RMIT
Phone: +61 3 9925 2457
Email: arnan.mitchell@rmit.edu.au

Arnan Mitchell

Arnan Mitchell received the PhD degree in Engineering from RMIT University, Australia in 1999. From this time until 2004 he worked on commercial projects developing integrated optic device technology for industry with the Australian Photonics CRC and also with the Australian Defence Science Technology Organisation (DSTO). During this period he led a team that designed and developed high speed modulators that were licensed to industry.

From 2004 until the present, Professor Mitchell has held an academic position at RMIT University, focussing on photonics. In 2010 he founded the 'Microplatforms Research Group' which is dedicated to the creation of microtechnology solutions which enable fundamental research in diverse disciplines spanning fundamental physics, chemistry and biomedical science. This team now numbers over 50 research staff and students, including 3 ARC APD and 2 ARC DECRA Fellows, working in Integrated Optics; Functional Materials and Microsystems; Microwave Photonics; Lab-on-a-chip Technologies; Sensors; and RF Microplatforms and Metamaterials. This multi-disciplinary team provides a rich field of opportunities for CUDOS not only in terms of applications of the centre research, but also providing technology solutions for core CUDOS activities.

Key Areas of Research Contribution and 2011 Achievements

The key activities of Professor Mitchell's team that are central to CUDOS are found in the Hybrid Integration flagship report. With his team he is also involved in research activities outside CUDOS, but has strong potential for connection to CUDOS research.

A large part of the activity of the Microplatforms group is in materials engineering, which is of critical importance to the Hybrid Integration project. They focused on electrically-tunable materials, in which they had a number of significant outcomes in 2011.

They demonstrated that nano-structured ferroelectric thin film materials can be used to effectively transfer mechanical deformation into both electrical voltage and current [1] and that nano-textures on the surface of this materials can significantly enhance the efficiency of this conversion [2]. This work was featured on the cover of the prestigious journal 'Advanced Functional Materials'[1] and due to its potential applications in renewable energy harvesting, generated overwhelming media and community interest appearing on national television, national and international radio, newspapers and hundreds of technology websites. The films being studied are similar to those being pursued under the CUDOS Hybrid Integration flagship program to achieve second order nonlinear optical waveguides and thus our enhanced understanding of these films and how they can be tuned will be of direct benefit to this future centre research.

Another electrically tuneable optical material that Professor Mitchell's team researched is tungsten oxide. This is an 'electro-chromic' material that radically changes its optical properties, in particular its colour, when you apply an electric field. This material has been used to achieve so called 'smart glass' that can be switched from being transparent to opaque with the application of an electric potential. In 2011 the team published a comprehensive review of this tunable material in 'Advanced Functional Materials', particularly focussing on its nano-particle form [3]. The optical change in this material can also be stimulated chemically allowing this material to act as the active component of optical sensors. The potential to integrate this material with the photonic chips being studied under CUDOS thus presents a significant opportunity for new applications.

Professor Mitchell's research group also explored the use of metallic nanostructures as a sensing platform, exploiting the surface enhanced Raman scattering (SERS) effect. They

created a technique where SERS structures are integrated onto the tip of an optical fibre and interrogated through the fibre, enabling SERS sensors to be introduced via a hypodermic for chemical analysis of the blood stream within living animals or people. In 2011 they presented an elegant technique for rapidly and cheaply manufacturing these structures [4]. Their technique enabled replication of features with resolutions exceeding 15nm using hybridised optical fibre and nano-imprint lithography techniques. The team also explored the impact of applying electric fields during SERS sensing and found that the signal from certain chemical bonds react more strongly to the electric field than others [5]. This finding presents the opportunity for the use of signal processing to extract extra chemical information from SERS measurements, improving their sensitivity and particularly their selectivity. These findings may find application in the nano-plasmonic flagship program within CUDOS.

A further major outcome for Professor Mitchell's team of great relevance to CUDOS was their successful ARC LIEF funding for a 'Thin film processing cluster: precise synthesis and nano-patterning of functional coatings' (LE120100004). This suite of equipment will greatly enhance their ability to engineer materials and create new nano-structured components of central importance to our core CUDOS activities. The value of the equipment is in excess of $1.4 million with the majority provided by the partner institutions. This significant financial commitment is recognition of the value of our research and commitment to the research over the long term.

References

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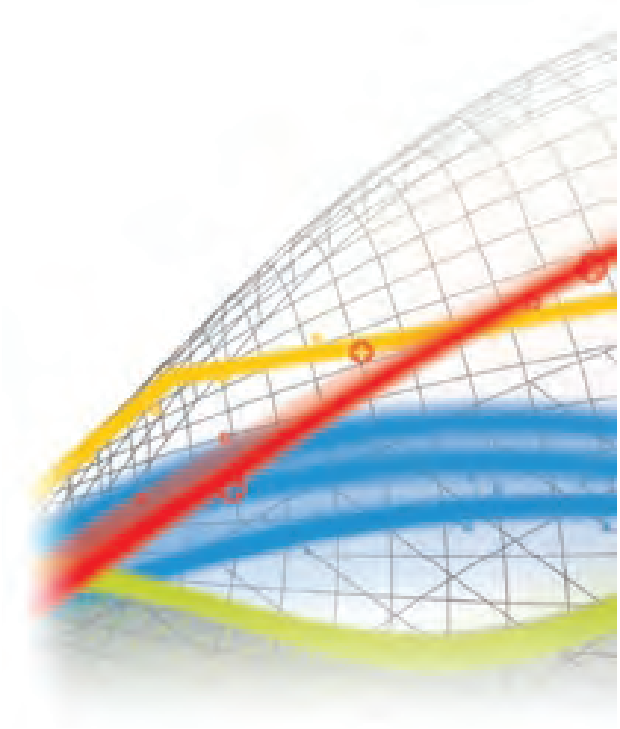

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