
- [5] A. Ashkin, J. M. Dziedzic, and T. Yamane, Nature, 330 (1987), 769-771.
- [6] S. B. Smith, Y. Cui, and C. Bustamante, Science, 271 (1996), 795-799.
- [7] G. V. Shivashankar and A. Libchaber, Appl. Phys. Lett., 71 (1997), 3722-3729.
- [8] E. Betzig, and J. K. Trautman, Science, 257 (1992), 189-195.
- [9] L. P. Ghislan, and W.W. Webb, Opt. Lett., 18 (1993), 1678-1680.
- [10] S. Kawata, Y. Inouye, and T. Sugiura, Jpn. J. Appl. Phys., 33 (1994), L1725-L1727.
- [11] M. Gu, and P. C. Ke, Opt. Lett., 24 (1999), 74-76.
- [12] A. Ashkin, J. Biophys., 61 (1991), 569-582.
- [13] M. Gu, P. C. Ke, and X. S. Gan, Rev. Sci. Instrum., 68 (1997), 3666-3668.
- [14] P. C. Ke, and M. Gu, Appl. Opt., 38 (1999), 160-167.
- [15] P. C. Ke, and M. Gu, J. Mod. Opt., 45 (1998), 2159-2168.

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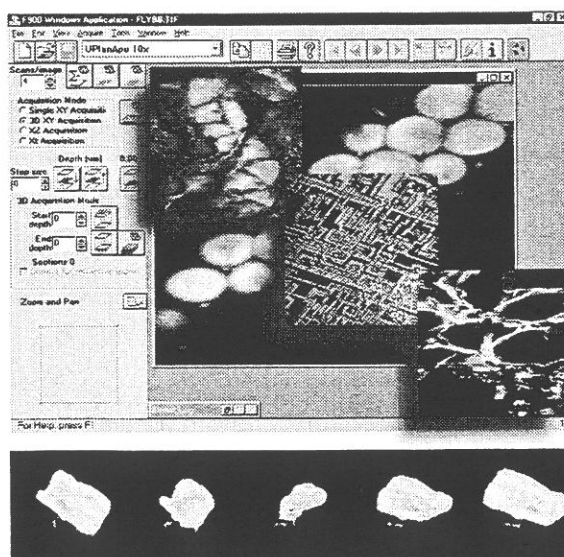
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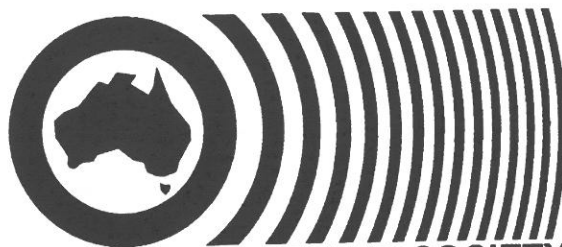




## Meetings Calendar at a Glance



Date	Meeting	1999	Contact	Location
Feb 21-26	Medical Imaging		SPIE	San Diego, CA
Mar 1-5	Smart Structures and Materials		SPIE	Newport Beach, CA
Mar 3-5	Nondestructive Evaluation for Aging Infrastructure and Manufacturing		SPIE	Newport Beach, CA
Mar 14-19	Microolithography		SPIE	Santa Clara, CA
Mar 22-26	Principles and Applications of Time-Resolved Fluorescence Spec.		OSA	Baltimore, MD
Mar 30-1	Symposium on Design, Test, and Microfabrication of MEMS/MOEMS		SPIE	Paris, France
Apr 5-9	AeroSense		OSA	Orlando, Florida
Apr 12-16	OIC '99 - Optics in Computing		OSA	Aspen, CO
Apr 12-16	QOE '99 - Quantum Optoelectronics		OSA	Aspen, CO
Apr 12-16	SLM '99 - Spatial Light Modulators		OSA	Aspen, CO
Apr 12-16	UEO '99 - Ultrafast Electronics and Optoelectronics		OSA	Aspen, CO
Apr 13-16	International Conference on Optical Fiber Sensors		OSA	Kyongju, Korea
May 19-21	Symposium on Microelectronic Manufacturing Technologies		SPIE	Edinburgh, Scotland
May 20-22	Optoelectronic Distance: Displacement Measurements and Applications		OSA	Pavia, Italy
May 23-28	CLEO'99 - Conference On Lasers and Electro-Optics		OSA	Baltimore, Maryland
May 23-28	QELS - Quantum Electronics and Laser Science Conference		OSA	Baltimore, Maryland
May 24-28	Symposium on Optical Systems Design		SPIE	Berlin, Germany
Date	Meeting	1999 (cont')	Contact	Location
Jun 7-10	Fourier Transform Spectroscopy: New Methods & Applications		OSA	Monterey, CA
Jun 7-10	Optical Remote Sensing of the Atmosphere		OSA	Monterey, CA
Jun 8-11	6th International Symposium on Metallomesogens		OSA	Germany
Jun 9-11	Optical Amplifiers and their Applications		OSA	Nara, Japan
Jul 4-7	ACOFT99 - Australian conference on Optical Fibre Technology		AOS	Sydney, Australia
Jul 7-9	AOS XII - 12th Conference of the Australian Optical Society		AOS	Sydney, Australia
Jul 12-16	Workshop on Adaptive Optics for Industry and Medicine		OSA	Durham, England
Jul 14-16	7th Microoptics Conference		OSA	Chiba, Japan
Jun 16-18	Optical Engineering for Sensing and Nanotechnology		SPIE	Yokohama, Japan
Jul 18-23	SPIE Annual Meeting		SPIE	Denver, Colorado
Jul 19-21	Integrated Photonics Research		OSA	Santa Barbara, CA
Jul 21-23	Photonics and Switching		OSA	Santa Barbara, CA
Aug 29-3	Conference on Ferroelectric Liquid Crystals		OSA	Darmstadt, Germany
Sep 1-3	Nonlinear Guided Waves and Their Applications		OSA	Dijon, France
Sep 17-22	Photonics East		SPIE	Boston, MA
Sep 24-26	Bragg Gratings, Photosensitivity and Poling in Glass Waveguides		OSA	Santa Clara, CA
Sep 24-26	Organic Thin Films for Photonics Applications		OSA	Santa Clara, CA
Sep 25-1	Interdisciplinary Laser Science Conference		OSA	Santa Clara, CA
Sep 26-1	OSA'99 Annual Meeting		OSA	Santa Clara, CA
Oct 25-27	New Developments and Applications in Optical Radiometry		-	Madrid, Spain
Date	Meeting	2000	Contact	Location
Jan 21-27	Photonics West		SPIE	San Jose, CA
Mar 5-10	Optical Fiber Communication Conference		OSA	Baltimore, Maryland
Mar 7-12	CLEO Conference on Lasers and Electro-Optics		OSA	San Francisco, CA
Mar 7-12	QELS - Quantum Electronics and Laser Science		OSA	San Francisco, CA
Jul 30-4	SPIE Annual Meeting		SPIE	San Diego, CA
Sep 10-15	CLEO/Europe2000 - Conference on Lasers and Electro-Optics		OSA	Nice, France
Sep 10-15	IQEC - International Quantum Electronics Conference		OSA	Nice, France
Nov 3-8	Photonics East		SPIE	Boston, MA
Date	Meeting	2001	Contact	Location
Feb 12-14	Photonics West		SPIE	San Jose, CA
Feb 18-23	Optical Fiber Communication Conference		OSA	San Francisco, CA
May 6-11	CLEO - Conference on Lasers and Electro-Optics		OSA	Baltimore, Maryland
May 6-11	QELS - Quantum Electronics and Laser Science Conference		OSA	Baltimore, Maryland



AUSTRALIAN OPTICAL SOCIETY

**12<sup>TH</sup> CONFERENCE OF THE  
AUSTRALIAN OPTICAL SOCIETY**

and

**AUSTRALIAN CONFERENCE ON OPTICAL FIBRES AND  
TECHNOLOGY '99**

**The University of Sydney**

**Sunday July 4 to Friday July 9 1999**

**ACOFT'99 Sunday July 4 to Wednesday July 7 1999**

**AOS'99 Wednesday July 7 to Friday July 9 1999**

**Wednesday July 7 is a joint ACOFT/AOS day**

**CALL FOR PAPERS**

*Deadline for receipt of abstracts is April 2, 1999*

Authors are invited to submit abstracts or papers for consideration for presentation (oral or poster) at either AOS'99 or ACOFT'99. Note the different abstract/paper requirements for the two conferences: Camera-ready abstracts are required for AOS'99, while longer technical papers are to be submitted to ACOFT'99.

Topics to be considered for presentation at AOS'99 include, but are not restricted to, the following areas:

- Physical optics
- Microscopy
- Lasers
- Atom and other particle optics
- X-ray optics
- Astronomical optics
- Vision science and medical optics
- Nonlinear optics
- Spectroscopy
- Interferometry and holography
- Radiometry, photometry and colour
- Thin Films
- Quantum Optics
- Teaching
- Optical instrumentation, design, fabrication and testing

Each abstract should be in camera-ready format and:

- Not exceed one A4 page and be printed in Times New Roman or similar 12 point font;
- Include the title, centred, bold and in capitals at the top; followed by the list of authors, their affiliations, and the e-mail address of the contact author;
- The text (including title and footnotes) should be surrounded by a margin of size no less than 3cm.
- The abstract should be accompanied by a separate cover page which contains -
  - abstract title
  - list of authors, their full return addresses, e-mail addresses, phone numbers and facsimile number



Technical papers submitted for consideration for presentation at ACOFT'99 should describe significant research as well as innovative developments and applications in one or more of the following areas:

- Optical fibre technology, devices and theory
- Optoelectronics
- Temporal and spatial solitons
- Gratings
- Nonlinear optics
- Planar waveguide technology, devices and theory
- Optical sensing
- Optical transmission systems
- WDM networks and enabling technologies

Each paper should:

- Not exceed four pages and should be printed in a Times New Roman or similar 12 point font;
- Include a cover page listing the name, affiliation, complete return address, telephone and facsimile numbers and e-mail addresses of all authors
- Include a 50-word abstract and indicate the appropriate technical subject area;

6 copies of each abstract or paper should be sent by Friday, April 2, 1999 to the conference secretariat (address below)

## REGISTRATION

Registration will be carried out via the conference web site (see address below) or registration forms can be obtained from the conference secretariat (contact details below). Registration information will also be mailed to all authors on submitted abstracts and papers.

REGISTRATION FEES		
<b>ACOFT'99</b> July 4 to 7, 1999 ACOFT'99 fees include Proceedings, morning and afternoon tea, lunch, Welcome Reception and Conference Dinner	Member (IREE/AOS/Aust Photonics CRC)	\$250
	Non-member	\$300
	Student	\$175
<b>AOS'99</b> July 7 to 9, 1999 AOS'99 fees include Abstracts, morning and afternoon tea and lunch.	Member (IREE/AOS/Aust Photonics CRC)	\$200
	Non-member	\$230
	Student	\$90
<b>ACOFT/AOS '99</b> July 4 to 9, 1999 ACOFT/AOS'99 fees include ACOFT Proceedings, AOS Abstracts, morning and afternoon tea, lunch, Welcome Reception and Conference Dinner.	Member (IREE/AOS/Aust Photonics CRC)	\$340
	Non-member	\$400
	Student	\$200

## CONTACT DETAILS

Conference Secretariat  
The IREE Society, PO Box 495, Milsons Point, NSW 1565  
Telephone: 61 2 9929 0099 Facsimile: 61 2 9929 0587  
E-mail: [ireesoc@ozemail.com.au](mailto:ireesoc@ozemail.com.au)

*For regular updates of conference information please refer to the Conference Secretariat webpage at [www.ozemail.com.au/~ireesoc/conferences](http://www.ozemail.com.au/~ireesoc/conferences)*

# SPIE MEETINGS CALENDAR

1998

## Photonics East®

1-6 November

Hynes Convention Center  
Boston, MA USA

*Including international symposia on*

- Intelligent Systems and Advanced Manufacturing
  - Voice, Video, and Data Communication
  - Industrial and Environmental Monitors and Biosensors
  - Law Enforcement
- Technical Exhibit  
SPIE Short Courses and Education Program.

1999

## Photonics West®

23-29 January

San Jose Convention Center  
San Jose, CA USA

*Including international symposia on*

- LASE '99—High-Power Lasers and Applications
  - OPTOELECTRONICS '99—Integrated Devices and Applications
  - BIOS '99—International Biomedical Optics Symposium
  - SPIE/IS&T's EI '99—Electronic Imaging: Science and Technology
- Technical Exhibit 26-28 January  
Education Program and Short Courses

## Medical Imaging 1999

20-26 February

San Diego, CA USA

Technical Exhibit  
Instrument exhibition  
SPIE Short courses

*1999 Symposium on*

## Smart Structures and Materials

1-5 March

Marriott Hotel and Tennis Club  
Newport Beach, CA USA

Technical Exhibit  
SPIE Short Courses

*1999 Symposium on*

## Nondestructive Evaluation Techniques for Aging Infrastructure and Manufacturing

3-5 March

Marriott Hotel and Tennis Club  
Newport Beach, CA USA

Technical Exhibit

*1999 International Symposium on*

## Microlithography

14-19 March

Santa Clara Convention Ctr.  
and Westin Hotel  
Santa Clara, CA USA

Technical Exhibit  
SPIE Short Courses

## Design, Test, and Microfabrication of MEMS/MOEMS

30 March-1 April

Le MERIDIEN Montparnasse Hotel  
Paris, France

Technical exhibit

## AeroSense '99

### Aerospace/Defense Sensing and Controls

5-9 April

Marriott's Orlando World Center  
Resort and Convention Center  
Orlando, FL USA

Exhibit 6-8 April  
SPIE Short Courses

## Photomask Japan '99

### Symposium on Photomask and X-Ray Mask Technology

13-14 April

Kawasaki City, Kanagawa Japan

Abstract Due Date: 13 November 1998

Technical Exhibit

Contact: Business Ctr. For Academic Societies  
Japan, Conference Dept., 5-16-9 Honkomagome,  
Bunkyo-ku, Tokyo, Japan. Phone: 81-3-5814-  
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## Microelectronic Manufacturing Technologies

19-21 May

Edinburgh, Scotland

Abstract Due Date: 19 October 1998  
Technical Exhibit

EUROPTO®  
SERIES

## Optical Systems Design

24-28 May

Berlin, Germany

Abstract Due Date: 26 October 1998  
Technical exhibit

EUROPTO®  
SERIES

## Industrial Lasers and Inspection

14-18 June

Munich, Germany

Abstract Due Date: 16 November 1998  
Technical Exhibit

*International Conference on*

## Optical Engineering for Sensing and Nanotechnology (ICOSN '99)

16-18 June

Yokohama, Japan

Abstract Due Date: 30 September 1998  
Technical Exhibit

Cosponsored by Optical Society of Japan (OSJ)  
and SPIE

## Optical Data Storage

11-15 July

Kauai, HI USA

## International Symposium on Optical Science, Engineering, and Instrumentation

### SPIE's 44th Annual Meeting

18-23 July

Denver, CO USA

Abstract Due Date: 21 December 1998  
Technical Exhibit

## 18th Annual BACUS Symposium on Photomask Technology and Management

15-17 September

Monterey, CA USA

Abstract Due Date: 22 February 1999  
Technical Exhibit

## Photonics East®

17-22 September

Boston, MA USA

Abstract Due Date: 22 February 1999

*Including international symposia on*

- ISAM '99—Intelligent Systems and Advanced Manufacturing
  - VVDC '99—Voice, Video, and Data Communications
  - LE '99—Law Enforcement
  - Industrial and Environmental Monitors and Biosensors
- Technical Exhibit 20-22 September 1999

## Micromachining & Microfabrication

20-21 September

Santa Clara, CA USA

Abstract Due Date: 22 February 1999  
Technical Exhibit


## Microelectronic Manufacturing

22-23 September

Santa Clara, CA USA

Abstract Due Date: 22 February 1999  
Technical Exhibit

For more information about any of the above symposia, please contact SPIE directly by phone or fax, e-mail [spie@spie.org](mailto:spie@spie.org), or view the SPIE website at <http://www.spie.org>.

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## News from the AOS Council

The AOS held both a "members' feedback meeting" and a council meeting in Christchurch, New Zealand, in December 1998, concurrent with ACOLS '98.

The feedback meeting, to which all interested AOS members were invited, was held on 15 December. Although there were some empty seats, this meeting was of considerable interest due to the presence, by invitation, of Janet Fender and John Otten of the Optical Society of America. One important issue which received an airing was the possible merger, or at least strong collaboration, between OSA and SPIE. One perceived advantage of the closer ties between the societies would be that meeting conflicts would be minimised, and there could be opportunities for AOS to be involved in a number of local meetings.

AOS members expressed concern that the new International Council of OSA as yet has no representation from Australia or New Zealand, an omission which it was hoped could still be remedied.

Another issue discussed at the feedback meeting was the use of AOS funds and the matter of prizes. Many felt that the prizes offered by the AOS were not widely enough advertised, and more extensive use of the member database and e-mail was suggested.

The proposed AIP/AOS co-location in Adelaide in 2000 was also discussed, and perceived as presenting a number of logistical difficulties due to the large numbers that a combined meeting might be expected to attract. Council will address these issues over the next few weeks and months.

We realise that many AOS members were unable to be present at the Christchurch meeting, and if any of you have views on the above issues, or any other AOS matters, Council will be happy to receive and consider your opinions. They may be sent in the first instance to me by e-mail or fax (clyde.mitchell@cmst.csiro.au and 03-9544-1128 respectively).

The AOS council meeting was held on 17 December, immediately following the close of ACOLS '98.

Halina Rubinsztein-Dunlop, in her President's Report, expressed concern about the future directions for the Australian Research Council, the role of which seemed to be likely to be reduced or eliminated altogether. The allocation of block grants to universities could lead to loss of the peer review system, could lead to undesirable differentiation between theoreticians and experimentalists, and to difficulties in interdisciplinary

areas. On behalf of the AOS, she and Brian Orr (Past President) had written to the Minister for Education, Training and Youth Affairs, Dr David Kemp, expressing concern at the proposed changes.

The President also expressed Council's gratitude to the organisers of the ACOLS '98 conference.

Barry Sanders presented his report as Treasurer. Membership figures for 1999 stood at 296 ordinary, 26 student, and 11 corporate. About half had already paid 1999 dues. He expressed concern at the decline in numbers of corporate members (from 14 in 1998), and also suggested a more active campaign to recruit members from New Zealand.

We welcome Lew Whitbourn back to Council after a brief sojourn 'in the cold' - he takes the place of Esa Jaatinen who leaves Council after two years as treasurer and one as past-treasurer.

Council considered further the matter of the OSA International Council that had been raised at the feedback meeting. Council decided not to wait for a response from John Otten, but to be proactive and sent a strong letter urging the inclusion on the council of a representative from our geographical area.

In other areas of international outreach, Council learned that our interaction with SPIE appears to be going smoothly, and we also decided to nominate a member of AOS as an officer with ICO (the International Commission for Optics).

We discussed our interaction with FASTS (the Federation of Australian Scientific and Technological Societies) and noted a number of important matters, in particular the points made by the President, Prof Peter Cullen, in his Annual Report, and in his Address to FASTS Council. These may be found at <http://www.usyd.edu.au/su/fast>s, as may the list of the Top Ten FASTS Policies which has been developed. Council also noted the importance of linking, through FASTS, to PMSEIC (the Prime Minister's Science, Engineering and Innovation Council), the web address of which is

<http://www.dist.gov.au/science/pmseic/pmseic.html>

We decided to send one or two AOS representatives to the lobbying event "Scientists on Parliament Hill", which is to take place in November 1999.

Professor Wes Sandle, an invited guest of Council and the Chair of the ACOLS '98 Organising Committee, spoke to us about the conference, and strongly recommended the idea of having separate program and



organising committees. A refereeing process made the presentations more useable for funding purposes. He suggested that we should also take advantage of the excellent web-based package that has been put together by Peter Manson for ACOLS '98. He thanked the optics and laser spectroscopy community for their support of the conference, and recognised the goodwill and loyalty that exists towards New Zealand in this area. The field is clearly alive and vigorous.

Due to some confusion in the numbering of AOS conferences, we have decided to abandon the system of Roman numerals, and instead designate each conference solely by its year. The upcoming ACOFT '99 conference in Sydney in July 1999 will thus be co-locating with AOS '99, and not AOS XII as indicated in early publicity material. Program planning for this conference is well under way, although many details remain to be finalised. AOS will award a student poster prize, and the AOS 1999 Annual General Meeting will take place during this conference. We adopted the principle that to attend an AOS meeting a person must be an AOS member.

We have decided that AOS 2000 will be co-located with the AIP Congress in Adelaide in December 2000. We also decided to look into the possibility of making a contribution to the Conference on Precision EM Measurements, to be held in May 2000.

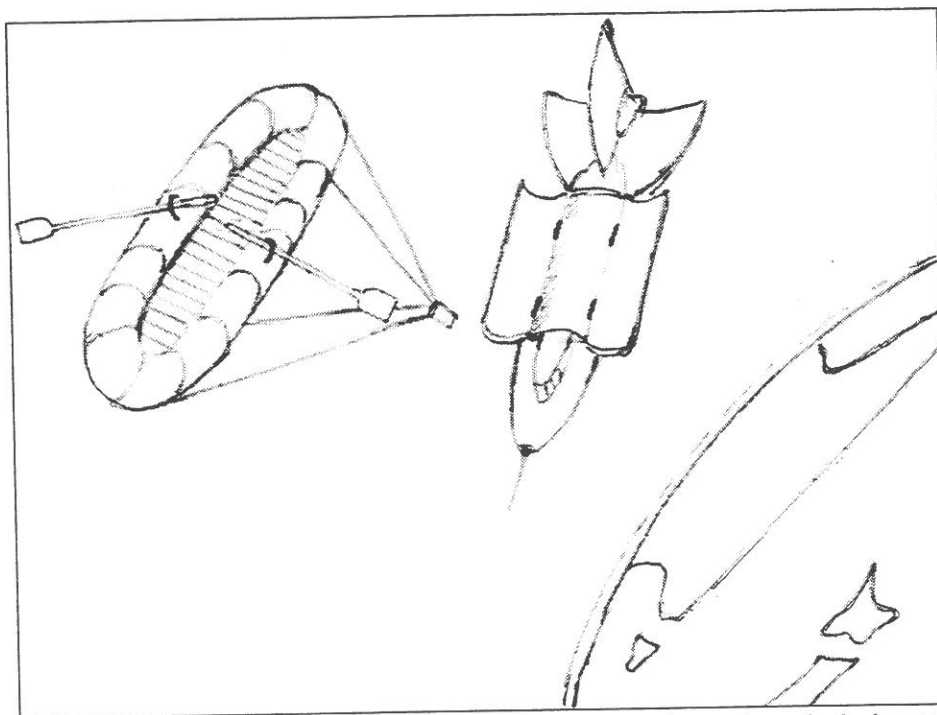
Council decided to actively seek more nominations for the AOS Medal, which close at the end of February 1999. Please consider nominating eminent people in optics for this prestigious award!

We approved the award of the Postgraduate Student Prize to Daniel Day, of the Optoelectronic Imaging Group at Victoria University of Technology.

We had a number of other items on our lengthy agenda, including the AOS Technical Optics Award, which attracts very few applications, but discussions on these matters had to be deferred due to lack of time.

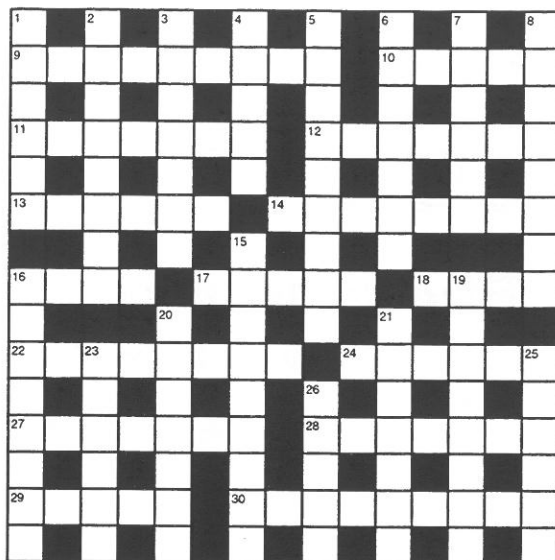
Clyde Mitchell

Secretary



Deployment of the inflatable antenna ends in embarrassment after a mix-up in the luggage

## Optics Cryptic Crossword No. 1



## Across

- 9 Instrument openings in rear setup? (9)  
 10 Forearm bones describe circles (5)  
 11 Trifles can be spectrally selective (7)  
 12 Bend light inside a glassware fracture (7)  
 13 Turn on an atom (6)  
 14 Polariser fitted to any laser (8)  
 16 Ribbon worn in Kansas hotel (4)  
 17 Negative or positive images found on coated optics (5)  
 18 Its in the satirist's diaphragm (4)  
 22 Yes, eight had twisted vision (8)  
 24 Gyroscope ring is a part of whirligig I'm balancing (6)  
 27 High frequency speaker made from a wet tree (7)  
 28 Natural spectrum found in a rough wino bar (7)  
 29 Make concentric using a lag in reverberation (5)  
 30 Stiff card produces interference pattern (9)

## Down

- 1 Stump used for stopping stray light (6)  
 2 Thinks about unstable clefts (8)  
 3 Setters wander the roads (7)  
 4 Optical wedge made by the prim south (5)  
 5 Night sky study of a stray moon, perhaps? (9)  
 6 Outline the peril of disturbance (7)  
 7 The personal principles of bonafide Alsatian (6)  
 8 Pie crust makes a mess of photographs (8)  
 15 Very pure in the sixth form? (4,5)  
 16 Spelt car wrongly with a certain frequency (8)  
 19 Cleans junk off surface with SBUR (4,4)  
 20 Glint it put out when leaning over (7)  
 21 The act of copying girl weep (7)  
 23 Shutter for the viewer (6)  
 25 Torn towels at the bottom of the heap (6)  
 26 Meaning of type of wood from the sea (5)

## Editorial

This is the December issue of the *AOS News*, and, as you may have noted, it is now March. I must apologise for the lateness of this issue, which was caused partly by ACOLS, Christmas, and my work commitments.

This is also the last issue under my editorship. Shaun Griffin takes over as editor in March. I will probably have some role in the next issue, and will continue to accept material for the *AOS News* which I will pass on to Shaun. I'm sure Shaun will enjoy his time as editor, and I hope that our readers will continue to contribute enough articles to make his job a pleasant one.

I'd like to thank all of the contributors to this magazine — their articles have been interesting and of a high standard, without exception. Several contributors have also made my job particularly easy, in particular I wish to mention Ken Baldwin, Judith Dawes, Martijn de Sterke and Barry Sanders. Esa Jaatinen has helped out many times, and filled in as editor in my absence. The AOS presidents during my term (Chris Walsh, Brian Orr and Halina Rubinzstein-Dunlop) have always been supportive and punctual with their reports.

The cryptic crossword which appears to the left is my parting challenge to the AOS readership.

Finally, a reminder that the AOS web site can be found at

<http://www.physics.mq.edu.au/~aos/>

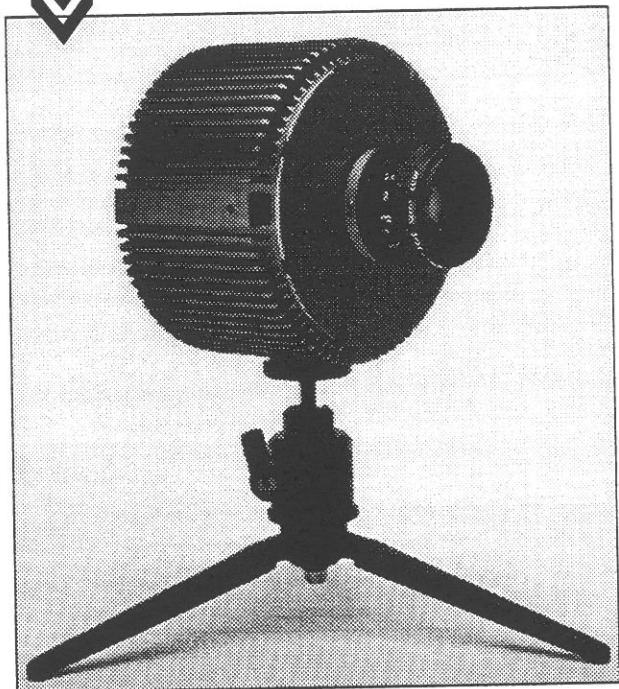
Duncan Butler

"An astronomer, a physicist and a mathematician (it is said) were holidaying in Scotland. Glancing from a train window, they observed a black sheep in the middle of a field. 'How interesting,' observed the astronomer, 'all Scottish sheep are black!' To which the physicist responded, 'No, no! *Some* Scottish sheep are black!' The mathematician gazed heavenward in supplication, and then intoned, 'In Scotland there exists at least one field, containing at least one sheep, at least one side of which is black.'"

— Ian Stewart, in *Concepts of Modern Mathematics*.



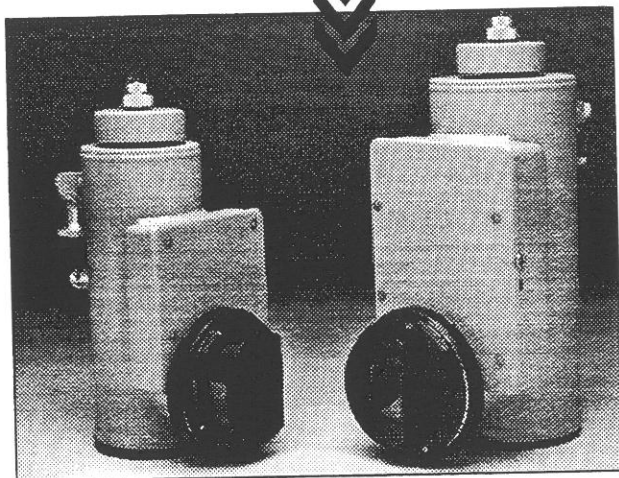
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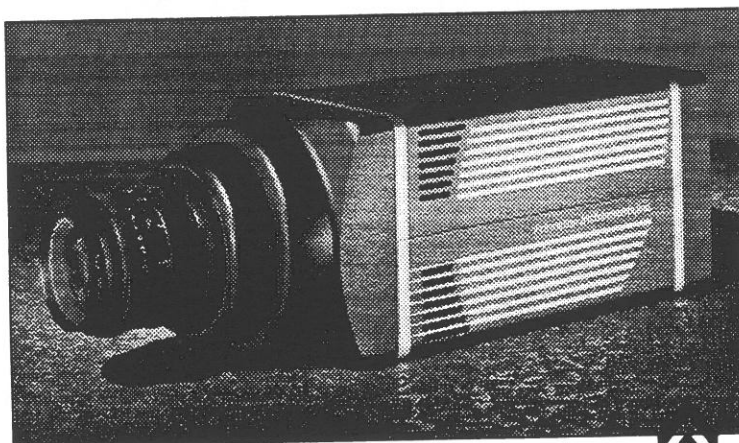
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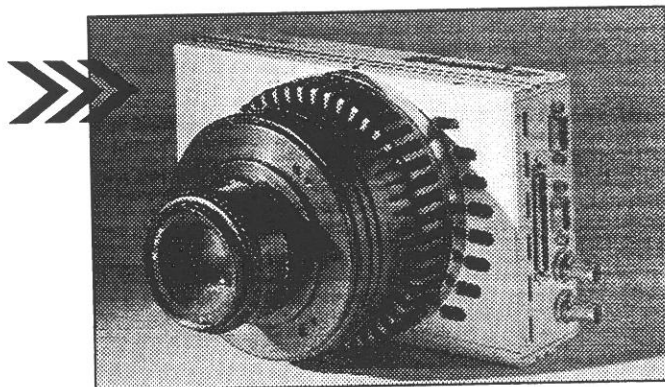
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"I really liked the facilitators ability to get us to get up and speak without any negative judgements from them. It was all very constructive" (Townsville researcher, July 1998)

## The Testing of Sunscreens

Frank Wilkinson

CSIRO National Measurement Laboratory  
POBox 218, Lindfield NSW 2070

*Sunscreens are rated for their ability to block the access of ultraviolet radiation from sunlight to our skin. The testing of this rating, or SPF, is no simple matter. For reasons to be discussed the most favoured methods use real human skin but an artificial source. The characteristics of this source have not been fully standardised, so significant differences between methods and ratings may occur. Some of the difficulties currently being considered will be outlined here.*

### 1. Introduction

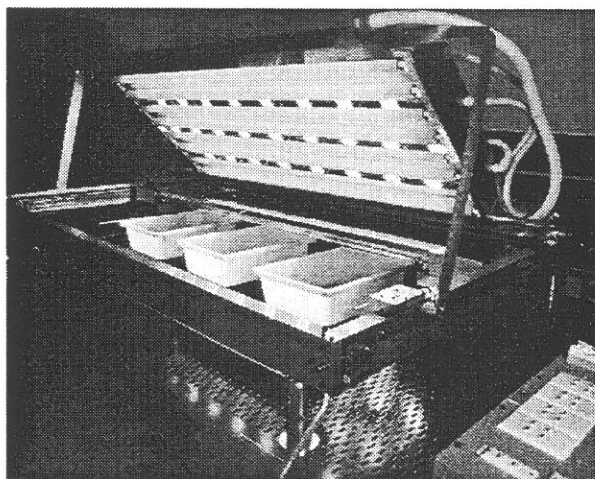
Sunscreens have been developed primarily to block ultraviolet radiation (UVR) from sunlight or daylight. This radiation includes the scattered UVR in skylight, which is about equal to that in the direct sunlight beam. A high performing sunscreen will usually also be very effective against artificial UVR sources such as welding arcs and germicidal lamps that emit radiation at shorter wavelengths than found in sunlight, but this subject will not be discussed in this article.

Sunscreens are rated according to their Protection Factor, defined as "the ratio of UV radiation dose required to produce recognisable erythema on skin that has been protected with a sunscreen product to the dose required on unprotected skin under the same conditions" [1]. The Label or Sun Protection Factor (SPF) is obtained by classifying the protection factors into different categories.

It became obvious some time ago that a reliable performance rating could not be easily obtained *in vitro* by, for example, measuring diffuse spectral transmittances of these products spread on quartz plates or other substrates. Skin is highly irregular and porous and, of course, contains lots of chemicals that may interact with the sunscreen, its distribution, and the way it is absorbed. Various forms of artificial skin have been tried but test results do not generally compare well with *in vivo* results using human skin. Naturally, the latter are expensive to perform so the artificial line of investigation continues. In either case, spectral transmittance data are still useful for modelling the effects of varying source spectra.

### 2. Skin reactions to sunlight

Excess amounts of UVR from sunlight damages skin. Amongst the first signs of damage is delayed erythema, a reddening of the skin which most fully develops about 24 hours after exposure. Long term damage includes skin cancers, melanoma, immuno-suppression, and symptoms of ageing. The action spectrum (response to different wavelengths) of erythema is fairly well established, whilst the spectra of these other effects are not well defined but thought to be similar to erythema. These are currently being studied in various research centres including the Sydney University Department of Veterinary Pathology. A large-area full-spectrum solar simulator, pictured in Fig. 1, was collaboratively designed and built at the CSIRO National Measurement Laboratory for studies of small animal skin cancer production by UVR and the protection given by various types of sunscreens.



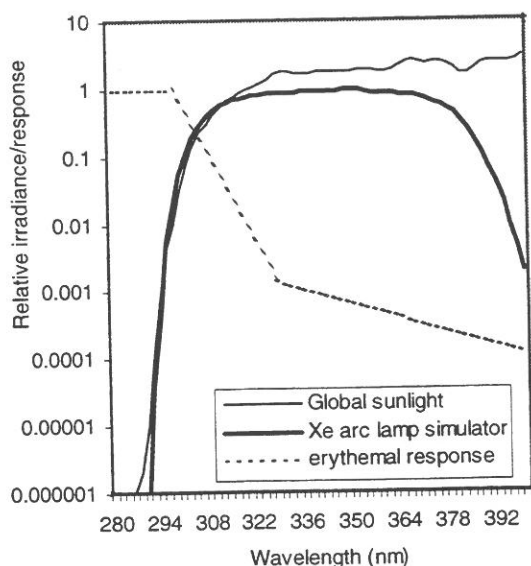
**Figure 1:** A solar simulator built for the Department of Veterinary Pathology to be used for studies of skin cancer production by UV radiation in small animals.

A just-perceptible minimum erythema is used as the *in vivo* indicator of sunscreen performance. Skin responses vary with type, but for light, sensitive, untanned skin it takes about 12-15 minutes of exposure to midday high-elevation summer daylight to produce a minimum erythematous dose (MED). This time rapidly lengthens earlier and later in the day, at higher latitudes and away



from summer. If a sunscreen product with an SPF of 20 is used it should take twenty times as long to obtain an equivalent erythema, ie about 4-5 hours. In fact, there are not normally twenty MEDs in one day's exposure. One solution would be to intensify the skin-site irradiance by concentrating sunlight with lenses or mirrors. After necessary removal of the excess heat produced, it is still found that the UVR content varies too much. The vagaries of the weather, changing seasons and laboratory site differences make it impossible to use natural sunlight for reliable testing.

In 1969 Dan Berger published a paper [2] on his design of a solar simulator for sunscreen testing that would overcome many of these problems. It uses a xenon arc lamp, filters, mirrors and lenses to produce a concentrated beam or high irradiance of UVR on skin with virtually all of the infrared and visible wavelengths removed. The spectrum of the beam from his lamp is compared with a typical peak summer daylight spectrum in Fig. 2. The standard action spectrum of the erythema response [3] is also shown. Note that the vertical scale is logarithmic.

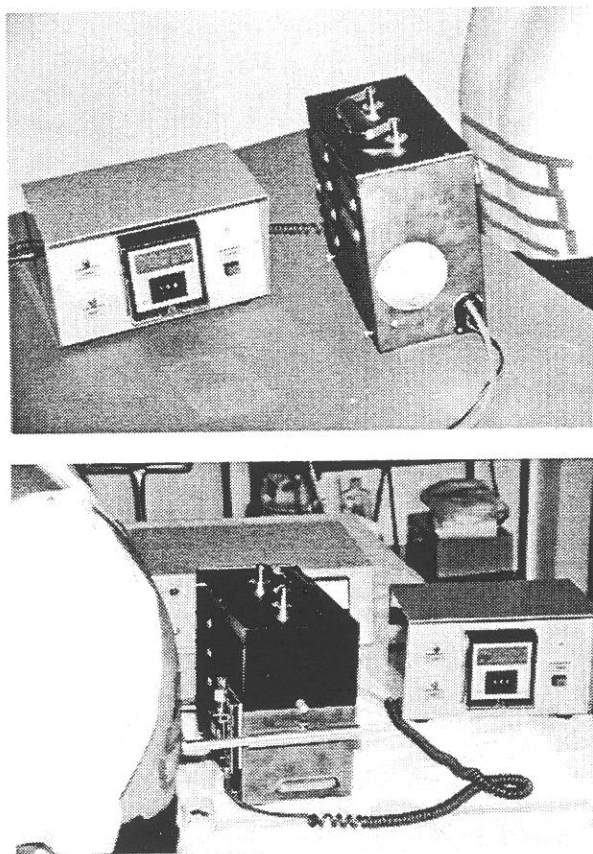


**Figure 2:** Relative spectral irradiances of global summer daylight (thin line) and a xenon arc solar simulator (thick line), and the standard erythema spectral response (dashed line).

### 3. Current *in vivo* testing

The Berger lamps have been marketed by the Solar Light Company, Philadelphia, and they and similar models are now widely used around the world. Figure 3 shows a recent model in use. Various national Test Methods (eg. Australian/New Zealand Standard 2604 [1]) have evolved specifications for the test source based largely on this design. These lamps appeared to work very well for testing lower SPF products in past years, but the drive for higher protection sunscreens with label protection

factors of 30 or higher is now pushing the simulator technology to its limits.

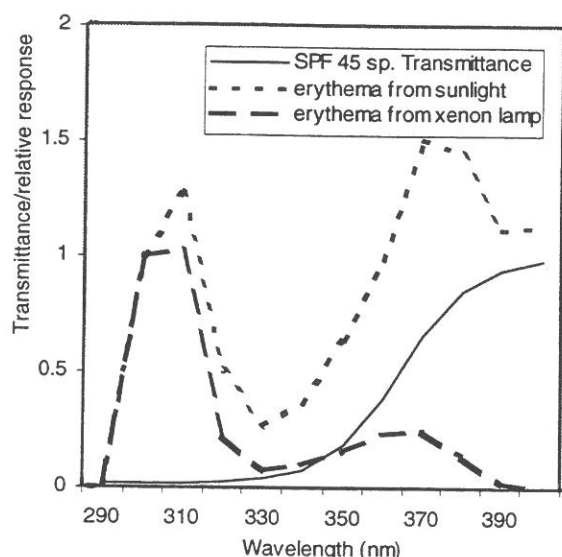


**Figure 3:** Sunscreen testing on human skin using Berger lamps.

UVR at wavelengths in the so-called UVA range (315-400 nm) does produce erythema, albeit at much higher dose levels than wavelengths in the UVB (280-315 nm). From spectrophotometric studies, high SPF sunscreens are known to commence transmitting in the middle or upper UVA range. Therefore, there must be sufficient energy from the lamp in this range of transmission and where erythema still responds to do the test correctly. If there is a high imbalance between the UVB level that produces the erythema in the absence of the sunscreen and the UVA level that produces a significant amount of the erythema with the sunscreen applied, then the ratio of doses will not represent the true SPF of the product.

The transmission characteristics of a representative sunscreen product are shown in Fig. 4 together with the relative contributions to erythema of various wavelengths of unfiltered and filtered simulator radiation, or sunlight radiation if that was used. Note the higher proportion of erythema produced in the UVA region by sunlight compared with the simulator. This changes the protection factor of the sunscreen, as both sources produce most of the erythema from UVB radiation without the sunscreen, but one (sunlight) produces relatively more than twice as

much erythema with the sunscreen applied, most of it from UVA radiation. In this study, the protection factor of the product (which has an SPF45 label) can be calculated from the transmittance data. In this case the measured protection factor would be 17 in sunlight and 40 using the Berger lamp solar simulator.



**Figure 4:** Measured spectral transmittances of an SPF45 sunscreen (solid thin line) and calculated spectral contributions to erythema through the sunscreen using sunlight (dotted line) or a xenon arc simulator (dashed line) [5].

#### 4. A heat problem

A logical question is: Why not add more UVA radiation to the simulator beam to make up the deficiency? The main reason is that test laboratories and lamps are already working near the heat limits of comfort. Current models produce up to about 150 - 200 mW/cm<sup>2</sup> of UVR irradiance on each 1 cm circular test site, about twice the maximum total solar irradiance of full summer daylight. Higher irradiances cannot normally be tolerated. Some individuals have a higher heat tolerance, and it depends also on the rate of heat removal, such as air flow past the test site.

Even at this level it takes about 4 minutes of a volunteer sitting very still to receive 1 MED when protected by a product with an SPF of 30. Higher doses must also be delivered to choose the time recorded for the "just perceptible" dose, the dose series usually being spaced at  $\sqrt{2}$  factor intervals. Therefore, to include just one exposure above 1 MED will involve an exposure of about 6 minutes for the SPF30 sunscreen. A full set of exposures might take about 15-20 minutes. Double this for an SPF60 product (yes, they do exist!).

The upper UVA cutoff of these simulators is normally provided by a UV transmitting glass filter. There are few suitable glass types available and nothing that provides a

more sudden cutoff just below the visible range. An alternative would be to control this with multi-layer interference filters or mirrors and these are being introduced by some suppliers. However, the extra UVA adds to the total thermal loading to the skin so a trade-off is necessary.

The testing of high SPF products by this method has therefore struck limits set by heat tolerance and dose delivery times. The testing of products with SPF values of 40 or more has become very difficult.

#### 5. Reliability of SPF values

Next, there is the question of the accuracy of these tests. While I do not wish to question the accuracy of the test methods, it must be remembered that the value determined applies only to the type of UVR source used. Does it also apply reasonably to daylight?

Here, we run into major difficulties of trying to compare high SPF values obtained using radiation from these simulators and others with a fuller spectrum, closer to sunlight. Sunlight itself cannot be used — as previously noted it simply takes too long and varies too much over time. In addition, following and even during most skin damage events, repair responses commence which, in this case, mitigate the erythema response. Two responses cannot be reasonably compared where the dose delivery times vary by an order of magnitude or more and extend over many hours.

There is little published information comparing high SPF values obtained with "standard" solar simulators and either sunlight or spectrally modified simulators. Most studies have been of low protection products (PF < 10) which were reported more than 10 years ago. One recent *in vivo* limited study in Sydney [4] reported a reduction from PF54 to PF37 of a product tested with a standard simulator and one modified to reduce the UVB level relative to that from the UVA spectral region. Most of the studies have been modelled on *in vitro* spectral transmittance data, most obtained from sunscreen applied to excised mouse skin [5,6]. The transmission data is convolved with the standard erythema action spectrum and various source spectra such as sunlight, the standard xenon arc simulators or modified simulators.

The comparisons tend to show reasonable agreement of the protection factors at the lower levels (PF < 20) but increasing discrepancies at higher levels. For products with protection factors of about 30 several findings [5,6] were that the standard simulator over-estimated the protection factor by about 33% compared with what it should be for sunlight. For products with PF ~ 50 the over-estimation by the standard simulator is about 50%. These are modelling studies which are subject to some uncertainty but are difficult to confirm by *in vivo* tests.

New test methods specifically for UVA protection are currently being discussed. At present, some standards use upper limits applied to *in vitro* UVA spectral transmittances measured under a range of conditions. Suitable biological indicators are being evaluated for *in vivo* tests. These will also require a suitable test source — as similar to sunlight through the UVA range as is practicable.

## 6. Standard test methods

Another area of concern is the loose specification of the simulators in various "standard" test methods. The Australian/New Zealand Standard [1] together with similar standards in, for example, the USA, Japan, Canada, Germany, and South Africa specify the characteristics of the simulators that may be used for SPF testing. There are some other "standards" published by industry groups such as the European Cosmetic Toiletry Association (COLIPA) [7] and the International Commission on Illumination (CIE) [8]. Some similar specifications are shared by some of these standards but there is considerable variation between the wavelength ranges specified and the limits allowed.

Some standards set a UVB "envelope" of lower and upper limits for the short wavelength cutoff of the simulator radiation but then say little or nothing about the UVA content. Others simply call for a "continuous emission spectrum from 290 to 400 nm similar to sunlight" [9]. There is no criterion for the match. It is only quite recently that mercury discharge lamps were dropped as suitable test sources from some standards. It is the fortunate wide spread adoption by the industry and associated testing laboratories of similar models of xenon arc lamps that at present results in some degree of uniformity, but this is not guaranteed by the standards themselves.

The current specifications could allow some exploitation of differences by using tests in some countries which result in higher SPF ratings, to their market advantage. It would then be necessary to block the import of such products without retesting to the local standard, an expensive waste of resources and counter to the free trade objective.

These standards are constantly under review and a well recognised international standard is being sought which might then be widely adopted at the national level. The

CIE standard [8] is quite deficient in its simulator specification and the technical committee responsible is being reactivated to consider submissions. The A/NZ Standards committee CS/42 Sunscreen Agents recently made a submission regarding the simulators and local participation on the CIE technical committee is sought and expected.

## 7. Conclusion

It is generally thought that the current methods at least result in the correct ranking of sunscreens in their performance, even if the numbers are a little optimistic. Improved standards will ensure "a level playing field" for manufacturers and, hopefully, ratings that more accurately reflect the performance of these products in practice.

## References

- [1]. *Standards Australia, Standards New Zealand: Sunscreen products- evaluation and classification. AS/NZS 2604:1997.*
- [2]. Berger DS. Specification and design of solar ultraviolet simulators. *J Invest Dermatol* **53**, 192-199, 1969.
- [3]. McKinlay AF, Diffey BL. A reference action spectrum for ultraviolet induced erythema in human skin. *CIE Journal* **6**, 17-22, 1987.
- [4]. Greenoak GE, Australian Photobiology Testing Facility. Report on SPF tests on two sunscreens using 1) a WG320 clear UV filter with a transmission at 300 nm of approx. 10% (and with which SPFs of the two sunscreens had been previously established to be 23 and 53); 2) a WG320 with a specified transmission of 2% at 300 nm; 3) a UG5 blue filter to replace the UG11 blue filter, and 4) no blue filter. Personal communication, 1993.
- [5]. Sayre RM, Kollias N, Ley RD, Baqer AH. Changing the risk spectrum of injury and the performance of sunscreen products throughout the day. *Photodermatol Photoimmunol Photomed* **10**, 148-153, 1994.
- [6]. Stokes RP, Diffey BL. In vitro assay of high-SPF sunscreens. *J Soc Cosmet Chem* **48**, 289-295, 1997.
- [7]. The European Cosmetic Toiletry Association (COLIPA). COLIPA sun protection factor test method. Ref. **94/289**, 1994.
- [8]. Commission Internationale de L'Eclairage (CIE). Sunscreen testing (UV.B). Technical Report, Publ. No. CIE 90, 1991.
- [9]. Department of health and human services, FDA, USA. Sunscreen drug products for over-the-counter human use: tentative final monograph: proposed rule. Federal Register **21 CFR part 352**, 28194-28302, 1993.



Federation of Australian Scientific &  
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## Presidents Address to Council, 1998

### 1. The Challenge of Innovation

I have little doubt that the greatest science policy issue facing Australia relates to the commercialisation and uptake of the fruits of science to provide for a better society.

As I said in my address last year: "Scientists must 'add value' to the society in a clear and demonstrable way. We need to articulate the sort of Australia we seek, and how investment in science and technology can help us get there. I believe Australia needs to seek a high technology future, based on our science. We can choose to be part of the "knowledge" world, or choose to go down the low wage, low skill path. The low path seems favoured by our present mix of policies. If we seek the other direction we will need to shift resources into more knowledge intensive industries."

#### 1.1 International Competition

Most other countries seem well in front of us in thinking through this problem and taking action. In the last 12 months President Clinton and UK Prime Minister Tony Blair have both written editorials in the prestigious "Science" announcing significant funding increases to science. The French Minister for National Education, Research and Technology has released a blueprint for science education in France looking to lift international competitiveness and boost funding.

#### 1.2 Building alliances for Lobbying

Early in my term there was intense lobbying by the CRCs and their supporters as the CRC program went before the expenditure review committee, and treasury and others sought to liberate the funds for other purposes. The CRCs are no slouches at public communication and committed real resources to this issue. FASTS also was active. All the conventional things were done including media, letters to and meetings with politicians, and seeking support from other interest groups. This was all carried out professionally and well. But the real powers behind the CRC lobbying were the industry partners who expressed very strong support for what they saw as the benefits to industry of the program. They also used their political networks, which are different to those used by the science lobby.

The success of this campaign is now well known. The Government announced its ongoing support for the CRC program about a month before the budget was announced.

There is a lesson in this. Scientists can push for budget support on all manners of grounds from the aesthetics of science to the utilitarian of a cancer cure. Yet industry pull seems to be a more powerful tool in moving Governments. When both are aligned and giving Governments the same message, then the pressure on politicians becomes intense.

#### 1.3 Some Challenges of Innovation

There are many aspects to innovation, and many reports have been written. Four fundamental issues are:

- Do we have the right sorts of industries?
- Picking winners and losers
- How do we stimulate knowledge-based industry?
- How do we get effective brokerage of ideas across the present chasm?

#### The Right Industries

The low Australian business expenditure has been a concern for some time. Marceau argues that this is due to the mix of Australian industry which causes us to have low investment by Business in R&D. Our agricultural and mining industries do in fact invest in and use S&T for international competitive advantage. But many of our emerging areas of employment are related to services like pizza delivery where the advantages of research are less apparent.

If this is true, then berating existing industry, developing innovation packages or bribing industry with generous tax concessions may not be effective. Unless industry can see clear competitive advantage, in a realistic time frame, it may be sensible for them to be followers.

Jurisdictions undertaking audits of S&T capacity may do well to include an assessment of the capacity of their industry base to benefit from S&T investment.

#### Picking Winners and Losers

It is an industry mantra that Governments cannot pick winners, and that this must be left to the private sector. Yet business and competition have not done very well, and have certainly not been prepared to invest in the way their more enlightened colleagues in other countries have been.

If Marceau is correct in her assessment that the existing industries are a key part of the problem, then it is hardly a surprise that they exhort Governments not to pick winners. Their solution is to give generous tax concessions to all.

The reduction of the tax concession for research in Australia led to a marked drop in reported research in the finance industries, with so far only a minor drop in industry research. This might be a function of lag times, or evidence that "bench based" R&D is not so sensitive to the tax deductions. It is also interesting to speculate whether the finance houses have stopped doing their "research" or whether they just can't see much point in reporting it.

What seems clear is that existing or struggling industries do have the ear of governments. If our industry mix is inappropriate for the future we desire, then who lobbies for the new "knowledge-intensive" companies that do not have advocates in Canberra, or the ability to lobby local members?

Governments have been selecting thematic areas of research for a long time. We have invested heavily in agricultural research and the minerals area. The pressures are to move research priority from these areas towards emerging areas, such as information technology, environment, materials, energy, health and so on. Governments lack an effective bargaining arena for such cross-portfolio choices, and established areas have large and powerful bureaucracies as well as industries fighting for them in a way emerging industries do not. While it is clear that governments are not well equipped to "pick winners" at the project level, it is less clear that standing back and allowing

future investment to be driven by past infrastructure is a very smart response.

#### Stimulating Knowledge-Based Industries

If we are to build companies that use science to develop products and services that the world needs and will pay a premium for, then we need to look at the financial and taxation environment of these companies. Our science is demonstrably good enough. We are failing at the innovation process and in enabling knowledge based companies to stay Australian and to grow their businesses here. The departure of high technology Memtec for the USA suggests we must ask why we cannot provide a competitive business environment in Australia for such firms.

Perhaps these emerging knowledge intensive companies do not even care much if the Australian policy settings are wrong. They are highly desirable international properties and can move to the country that most favours their development.

The Australian Business Foundation report "The High Road or the Low Road: Alternatives for Australia's Future" suggests that Australia, almost alone amongst developed countries, is failing to shift resources into more knowledge intensive industries. Governments are responsible for this through their direct investment and through the financial and taxation environment they provide for industry.

The report identifies a number of strategies for a Government interested in pursuing the high technology, high knowledge route, one of which is sustained investment in education and research, as well as paying real attention to the innovation process. A number of our competitor countries have chosen these strategies.

#### How do we get effective brokerage of ideas across the present chasm?

There is no doubt a major gap in culture exists between the producers of knowledge in our research establishments and the users of knowledge in industry and in Government. There are a few individuals who can bridge the chasm; most players simply do not even understand the language of the other.

Exhorting scientists to learn more about innovation and industry, and imploring Boards to have at least one member who can spell science are useful, but minor steps. The survey you will hear about after lunch highlights some deep seated cultural barriers that need to be acknowledged and confronted.

#### **2. Science in the Universities**

FASTS held a most successful one day forum on University Science: Crisis or Crossroads. The forum achieved national

publicity and helped focus attention on these problems. Jan Thomas took the lead in organising this outstanding event.

The Federal Governments slash and burn approach to Higher Education is reducing our capacity to undertake fundamental research in the Universities, with a marked swing to strategic and tactical research that can be supported by industry. The CRC program is one spectacularly successful program of industry-research linkage which is attracting international attention. Niland (1998) suggests that this decline in basic sciences is a national disaster and should be urgently addressed by Governments.

Surveys of staff show that morale has collapsed. The lack of resources, increasing work loads, lack of recognition and the almost constant re-organisation have taken a toll and individuals are reacting in a variety of predictable ways. It is clear we are failing to renew the academic talent base. It is also clear that many academics close to retiring age can hang in and perhaps disengage.

International comparisons show that even in our larger well funded Universities we are spending only about 70% per student on higher education than is spent by comparable institutions in comparable countries (Niland, 1998). This sort of information does not support the Government's view that the University sector is inefficient and needs to be further squeezed. Diversity would be seen by some as strength, yet Minister Kemp sees it as inefficiency.

Unfortunately the West report chose not to argue for increased Government spending based on such international comparisons, but sought to transfer more of the cost burden to students.

Courses that are expensive, and where student demand, especially from fee-paying students, is soft, are obvious targets. Monash, which has an international reputation in science, has just cut science by 9%. It is not easy to get facts on these issues. Overall the dip in science enrolments is probably not great; the problem is that sharp drops in basic disciplines like chemistry, physics and mathematics are hidden by rises in applied sciences. The Deans of Science are undertaking a project to improve the basis of application, enrolment and completion statistics.

#### **3. Employment of Young Scientists**

The FASTS workshop and resulting publication helped focus attention on the plight of postgraduate students who have bleak career prospects in many fields. There are things we need to do in curriculum to help make these people more employable. We also need to be realistic in the advice we give to such students about likely career prospects. Hopefully FASTS has helped put these items on the agenda.

---

#### **FASTS ON ARC GRANTS**

Australia's peak council for scientists and technologists today (Tuesday) welcomed a slight increase in the proportion of successful applications for research grants from the Australian Research Council, from 19.6 per cent to 20.7 per cent.

Professor Peter Cullen, President of the Federation of Australian Scientific and Technological Societies (FASTS), also welcomed the Government's commitment to the knowledge-based economy.

"Research is the driver of economic growth in Australia, and I am encouraged by the Minister's statement that support of research funding is a priority for Government," he said.

"But Australians need to look at funding going to high-quality research in a new way. It should be regarded as an investment, not a drain on the public purse."

Professor Cullen said that he was concerned that applications for large grants dropped by seven per cent this year. While success

rates are up, the size of the average grant has fallen by about \$2000 over last year's.

"The Government needs to lift its investment in Australian science if it is genuinely committed to promoting excellence in research and research training," he said.

Professor Cullen noted a strong increase in the number of applications for SPIRT grants, with new applications up by almost 15 per cent.

"This increase shows a strong commitment by industry, and

there is a clear case for extending the funding of this successful cooperative effort between Government and industry."

Professor Cullen said that the scientific community supported the existing methods of selecting which science projects should be funded, even if the process needed a little fine-tuning to make it work better.

"It's very important that we preserve the international standing of our science by using a competitive, peer-reviewed process to select the best and most promising projects."

## FASTS TEN TOP POLICIES for 1999

Professor Peter Cullen, President of the Federation of Australian Scientific and Technological Societies (FASTS), said the list this year was dominated by two issues: funding university science, and commercialising the best ideas of Australian scientists and technologists.

"I want to propose a New Year's Resolution to the Government: that they resolve to sort out the mess in our universities before it is too late," he said. "The universities are slowly being squeezed to death, and the quality of Australian science is being affected by increasing workloads and a failure to renew equipment and laboratories."

Professor Cullen said that Australians needed to view public support for R&D as an investment rather than a drain on the public purse, and pointed to massive boosts to research budgets by the Governments of the USA and Britain.

### 1. UNIVERSITIES AT THE CROSSROADS

FASTS urges the Government to restore stability in the higher education sector through realistic annual salary indexation to help meet negotiated salary increases, and through realistic annual indexation of infrastructure costs that recognises the impact of the exchange rate on library acquisitions, information technology and purchases of major equipment.

### 2. PEER-REVIEW FUNDING: THE BEST WAY TO GO

Australia must retain a nation-wide competitive, peer-reviewed process as part of a plurality of research funding mechanisms. The ARC should be independent like the NH&MRC, and its budget increased to allow more top-ranked science projects to be funded.

### 3. INCENTIVES FOR SCIENCE AND MATHS TEACHERS

The shortage in qualified teachers of science and mathematics will worsen unless good quality graduates are attracted to the profession by incentive schemes such as delayed or reduced HECS repayments. Universities need incentives to provide extra teacher-training positions.

### 4. SCIENCE IN THE BUSH

S&T can help create new jobs in regional Australia in industries such as aquaculture, wine-making and biotechnology as well as coping with salinity and other environmental issues. These matters need an "all-of-government" approach, with the active participation of regional governments.

### 5. AUSTRALIA: AN ATTRACTIVE PLACE TO INVEST

FASTS urges the Government to introduce internationally competitive R&D tax concessions and capital gains taxes. These would support our highly skilled work-force and the relatively low cost of research to make Australia a very attractive place in which to invest in science and technology.

### 6. KEEPING UP WITH THE JONESES

Government support for R&D should be viewed as an investment rather than a drain on the public purse. Both Britain and America have sharply increased their spending on research, and Australia should follow this lead by investing in our future prosperity through increased funding for R&D.

### 7. INVESTING IN AUSTRALIA'S HEALTH

FASTS applauds the major recommendations of the Wills Review into Health and Medical Research, and urges government, research and industry to work together to implement its recommendations to improve the delivery of health and medical research in Australia.

### 8. SCIENTISTS THINKING COMMERCIALY

Universities and research agencies should offer real incentives and encouragement to scientists to commercialise their work. Commercial activities should be recognised as a valid professional activity in promotion and appointments, and existing training and assistance programs improved.

### 9. THE BENEFITS OF BEING INTERNATIONAL

The Government is urged to build Australia's international science links by investing in reciprocal projects such as the Global Biodiversity Information Facility, and capturing potential flow-on benefits in emerging technologies such as biotechnology and information sciences.

### 10. LANDMARK PROJECTS TO MARK 2001

FASTS invites the Government to capture the imagination of all Australians with landmark S&T-based projects to mark the Year 2001. These projects should create high-quality employment opportunities, and could include national research investment in Australia's Ocean Territory.

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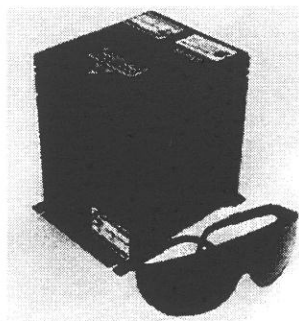
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## High Power Diode-Pumped Lasers from Light Solutions Corporation

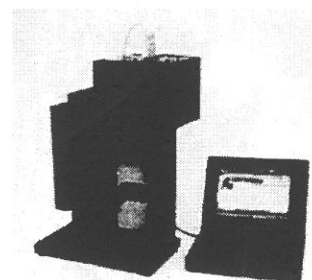


### The Orion



5W TEMoo Orion

The miniature air-cooled Orion is compact enough to "fit in the palm of your hand" and can produce in excess of 5 Watts at 1064nm in either CW or Q-switched format. This powerful little laser has a wide range of industrial marking, military and medical applications. The rugged, reliable portability of this system has meant that it has already been used on airplanes and helicopters, robotic arms and all terrain vehicles - anywhere where size and portability is critical.

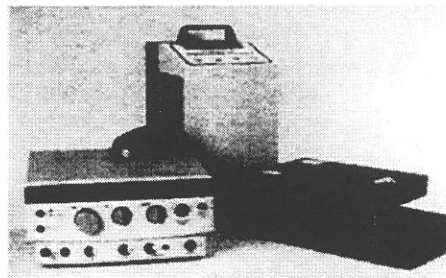


An air-cooled OEM Orion laser as part of a laser marking system

### The Lightbook System

The basic 10W *Lightbook* System produces > 10W of TEMoo output ( $M^2 = 1.1$ ) at 1064nm in either CW or Q-switched format. Pulse energies up to 1.5mJ and repetition rates from 1kHz to 100kHz enable many applications requiring high power and excellent beam quality.

The new *Spectrum* add-on allows the user to switch between 10W @ 1064nm, to 5W @ 532nm to 1W @ 355nm. Other add-ons available include monolithic OPO's for multiwatt output at 1.57, 2.1 or 3.4 $\mu$ m, and the upcoming PPLN OPO for output anywhere in the 1.5-5 $\mu$ m range. Amplifier Systems up to 20W and 30W are also available.



Complete Lightbook System with Laser Head, Driver and new all-solid-state chiller



## Tunable Deep UV from Light Age Inc.



### The PAL/PRO - UV Laser System

The PAL/PRO - UV laser system from Light Age Inc. is a tunable narrowband Alexandrite laser producing high energy pulsed output at 193nm, 248nm and many other UV wavelengths. The oscillator output is converted to deep UV using frequency conversion options to produce output at 190-200nm / 240-270nm (via 4HG / 3HG) and almost all wavelengths from 190nm to 400nm (via Raman shifting). The system can scan the SLM output over 10's of GHz with spectral linewidths <30MHz in the fundamental and < 25 fm at 193nm. The PAL-PRO - UV is ideal for applications like Deep UV Interferometry, Writing Fiber Gratings, seeding Excimer lasers, Photolithography and testing UV optics to name a few.



PAL/PRO-UV  
Solid-State Deep UV Source for  
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## WARSASH Scientific

### Photonics Spectra Circle of Excellence Awards for 1998

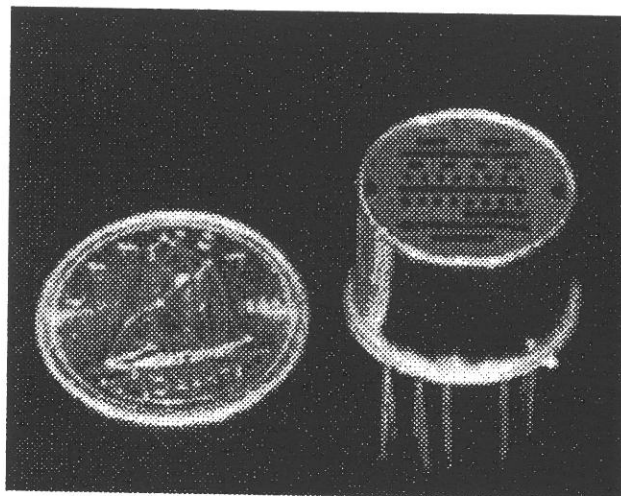
WARSASH Scientific is proud to announce that three companies we represent have won the prestigious Photonics Circle of Excellence Award for 1998. EG&G Canada Ltd Optoelectronics Division for their two band HARLID (high angular resolution laser irradiance detector), Labsphere, Inc. for their revolutionary BFC-450 bispectral fluorescent colorimeter, and Polytec PI for its six-axis nanoautomation stage with adaptive trajectory control.

We congratulate these three world leaders for their achievements in scientific development.

**EG&G** Canada's two band HARLID (*high angular resolution laser irradiance detector*) module has been designed to detect and provide angle of arrival information for incident laser pulses from rangefinders, target designators and other active electro optical systems. The assembly has a combined spectral sensitivity range of between 400 and 1700 nm.

The module field of view is  $\pm 45^\circ$  in both azimuth and elevation, and the angular resolution is approximately  $\pm 1^\circ$  in one plane either azimuth or elevation, depending on the module orientation.

The device is an ideal primary sensor for warning or taking counter measures against laser guided weapons and/or laser based surveillance systems.



**Polytec PI**, recognizing that the trend in microelectronics to smaller structures and a higher level of integration demanded that positioning errors be held to subnanometer and sub-arc-second levels, developed its *six-axis nanoautomation stage*.

With its digital controllers, it provides automatic real time correction of motion errors including flatness, straightness, pitch, yaw and roll. The result is better than 0.5-nm planarity of travel through any arbitrary plane that can be defined throughout a  $\pm 500$ - $\mu$ rad rotational range. The Z-positioning range is 6  $\mu$ m, with an in-position stability better than 0.033 nm rms. Step response is better than 8 ms.

Applications include near-field optical probing, waveguide metrology and fabrication, scanned-probe metrology, pole-tip recession measurement, white-light interferometry and nanomachining.

**Labsphere's** award was for their revolutionary BFC-450, the world's first *bispectral fluorescence colorimeter* designed for absolute measurement and quantification of the colour appearance of fluorescent materials.

The entire measurement routine is completed in less than 10 minutes with a full colour rating report generated instantaneously. The report displays complete sample data, time, names etc. as well as the values for luminescence reflectance, total tristimulus, chromaticity, brightness and many more, all independent of illumination method.





## **WARSASH Scientific**

### **Website Launched**

Like so many Sydney streets, our website has been "under construction" for some time, but now we can confidently point to an interesting and updated review of our suppliers' developments.

Check it out, and contact us to get more detailed technical data and see the many - unexpected - application possibilities.

You can find it all at:

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### **Super Luminescent Diodes**

EG&G Optoelectronics Canada have developed a line of super luminescent diodes CW operated types.

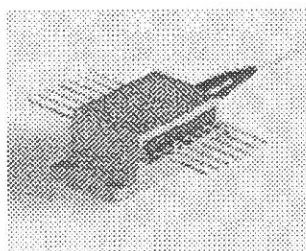
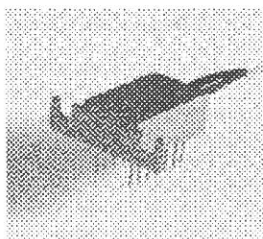
Operating at 850 nm, 960 nm (InGaAs) and 1300 nm (InGaAsP), they are produced using the latest MOCVD and MBE growth techniques.

Devices are offered in TO-style packages and 14 DIL and Butterfly outlines coupled to polarisation maintaining fibre (except C86115E-13, where 50/125  $\mu\text{m}$  fibre is standard).

Optional single mode and multimode optical fibre are also available on a custom basis. DIL (M) and Butterfly (V) packages are equipped with an integral TE cooler, thermistor, reverse protection diode and monitor photodiode.

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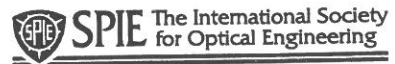
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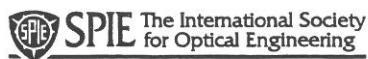
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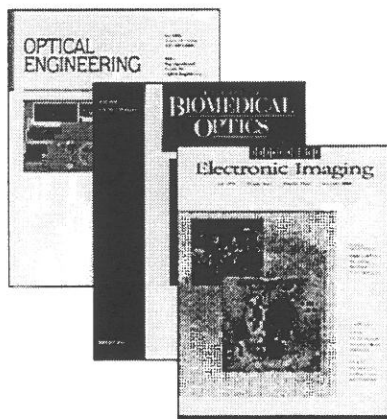
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