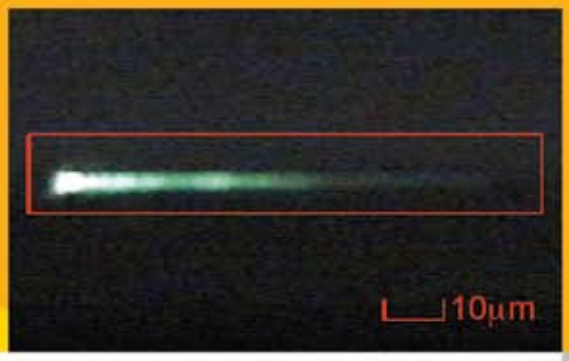
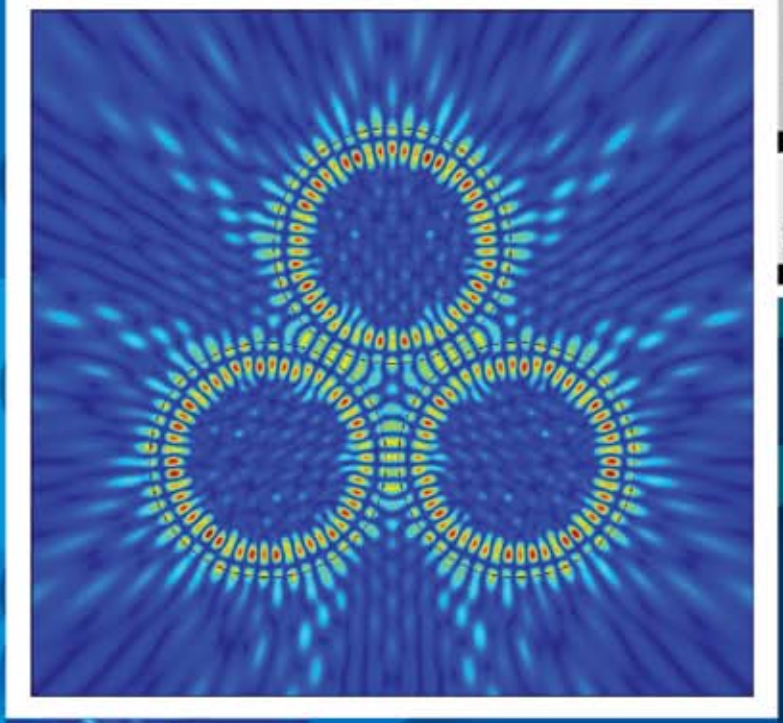
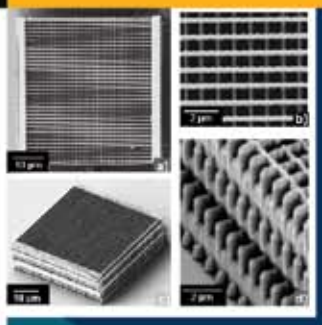
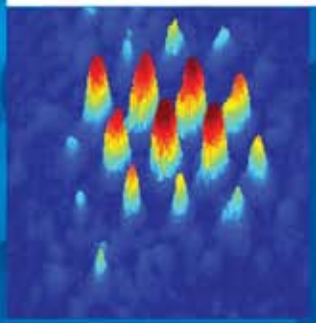
CUDOS

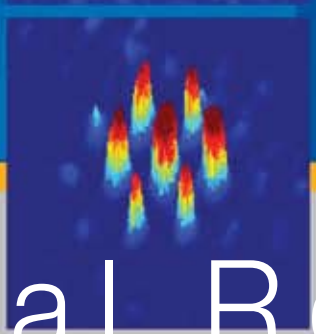
The Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS)

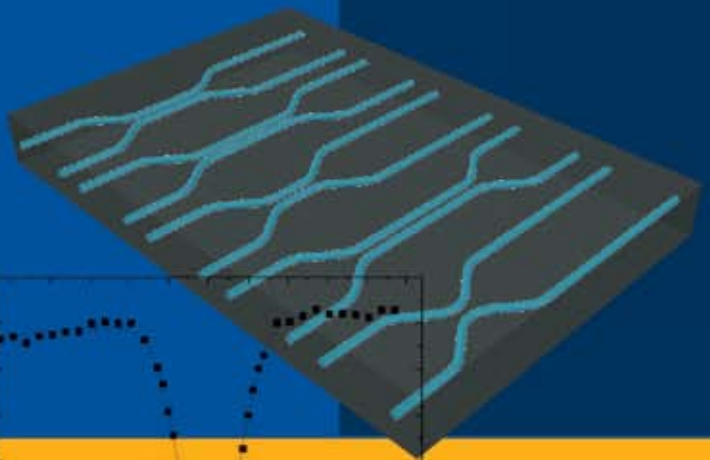


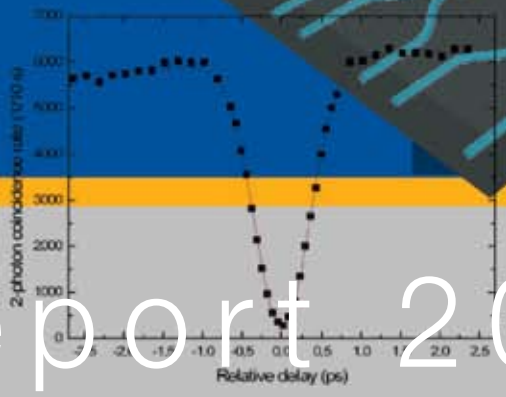












Annual Report 2008

Chief Investigator: Arnan Mitchell

CI short biography

A/Prof.Mitchell was awarded a PhD from RMIT University in 1999 for his research into the simulation and design of high speed optical modulators on the LiNbO3 integrated optic platform. His work in this field lead to the development, in collaboration with Australian defence industry and the Defence Science and Technology Organisation (DSTO), of photonic signal transport and processing devices which have been flight trialled in electronic warfare environments. He has developed two patents in the field and has licensed technology for commercialisation by Micreo Pty Ltd. His current research interests include photonic systems for electronic warfare, $LiNbO_3$ device platforms for fundamental nonlinear photonic research, micro-platform technologies including low-cost polymer integrated optics and microfluidic lab-on-a-chip and surface enhanced Raman scattering. A/Prof Mitchell leads the RMIT University node of CUDOS, is deputy director of the Microelectronics and Materials Technology Centre (MMTC) at RMIT and is leader of the Photonics Research Laboratory within the MMTC.

Awards, honours, major international visits

Mitchell was the general chair of the 2008 SPIE Conference on Microelectronics, MEMS, and Nanotechnology, and was a member of the technical program committee of OECC/ACOFT 2008. He was awarded a Department of Innovation Industry, Science and Research International Science Linkage grant to develop an emerging collaboration with Prof T Koch at Lehigh University, USA exploring silicon photonic waveguides to realise silicon lasers.

Key areas of research contribution within the Centre

Mitchell is Project Manager for the Flagship project: Tuneable Micro-Photonics. In this role he is responsible for coordinating research interaction between CUDOS nodes involved in this project (primarily Nonlinear Physics at ANU, The University of Sydney and RMIT University) and providing platform support in LiNbO3 and polymer integrated optics and microfluidics for the Flagship project. He leads a research project applying CUDOS nonlinear optics technology to microwave photonics for electronic warfare applications. This project aims to address the needs of end users such as DSTO and major players in the Australian and international defence industry.

Mitchell maintains several collaborations funded outside of CUDOS however, takes every opportunity to lever benefit and cross-disciplinary interactions for the centre. Examples of these interactions include an ARC Discovery with Dragomir Neshev in RF tuned nonlinear devices in LiNbO3, An NHMRC development grant with Paul Stoddart at Swinburne University exploring surface enhanced Raman fibre probes, an ARC Linkage project with CSL and the Australian Centre for Blood Disorders using microfluidics for investigating the nature of blood clotting and a DIISR International Science Linkage with Lehigh University, USA in the field of silicon photonics.

Achievements 2008

2008 was the first year of funding for RMIT within CUDOS and already through our collaborations across the centre we have produced significant research outcomes.

Flagship Project: Tunable Microphotonics

The goal of the tunable microphotonics platform has been to focus on the CUDOS goal of photonics on a chip with a particular emphasis on tunability. This project has three major components: Fluid infiltrated photonics, High-Q structures on $LiNbO_3$ and Nonlinear Microwave Photonics.

Fluid Infiltrated Photonics

RMIT has provided platforms for optofluidics [1] (not CUDOS). In 2008, building on the success of research conducted using infiltrated photonic crystal fibres at the Nonlinear Physics group at ANU and also at The University of Sydney CUDOS, RMIT initiated a program to develop a planar equivalent of the photonic crystal fibre. A planar platform using SU8 epoxy and lamination techniques was created by PhD student Eike Zeller[2] and we are in the process of exploring the use of this platform for fundamental experiments in nonlinear optics. An elegant variant on this platform has also been proposed by PhD student Tanveer Mahmud [3]. Here soft lithography is used to make optical waveguides and air channels. A large scale fluidic channel is then exposed through the whole waveguide stack as a final step. This enables interfacing onf optical waveguides in the middle of the sidewall of fluidic channels. Refinement of this platform and exploration of its application to nonlinear optics will be a major goal of 2009.

Hiqh-Q Structures on $LiNbO_3$

This project aims to realise either Bragg gratings or high-Q ring resonators on $LiNbO_3$ platform. One major challenge with this project is to achieve significant, but smooth etching of $LiNbO_3$. PhD student Vijay Sivan has discovered a new technique to etch $LiNbO_3$ during Ti in-diffusion[4]. The other challenge is to accurately simulate the coupling between the weakly guiding Ti in-diffused waveguide and strong perturbations incurred by high-index ring structures or etched gratings. Dr Lam Bui has made significant progress on this issue and we anticipate some high-profile outcomes in 2009.

Nonlinear Microwave Photonics

A primary aim of the tunable microphotonics flagship project is the realisation of a microwave photonics platform that can be used for electronic warfare applications. One important application is instantaneous frequency measurement (which can be likened to a motion sensor for radar activity at a particular frequency). The microwave photonics team consisting of Dr Lam Bui, and PhD students Hossein Emami and Niusha Sarkosh have recently achieved frequency measurement using nonlinear optical mixing in a semiconductor optical amplifier (SOA) [5]. Dr Lam Bui, in collaboration with Dr Mark Pelusi, PhD student Trung Vo and Prof Ben Eggleton, has developed a refined system which was implemented iutilising highly nonlinear fibre (HNLF) [6]. This nonlinear system will be a primary focus for research moving into 2009 with the aim of generating a large scale defence industry project on 2010 and beyond.

Nonlinear Optical Physics in LiNbO3 waveguide arrays

The ARC Discovery project between Mitchell and Neshev has focussed the realisation of nonlinear optical platforms using $LiNbO_3$ waveguide arrays. Although this work has drawn no funding from CUDOS, these platforms have presented several opportunities for collaborators across CUDOS to contribute to the research. Specifically, supercontinuum light has been used to simultaneously observe multi-colour nonlinear behaviour [7] and curved waveguide arrays have provided a platform for the observation of discrete optical behaviour [8,9]. This discovery will be finalised in 2009, however it is anticipated that the platforms realised will remain useful to researchers within CUDOS through 2009 and beyond.

Researchers and students

Dr Lam Bui

Hossein Emami

Eike Zeller

Niusha Sarkosh

Tanveer Mahmud

Tim Lunn

Kushan Dayaratne

Vijay Sivan

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