CUDOS

Collaboration

Annual Report 2004

The Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS)

An Australian Research Council Centre of Excellence

Collaboration

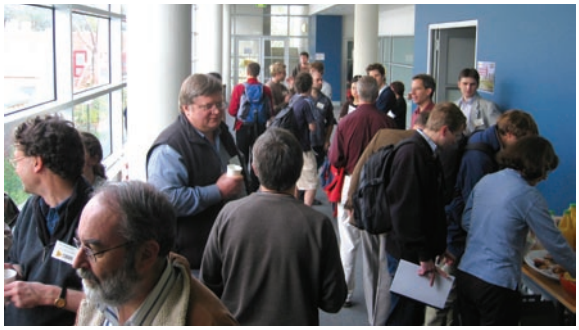
The CUDOS program would not exist without strong collaboration. New, ambitious goals can be achieved only by different University groups working together, and by research outputs from one group being smoothly incorporated into the project plans of another. There are two strong themes that characterise many of the CUDOS collaborations:

- The linking of strong theoretical teams with experimental efforts in photonic materials and devices across nodes. CUDOS has provided the focus that allows these groups to work on projects of common interest and build long term collaborations.
- The linking of research groups with advanced materials and micromachining capabilities to groups with knowledge and capabilities for developing novel optical processing devices.

Collaborative links of this kind are extremely important for photonics research in Australia and could only exist within a framework like CUDOS, where significant projects of mutual interest to all research groups are part of the overall research plan and an IP agreement facilitating collaboration is in place. Project planning meetings, workshops on topics of common interest and the general CUDOS workshop (held this year in Melbourne), all assist in cementing collaborative links and building new ones. In addition there has been a constant interflow of researchers between nodes to present seminars and for scientific dialogue. This year around one quarter of CUDOS papers in refereed journals were joint efforts between two or more nodes.

CUDOS Workshop

The third CUDOS Workshop was held on September 24-25 at Swinburne University's campus at Hawthorn. Prof Kathleen Richardson, Partner Investigator from the University of Central Florida, attended as the keynote speaker and gave an overview

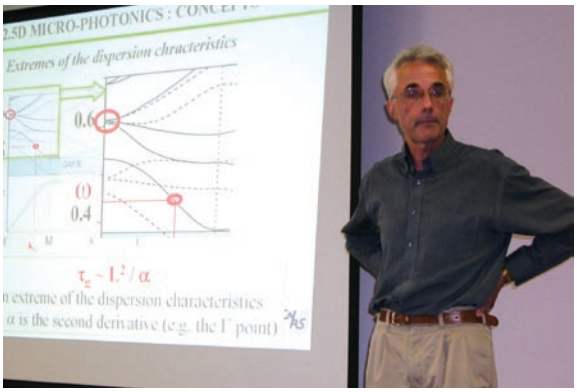


▲ **Discussion during a coffee break at the Swinburne Workshop.**

of her research program in chalcogenide glasses. The two day program featured eight research overview talks, fourteen contributed and twenty poster presentations. Over seventy CUDOS researchers attended the Workshop.

Lightline Workshop

The concept of the "lightline", which relates to the optical out-of-plane loss mechanism in 2-dimensional photonic crystals, is not well understood but its implications are crucial for any practical demonstration of photonic crystal devices. We were fortunate to have Pierre Viktorivich from Lyon, France, who was visiting Australia for the ACOFT meeting, available to



▲ **Pierre Vitorovich presents an overview of Lightline issues at the workshop.**

provide an overview presentation of this subject at a CUDOS workshop organised specifically on this topic. Eight other presentations were made by CUDOS researchers. The one day meeting was held at the Sydney Fish Markets and was attended by forty CUDOS researchers and students from all the five CUDOS nodes.

Strategic Planning Workshop

To complement the Annual Workshop, which provides a forum for the presentation of research results, the CUDOS Executive organised a strategic planning weekend involving all Project Leaders. The purpose of the weekend was to identify major opportunities that could arise from CUDOS research over the coming three years. Our focus was on two major areas of opportunity:

- Challenge projects – CUDOS activities that score the highest against a range of criteria including scientific merit, social benefit, commercial opportunity and (because of all of the previous criteria) newsworthiness. We colloquially refer to these as "Page 3" projects because the successful outcomes might ultimately appear in a story on that page of a major newspaper. Four such projects with champions and team members were identified. Work will proceed on these during 2005 and beyond.
- Projects that might have some commercial opportunities. While the principal focus of the Centre is research excellence, photonics is a field where good science often flows over into commercial opportunities. We identified several research activities where assessments were required of commercial opportunities, competitors and competing technologies.

Collaborative research activities

1. Collaboration between the groups of Profs Gu (Swinburne) and Kivshar (ANU) has led to a study of the in-plane and out-of-plane bandgap properties of two-dimensional triangular void channel photonic crystals fabricated by femto-second laser drilling in solid polymer material. The properties have been calculated at ANU for transverse electric and transverse magnetic polarisation modes, and compared with the experimental data obtained at Swinburne as part of a systematic study of bandgap properties in low index photonic crystals. A joint publication has appeared in Applied Physics Letters.

▲ **CUDOS Project Leaders at the strategic planning workshop in the Blue Mountains.**

2. Strong collaborations have existed for many years between Professors de Sterke, McPhedran (Sydney) and Botten (UTS). This collaboration has been strengthened through CUDOS and the presence of Dr Mike Steel from RSoft, who is an Honorary Associate at the University of Sydney. The combined theoretical expertise of these researchers is linked to the experimental projects listed below:

- Superprism modelling – with Dr Serbin and Mr Ventura at Swinburne.
- Fano resonance modelling – with the ANU group (Freeman, Luther-Davies) and Sydney (Grillet).
- Band structure modelling – with the Macquarie group.
- Dr. Michael Steel has visited both Swinburne and Macquarie to provide collaborative support with modelling and simulation.

3. A core objective of the CUDOS research program is the demonstration of nonlinear optical behaviour in a microphotonic system. However, the nonlinearity must be large to achieve the short interaction length needed for a microphotonic device. Drs Moss and Grillet, Profs

▲ **David Moss outlines the linkages in the nonlinear optics applications area at the CUDOS workshop in Melbourne.**

Eggleton and de Sterke (Sydney) and Professor Botten (UTS) are collaborating with Professor Luther-Davies, Dr Madden, Mr Freeman, Ms Ruan and others at ANU to address this challenge. Chalcogenide glasses, with their very high optical nonlinearity are candidates for application in microphotonics but are very difficult to produce. Prof Luther-Davies' group has collaborated with Dr Richardson at CREOL (CUDOS PI at the University of Central Florida) to develop the necessary expertise. They are now producing optical rib waveguides in chalcogenide with transmission

▲ **Mike Steel presents an overview of simulation tools at Macquarie University.**

losses of order 0.2 dB/cm and nonlinear phase shifts of 3.5 π over 6 cm at modest power levels. The team at Sydney has succeeded in writing gratings in these waveguides with spectral widths around 5 nm and more than 30 dB rejection.

4, Expertise in gratings at Sydney has been combined with the capability for focused ion beam micromachining at the ANU to produce waveguide gratings in Silicon. Mr Vahid Ta'eed (Sydney) and Mr Darren Freeman (ANU) were student collaborators on this project, along with Professors Eggleton, Luther-Davies and Dr Moss. The work, which was published in Applied Physics Letters and Optics Express, produced serendipitous results on the effects of surface gratings on waveguides.

5. Dr Claire Lynga (Sydney) and Professor Barry Luther-Davies (ANU) collaborated to build an optical parametric oscillator (OPO) funded under a LIEF grant in 2003 for use in experiments at Sydney. The LIEF grant also involves Chief Investigators from Macquarie University and ANU.

6. In recent exciting work, the gratings group at Sydney (Drs Fu and Bolger) collaborated with the femtosecond laser group at Macquarie (Dr Marshall) to successfully write Bragg gratings in microstructured optical fibre.

7. A/Prof Judith Dawes and Mr Sam Myers (Macquarie) worked with Dr Eric Magi and Professor Eggleton (Sydney) on the development of fibre tapers in microstructured fibre and the incorporation of dye into the fibre capillaries to study radiation dynamics inside the photonic crystal structure of the fibre.