Continued success in Nature family journals
The Centre for Micro-Photonics produced three Nature family journal publications in 2011. One Nature photonics and two Nature communications, respectively (right).

Chinese Minister of Science and Technology Visits Centre’s Petabyte Optical Data Storage Facility
(above) Swinburne University of Technology Chancellor Bill Scales (left) watches on as Chinese Minister of Science and Technology, Dr. WAN Gang is introduced to Petabyte optical data storage by Centre Director Professor Min Gu (right).

ARC Centre of Excellence – CUDOS relaunched
CUDOS and its Swinburne node were officially relaunched by the Australian Minister for Innovation, Industry, Science & Research, for its third term (left).
Vision
Our vision is:
- Nano and biophotonics for a sustainable future.

Mission
Our mission is to:
- To be an internationally leading nano and biophotonics centre for cutting edge research and student training.
- To develop innovative nano and biophotonic devices for a sustainable future, safer environment and healthier life.
- To combine research excellence with industry engagement.

Key facts
- Staff & student numbers:
  - Five professors, one senior lecturer, 32 research staff, 31 students, 4 administration staff and 4 technical staff.
- 70 publications in refereed journals.
- 16 plenary, invited, Editorial and keynote presentations at national and international conferences.
- 82 conference presentations at workshops, national and international conferences.
- Three provisional patents filed.
- One PhD thesis completion.
- Total cash income:
  - $1,460,138 from ARC grants;
  - $60,341 from NHMRC grants; and
  - $1,352,580 from industry grants and the CRC for Polymers.

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2011 was another extraordinary standout year for the Centre for Micro-Photonics (CMP). The CMP income in 2011 was $2.8 million resulting in a total of $10.4 million for the 2009-2011 period. CMP’s citations have more than doubled since last year to over 3100 in 2011. These outstanding results provide a solid foundation as the CMP endeavors to become the world’s preeminent Green Photonics research group in sustainable nano and biophotonics. Three major highlights transpired in 2011:

Firstly, the CMP continued to publish in high impact Nature family journals in 2011, including one Nature Photonics and two Nature Communication papers. CMP researchers in collaboration with the University of Shanghai for Science and Technology, CSIRO and the team from Stanford University, Australian National University, Shizuoka University and Carnegie Institute of Washington published Nature Photonics and Nature Communications papers, respectively. These papers generated a large number of media and follow up reports (>300) including Physics World, Nature Photonics, Nature-Asia Materials, Laser Focus World, ABC Science, Sydney Morning Herald, The Age and the Brisbane Times newspapers.

Secondly, the Australian Research Council (ARC) Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS), in which the CMP is a major partner since 2003, was officially relaunched by the Australian Minister for Innovation, Industry, Science & Research, Senator the Hon Kim Carr for its third term (2011-2017).

Thirdly, the Victoria-Suntech Advanced Solar Facility (VSASF) consolidated its position as the world leader in nanoplasmic (NanoPlas) solar cells. The VSASF team developed a novel ‘nucleated’ nanoparticle model to achieve broadband plasmonic enhancement and achieved a world record of 23% efficiency enhancement in thin film solar cells. As a result, the Chinese Minister of Science and Technology, Dr. WAN Gang visited Swinburne’s Hawthorn campus. The visit showcased the Centre’s activities in the new Advanced Technologies Centre (ATC).

In addition, the outstanding achievements in research and training of the six CMP research groups within the two focus areas of biophotonics and nanophotonics are briefly summarised as follows:

**Biophotonics**

1. The Advanced Nano/Biophotonics, in-vivo Biophotonics team successfully employed by supercontinuum light from a nonlinear photonic crystal fibre to simultaneously enhance two photon fluorescence and second harmonic generation imaging modalities. In addition the dysplasia was identified in real time by fluorescence endomicroscopy.

2. The Cell Biology group in collaboration with Peter MacCallum cancer centre was successful in discovering Asymmetric Proteasome Segregation as a Mechanism for Unequal Partitioning of the Transcription Factor T-bet during T Lymphocyte Division. These results were published in high impact factor journal Immunity.

3. The Cell Biophysics Laboratory used a novel strategy to examine the effect of antibodies on EGF receptor using a combination of image correlation spectroscopy and polarization imaging. Antibodies offer promise as therapeutics for cancer. This work was published in ACS journal Biochemistry and received coverage in global medical discovery.com and Australasian Science Magazine.

**Nanophotonics**

1. The Advanced Nano/Biophotonics, Green Photonics team incorporating the Laureate fellowship developed the world’s first nanoparticle enabled multi-dimensional optical disc and dynamic recording system. Also, three-dimensional orientation-unlimited polarisation control has been successfully demonstrated. Its application in gold
nанороды disпертированный полимер has enabled поляризационная информация шифрование с ultra-безопасность and further expanded the storage density by one order of magnitude.

2. Researchers at the Centre for Micro-Photonics, Advanced Nano/Biophotonics group in collaboration with the Australian National University as part of the CUDOS ARC CoE have demonstrated the generation of λ/12 Chalcogenide Nanowires. The wires, with a size of 68 nm allow for efficient and compact all-optical interactions that have the potential to enhance data communication speed and efficiency.

3. An Optics Express paper from the Applied Plasmonics group on the use of ion beam lithography for the creation of 3D photonic crystals has been featured in Nanowerk, a leading resource for nanotechnology and nanoscience information. This paves the way for production of a full photonic bandgap in the visible spectral range.

4. The Nanotrapping and Super-resolution group were successfully able to show vertical plasmonic nanowires for 3D nanoparticle trapping and demonstrate opto-thermal plasmonic trapping.

5. Optical Nanoparticle Spectroscopy for Photonic Applications group demonstrated plasmonic random media based on gold nanorods as an optical storage medium.

**Industrial collaboration**
A highlight of CMP industrial collaboration in 2011 was

1. The VSASF consolidated its position as the world leader in nano plasmonic (NanoPlas) solar cells with relevance to today’s industry. The VSASF developed a novel ‘nucleated’ nanoparticle model to achieve broadband plasmonic enhancement and achieved 23% efficiency enhancement on Suntech’s thin film solar cells using the nucleated particle. The VSASF also achieved 35% efficiency enhancement on Suntech’s planar silicon wafer solar cells using metallic nanoparticles.

**New national competitive research grants**
1. Dr James Chon ARC Future fellowship
2. Dr Baohua Jia Discovery Early Career Researcher Award
3. Dr Sarah Russell NHMRC Project Grant
4. Prof. Saulius Juodkazis Linkage Grant
5. Prof. Saulius Juodkazis Discovery Project (Via the Australian National University)

**Prestigious awards**
- Professor of Nanophotonics Saulius Juodkazis has been elected to the Fellowship of the International Society for Optical Engineers (SPIE).
- CMP student Ms. Hong Kang has been awarded a prestigious Chinese government scholarship for outstanding self-financed students studying abroad.
- CMP postdoctoral research fellow Dr. Stefania Castelletto was awarded funding from the Australian Academy of Science under the Scientific Visits to Europe 2010/2011 funding scheme.
- Dr Xiangping Li was awarded the Vice Chancellor’s Research Award (Early Career).
- The VSASF research team, consisting of Professor Min Gu, Dr Baohua Jia, Dr Xi Chen, Dr Narges Fahim, Dr Zi Ouyang, Dr Jhantu Kumar Saha, Dr Nicholas Stokes, Dr Daniel Day, Ms Jia Lou, Ms Pierrette Michaux, and Mr Rian Lourens was awarded the Vice Chancellor’s Industry Engagement Award

**Other highlights**
- Elissa Nicoletti was awarded a PhD for her thesis, titled “Engineering and characterisation of chalcogenide-based photonic microstructures”.
- Optical Society of America student chapter, Swinburne Optics and Applied Physics (SOAP), Centre for Micro-Photonics students have jointly hosted the KOALA 2011 optics students conference with the University of Melbourne and RMIT University. The KOALA conference series is the largest student conference on optics in Australia and New
DIRECTORS REPORT

Zealand, bringing over 50 Honours, Masters and PhD students together for a week of networking and scientific presentations. The conference was chaired by CMP student Ben Cumming.

Finally, I would like to express my sincere thanks to all staff and students of the CMP for their excellent achievements and the continuing support of the University; without this it would not have been possible for the CMP to achieve these goals in 2011. Thank you!

Professor Min Gu
Director of the CMP
Melbourne, October 2012
MEMBERS

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Professor Min Gu

**Deputy Director**  
Professor Saulius Juodkazis

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Dr Ze’ev Bomzon  
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Professor Tim Davis  
Professor Richard Evans  
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**Research Staff**  
Dr Hongchun Bao  
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Dr Xiaojian Hao  
Dr Baohua Jia  
Dr Betty Kouskousis  
Dr Xiangping Li  
Mr David McDonald  
Dr Elisa Nicoletti  
Dr Zi Ouyang  
Dr Lorenzo Rosa  
Dr Jhantu Kumar Saha  
Dr Cuixia Sheng  
Dr Nicholas Stokes  
Dr Yahui Su  
Dr Michael James Ventura  
Dr Qiming Zhang

**Research Students**  
Mr Ricardas Buividas (2nd year PhD)  
Mr Boyuan Cai (2nd year PhD)  
Mr Tim Chow (2nd year PhD)  
Mr Ben Cumming (3rd year PhD)  
Mr Tom Farrington (2nd year PhD)  
Mr Zongsong Gan (3rd year PhD)  
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INTERNATIONAL ADVISORY COMMITTEE

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PUBLIC SEMINARS

Professor Min Gu

“Transformational nanophotonics”, Public Lecture, RMIT University, Australia, March 17, 2011.


“Nanophotonics: a transformational technology”, Public Lecture, Deakin University, Australia, November 11, 2011.

“Nanophotonics: a transformational technology”, Public Lecture, Ningbo University, Ningbo, China, December 1, 2011.

Professor Saulius Juodkazis

“Nanophotonics”, Public Lecture, Deakin University, Geelong, Australia, 2011.

Dr James Chon

Dept. Seminar, “Single particle microscopy and spectroscopy of gold nanorods for their photothermal applications” Graduate School of Convergence Science and Technology, Seoul National University, 4 January 2011.

Seminar, “Progress on five-dimensional optical storage” at Digital Media Research Laboratory, Samsung Electronics Co. Ltd, Suwon, Korea, 5 January 2011.
COLLABORATIONS

Joint projects

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Konstanz University, Germany

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Peter MacCallum Cancer Centre, Australia

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Professor Yonggang Zhu  
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Massachusetts Institute of Technology, USA
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National Taiwan University, Taiwan
NTU, UK
Olympus Co., Japan
Osaka University, Japan
Oxford University, UK
Pulstech, Japan
Raith, Germany
Samsung, Korea
St. Andrews University, UK
Shanghai Institute of Optics and Fine Mechanics, China
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Seoul National University, Korea
Sony, Japan
State University of New York at Buffalo, USA
Stanford University, USA
Suntech Power Holdings Co. Ltd, China
Tokyo Technical Institute, Japan
Translational Genomics Institute, USA
Tsinghua University, China
University of California Berkeley, USA
University of Erlangen-Nuremberg, Germany
University of Pennsylvania, USA
University of Toronto
University Politechnica of Bucharest, Romania
Universidad Autònoma de Madrid, Spain
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Vilnius University, Lithuania
Yokohama University, Japan

National

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Australian National University
Australian Stem Cell Centre
Bio21
Cochlear Ltd
Coherent Scientific Pty Ltd
CSIRO
CRC-Polymers
Hawk Measurement Systems Pty Ltd
Image Cytometrics Pty Ltd
InVision Medical Technologies Pty Ltd
LasTek Pty Ltd
Ludwig Institute for Cancer Research
Newspec Pty. Ltd.
Macquarie University
Monash University
Monash Medical Centre
Olympus Pty Ltd
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University of Queensland
University of Sydney
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University of Wollongong, ANSTO
Victoria University
Walter Elisa Hall Institute
3DCD Technology Pty Ltd
Advanced Nano/Biophotonics (ANB)

In Vivo Bio-Photonics (ANB-BP)

Project leader: Prof Min Gu

Project coordinator: Hongchun Bao

Contributing staff: Hongchun Bao, Cuixia Sheng and Andy Li

Students: Wei Tao, Hong Kang and Navin Ghimire

Objective Integration of Photonics to endoscopy via imaging, tissue manipulation and precise tissue engineering.

Group overview

In vivo biophotonics group continues to lead the development of high resolution 3D fibre-optic nonlinear compact endoscopy, in vivo endoscopic imaging and endoscopic cancer diagnosis and therapy. These broad areas of research utilise biophotonics techniques involving nanoparticles, applications of supercontinuum and radially polarized beams, nonlinear and superresolution imaging.

Achievements for 2011

In summary:

1. Simultaneously enhance two photon fluorescence imaging and second harmonic generation imaging by supercontinuum light from a nonlinear photonic crystal fibre
2. Research photothermal difference in gold nanorods between absorption of dispersive waves and absorption of soliton in supercontinuum light
3. Optimization of radial polarized ultra-short pulses for effective two photon photothermal therapy
4. Design a double clad fibre with no chromatic dispersion for portable nonlinear optical endoscopy
5. Design nonlinear optical endoscopy for achieving image resolution of λ/40.
6. Identified dysplasia in real time by fluorescence endomicroscopy.
7. Achieving nonbleaching two photon luminescence imaging and two photon photothermal therapy with ultra-low power using graphene oxide nanoparticle marker.
8. Manipulating micro-particles and nanoparticles inside water by small nonlinear endoscopy probe

Aim for 2012

1. Superresolution optical endoscopy
2. Tweezing micro-particles and nanoparticles inside water for in vivo applications
3. Dispersion compensation free nonlinear optical endoscopy operating at broadband wavelengths
4. Two-photon luminescence imaging and photothermal therapy of cancer cells specifically labelled by graphene oxide nanoparticles.
5. Gastrointestinal abnormalities identified by fluorescence endomicroscopy

Collaborative links

- Dr Joe Wu, Rx Technologies Co. Ltd.
- Dr Alex Boussioutas, Western Hospital, Melbourne University and Peter MacCallum Cancer Centre, Australia.
- McGearey Aleixandria and Dr Rita Busuttil, Peter MacCallum Cancer Centre, Australia.
- Prof Huikai Xie, University of Florida, USA.
- Dr Jingliang Li, Deakin University, Australia
- Dr Glen Lichtwark, The University of Queensland, Australia.
- Les Richards, Hawk Measurement Systems Pty. Ltd. Australia
- Prof. Yonggang Zhu, CSIRO, Australia.

Figure: Nonbleaching two-photon luminescence images of cancer cells specifically labelled by graphene oxide nanoparticles.
RESEARCH PROJECTS

CRC-Polymers (ANB-CRC-P)
Project leader: Professor Min Gu

Contributing staff: Daniel Day, Michael Ventura, David McDonald, Richard Evans and David Haylock

Students: Stephen Weber and Mark Turner

Objectives
CMP is involved in three research projects with the CRC for Polymers. These are:
1. Project 1.1 - Controlling Cell Functionality – the aim of this project is to development smart surfaces for controlling stem cell fate and function.
2. Project 1.4 - Biosurfaces – to develop and commercialise microstructured surfaces for cell culture ware.
3. Project 3.1 - Functional Polymers for Photovoltaic Devices - To develop optically active titanium electrode specifically for use in photovoltaic devices using pulse laser patterning.

Achievements for 2011
In summary:
1. Project 1.1 – The development of novel particle manipulation in a microfluidic device through the coupling of large area directional surface plasmon resonance fields.
2. Project 1.4 - A technique for the fabrication of microstructured surfaces that can be incorporated into traditional cell culture ware has been developed, based on femtosecond pulse laser microfabrication of metal polymer injection molds. This technology could lead to the production of specifically micro-contoured surfaces or landscapes for different applications in the study of biological systems.
3. Project 3.1 - Through holes with diameters ranging from 5 to 40 µm have been produced in titanium foils under irradiation from amplified femtosecond pulsed laser light for integration in to dye sensitized solar cells.

Aim for 2012
Project 1.1 – The development of structured surface plasmon resonance fields for trapping, manipulation and sorting of cells, including surface plasmon resonance biosensing of the micro-environment.

Project 3.1 - Investigation into the mechanism of through holes generation in titanium foils under femtosecond pulsed laser light irradiation. Generation of patterned though hole arrays in titanium foil for use in photovoltaic devices in collaboration with the University of Wollongong. Development of an optical model of photovoltaic devices developed by the University of Wollongong, primarily to find the optimal photovoltaic architecture and allow for insight into how new architectures could further improve on the state-of-the-art.

Collaborative links
- Australian Stem Cell Centre
- CSIRO
- Monash University
- Romar Engineering
- University of Wollongong
- ANSTO
RESEARCH PROJECTS

CUDOS (ANB-CUDOS)
Project leader: Professor Min Gu

Project coordinator: Michael James Ventura

Contributing staff: Baohua Jia, Michael James Ventura, Yaoyu Cao, Dario Buso and Elisa Nicoletti

Students: Elisa Nicoletti, Md Muntasir Hossain, Ben Cumming, Mark Turner, Zongsong Gan, Zhengguang He and Han Lin

Objectives
Critical to the realisation of ultra-compact, high speed, all-optical signal processing on a photonic chip is an understanding of how light interacts with complex materials whose composition varies on a scale much smaller than the wavelength of light. Nanoplasmonics, the field of sub wavelength metal optics, is a pathway to the unprecedented control of light on a photonic chip. When metallic structures are integrated into artificial optical composites, nanoplasmonics provides a new method to localise light on the nano-scale with significant benefits in operational speed and energy efficiency. The Nanoplasmonics project forms one of six flagship projects under the ARC centre of Excellence CUDOS project and aims to investigate loss mitigation through plasmonic nanostructures with gain media, miniaturisation through advanced super-resolution all optical lithography techniques, and enhanced nonlinearity using materials whose optical response is a function of light intensity.

Achievements 2011
In summary:
1. Apply super-resolution techniques to the fabrication of nanoplasmonic structures in two- and three-dimensions with resolution of 50 nm.
2. Gain physical insight into the electromagnetic interactions in hybrid plasmonic nanostructures.
3. Demonstrate super-resolution fabrication of a pure metallic nanostructure through electro-deposition.
4. Infiltrate nano-diamonds into nanoplasmonic structures.

λ/12 feature size achieved with super-resolution photoinduction-inhibited nanofabrication (SPIN)
In collaboration with CSIRO we demonstrated patterning with resolution approaching 50 nm using the newly developed super-resolution photoinduction-inhibited nanofabrication (SPIN) technique. This technology, a forerunner for future methods to rival standard nano-patterning e-beam lithography, enables the rapid prototyping of two- and three-dimensional structures with resolution well below the diffraction limit. It offers an all-optical alternative to optical beam lithography, which suffers a diffraction-limited resolution equivalent of λ/2 (half of the wavelength of the light used in the fabrication).

Generation of λ/12 nanowires in chalcogenide glasses
During the year we demonstrated for the first time nanowires of dimension λ/12 in nonlinear chalcogenide material. Published in Nano Letters this ground-breaking work opens possibilities for active nanoplasmonic interconnects for the next generation of all optical circuits. The implications of this research work are three fold. First, the successful generation of nanowires means the footprint of the future photonic chips can be reduced significantly and thus a high degree of integration of photonic devices becomes possible. Second, the method used to generate nanowires is based on laser direct writing, a flexible method that can be adopted for up-scale fabrication. Third, the nanowires are made of a nonlinear material, chalcogenide glass. A nonlinear optical response is the key to the fabrication of all-optical signal processing.
RESEARCH PROJECTS

devices. The strength of the nonlinear response is significantly enhanced because of the nanoscale confinement, enabling reductions in the size of the photonic devices to the scale of a photonic chip. The impact of this paper has seen wide spread media coverage locally in The Age and COSMOS magazine and internationally though web based newfeeds culminating in over 200 individual articles.

Figure (a) COSMOS magazine story covering the realisation of nanowire in nonlinear materials [4]. (b) SEM image of nanowires fabricated under different laser repletion rates showing an optimal resolution of 68 nm at a repletion rate of 1.6 MHz.

Three-dimensional linear chiral lattices
Chiral networks are of particular interest in the field of nanoplasmonics as they display circular dichroism and optical activity, effects impossible to achieve in any two-dimensional structure. Using direct laser writing we fabricated a series of biomimetic chiral microstructures inspired by a recent finding in butterfly wing-scales showing cubic symmetry as well as chirality. Numerical and experimental characterisation show strong circular dichroism due to the chirality of the three-dimensional (3D) network. These 3D chiral microstructures can also be realised via direct laser writing in highly nonlinear materials such as chalcogenide. However, the technique suffers from optical aberration which introduces unwanted distortion, resulting in mechanically unstable, non-uniform structures.

Three-dimensional nonlinear chiral lattices
Aberration compensation can be used to counteract unwanted spherical aberration associated with direct laser writing within chalcogenide material. In collaboration with Innsbruck Medical University and the University of Oxford we demonstrated aberration-free fabrication in lithium niobate using this technique. By compensating for aberration, we fabricated high quality photonic lattice microstructures that exhibited enhanced optical properties in comparison to their uncompensated counterparts. The paper marked a significant milestone in establishing aberration compensation as an enabling technology for the realisation of high quality, functional nanoplasmonic elements.

Generation of an axial super-resolved quasi-spherical focal spot using an amplitude-modulated radially-polarised beam
We demonstrated an axial super-resolved quasi-spherical focal spot with 65% power efficiency using an amplitude-modulation filter combined with a tightly focused (NA=1.4) radially polarised beam. This resulted in a 34% improvement in aspect ratio and 18.5% enhancement in axial resolution compared with results without amplitude-modulation. In addition, the power efficiency of the amplitude-modulation is three times higher than for the linearly polarised...
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Beam. We verified this theoretical calculation experimentally. Using a spatial light modulator to generate an amplitude-modulated filter we measured an 18.5% improvement in the axial to lateral variation in the focal spot.

Optical nonlinearity in miniaturised waveguides
We demonstrate that a new kind of nonlinear nanoshell plasmonic waveguide can possess ultrahigh Kerr nonlinearity with total energy confinement and thus have the potential to be a unique candidate for realising novel nonlinear optical devices. The nonlinear nanoshell plasmonic waveguide comprising a nonlinear (silicon) subwavelength core and a silver nanoshell possesses three distinctive features. Firstly, it creates a subwavelength cross sectional confinement of the plasmon mode with an effective mode area as small as 0.0196 µm². Secondly, nearly 100% of the total mode energy can be confined within the subwavelength waveguide. Thirdly, the vectorial nature of the electromagnetic fields within the cylindrical subwavelength waveguide results in ultrahigh Kerr nonlinearity up to 4.1×10⁴ W⁻¹ m⁻¹.

Localisation of single semiconductor quantum dots inside a three-dimensional photonic crystal
The photon density of states inside a photonic crystal (PC) is position dependent and shows localised optical properties of the PC. To investigate the local optical properties of a PC, a super resolution imaging technique, which utilizes the stochastically temporal behaviour (photon blinking) of the quantum dots (QDs) as a function of time, is employed to precisely localise single QD emitters inside a three-dimensional PC. The fluorescence information from the localised single QD emitters inside the three-dimensional PC can be used to show the local optical properties of PC. Core shell semiconductor QDs CdSe/CdS were synthesized and attached to the surface of the PC structure via molecular linking. Using continuous wave 488 nm laser excitation, the stochastic “on” and “off” temporal behaviour of QDs was observed and recorded.

Spontaneous emission control with three-dimensional hybrid photonic crystals
Hybrid (metallo-dielectric) photonic crystals (HPCs) can possess complete photonic band gaps when the metallic layer is thick, while reducing the thickness of the metallic layer in HPCs can lead to localised plasmon resonances (LPRs). This feature provides a unique environment for the controlling the spontaneous emission of nano emitters for applications towards high speed communications, signal processing and low power devices. Work in this field has involved high quality 3D structures have been fabricated using IPL (Nanoscribe GmbH). A modified Tollens reaction was used for isotropic deposition of silver on complex three-dimensional (3D) geometries with thicknesses in the 40-50 nm range and good smoothness. The FTIR spectra show LPR effect and complete band gaps effect. For the control of the spontaneous emission, core-shell quantum dots (QDs) have been synthesised and introduced to HPCs by drop casting. We have realised a reduced lifetime of the QDs due to LPRs enhancement of the spontaneous emission.

Aims for 2012

- Advance nano-photo-lithography techniques that will allow material manipulation beyond the diffraction limit.
- Develop chiral photonic crystal for advanced polarisation control and devices.
- Develop parallel fabrication technology with optimised aberration compensation.
- Fabricate nanostructures below 20nm using SPIN.
Collaborative links

- Prof. Tony Wilson, Oxford University, UK.
- Prof. Daniel Jaque, Universidad Autónoma de Madrid, Spain.
- Prof. Nikolay Zheludev’s, Southampton University, UK
- Prof. Kobus Kuipers, FOM-institute for Atomic and Molecular Physics (AMOLF), Twente University, Netherlands
- Dr. Gerd Schroder, Institute für Theoretische Physik in Erlangen, Germany
Green Photonics (ANB-GP)
(Inc. Laureate Fellowship)

Projects leader: Prof Min Gu

Projects coordinator: Xiangping Li

Contributing staff: Betty Kouskousis, Yaohui Su and Qiming Zhang

Students: Mr. Azim Mullah, Mr. Ivaylo Ivanov, Mr. Jelle Storteboom and Ms. Chengmingyue Li
Ms. Priyamvada Venugopalan

Achievements 2011
In summary:
1. Negative refraction induced Inverse Doppler effect at optical frequency: Using the unconventional negative refraction in photonic crystals, we were for the first time able to reverse the Doppler effect in the optical region by constructing a two-dimensional silicon photonic crystal with a negative index property. This result has been published in Nature Photonics (Nature Photonics, 5,239–245, 2011) and covered by more than 300 major media reports.

2. The world’s first nanoparticle enabled multi-dimensional optical disc and dynamic recording system: The collaboration with Tsinghua University, one of the best universities in China, and Anwell Precision Ltd, the world’s second largest disc fabricator manufacturer, has led to the successfully development of the nanoparticle dispersed optical discs as well as the dynamic recording system.

3. Orientation-unlimited polarisation control: Using an optically-configured single vectorial beam, three-dimensional orientation-unlimited polarisation control has been successfully demonstrated. Its application in gold nanorods dispersed polymer has enabled polarisation information encryption with an ultra-security and further expanded the storage density by one order of magnitude.

4. Super-resolution imaging based on photoluminescence blinking of nanodiamonds: The photoluminescence blinking of NV centres in nanodiamonds has been discovered. Based on the blinking property, an optical resolution of 80 nm has been achieved, which can have great implications on the Petabytes optical data storage.

5. Nonlinear excitation of nanodiamonds: For the first time, the nonlinear excitation of NV centres in nanodiamond has been innovatively discovered. This discovery can potentially bridge the opto- and magnetic recording by exploring the spin property of nanodiamonds.

6. Nanofocusing in photonic crystal superlens: The negative refraction in a photonic crystal superlens allows unconventionally amplify evanescent waves which contain the fine details of the object. The experimental demonstration of superlensing effect has led an optical resolution of one third of the wavelength.

7. Far-field nanofocusing by a plasmonic lens: The optimised plasmonic lens design can focus the propagating plasmon and scatter into the far field. The far-field intensity distribution of the hot spot has been mapped using both a linearly and radially polarised beam.

8. Exciton-plasmon coupling mediated photorefractivity: Exciton-plasmon coupling mediated photorefractivity has been demonstrated in Type-II QDs and Au nanoparticles sensitised polymers. A near 100% enhanced two beam coupling gain coefficient and 65% improved response speed have been observed.
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Aims for 2012

- Develop dynamic drive system which can support dynamic recording and reading in multi-dimensional optical discs.
- Develop super-resolution recording methods for high density optical data storage.
- Exploit the subwavelength light-matter interaction using super-resolution methods.
- Develop digitalised holographic optics and algorithms for three-dimensional display.

Collaborative links

- Professor Guofan Jin, Tsinghua University, China
- Dr. Luping Shi, Data storage institute, Singapore
- Professor Xiang Zhang, University of California, Berkeley, USA
- Professor Masud Mansuripur, The University of Arizona, Arizona, USA
- Professor Dinping Tsai, National Taiwan University, Taiwan
- Anwell, China
- Hualu, China
- Pulstech, Japan
- GE, USA
- InPhase Technologies, USA
- Samsung, Korea
- Sony, Japan

Figure: (left) Normal (a) and Inverse (b) Doppler effect and featured in Nature Photonics. (right) CMP's first gold nanoparticle mediated multidimensional disc.
RESEARCH PROJECTS

VSASF (ANB-VSASF)

Project leader: Prof Min Gu

Senior Research Fellow: Baohua Jia

Contributing staff: Narges Fahim, Xi Chen, Nicholas Stokes, Jhantu Kumar Saha and Zi Ouyang

Technical and Administration staff: Daniel Day, Pierrette Michaux, Riaan Lourens and Amable Lou

Students: Shouyi Xie, Boyuan Cai, Thomas Farrington, Yinan Zhang

Objectives
- Understanding the mechanism of NanoPlas solar cells and optimising the theoretical model so that it can predicate and interpret the experimental results
- Controlled experiments on nanomaterials to find the tailored parameters to be integrated with solar cells
- Optimising the solar cell fabrication, integration and characterisation processes to achieve large efficiency enhancement in both NanoPlas wafer and thin film solar cells

Achievements for 2011
- Developed a novel ‘nucleated’ nanoparticle model to achieve broadband plasmonic enhancement.
- Achieved 23% efficiency enhancement on Suntech’s thin film solar cells using the nucleated particle.
- Achieved 35% efficiency enhancement on Suntech’s planar silicon wafer solar cells using metallic nanoparticles.
- Secured an Australian Solar Institute Fellowship for Dr Wengsheng Yan.
- Demonstrated a nanowire integrated solar cell.
- The VSASF received the Vice-Chancellor’s Industrial engagement award in 2011 for its close collaboration with the world largest solar module manufacturer-Suntech Power Holding Co. Ltd.

Aim for 2012
- Investigate novel technology for integrating nanomaterials to full sized solar cells
- Investigate low cost nanomaterials suitable for mass production
- Test NanoPlas solar cell prototype
Applied Plasmonics (AP): Industrial Applications

**Group Leader:** Professor Saulius Juodkazis

**Contributing staff:** Dr. Lorenzo Rosa

**Contributing students:** Ricardas Buividas and Gediminas Gervinskas

**Objectives**

Applied Plasmonics/industrial applications (AP) is engaged in development of nanofabrication approaches based on laser, electron/ion beam lithography fabrication and processing of material.

**Achievements for 2011**

- Nature Communications paper “Evidence of superdense aluminium synthesized by ultrafast microexplosion” published in collaboration with team from Stanford University, Australian National University, Shizuoka University and Carnegie Institute of Washington.
- An Optics Express paper by Centre for Micro-Photonics Applied plasmonics researchers on the use of ion beam lithography for the creation of 3D photonic crystals has been featured in Nanowerk, a leading resource for nanotechnology and nanoscience information. This paves the way for production of a full photonic bandgap in the visible spectral range.
- The SPIE Smart nano micro materials and devices conference was organised and hosted at Swinburne in the new ATC building by the members of the AP group.
- Research feature: Saulius Juodkazis and Sajeev John “Photonic crystals approach visible-light functionality” Laser Focus World 47 (8), (2011)

**Aims for 2012**

1. Utilise the recently established nanofabrication laboratory at the Centre for Micro-Photonics to fabricate photonic crystals with “visible” band gap.
2. To consolidate publications, projects and funding with collaborative partners in line with the AP group vision.

**Collaborative links**

- Agilent, USA
- Altechna, Lithuania
- Laser Systems, Japan
- Raith, Germany
- Dr Johannes Boneberg, Konstanz University, Germany
- Etienne Brasselet, Bordeaux University/CNRS, France
- Professor Paul Dastoor, University of Newcastle, Australia
- Dr Ewa Kowalska, University of Erlangen-Nuremberg, Germany
- Dr Dmitri Gramotnev, Nanophotonics Ltd.
- Professor Sajeev John, University of Toronto
- Professor Kestutis Juodkazis, Vilnius, Institute of Chemistry, Lithuania
- Dr Jurga Juodkazyte, Vilnius, Institute of Chemistry, Lithuania
RESEARCH PROJECTS

- Dr Toshiaki Kondo, Kanagawa Academy of Science and Technology, Japan
- Professor Masanori Koshiba, Hokkaido University, Japan
- Dr Reda Kubiliute, Vilnius University, Lithuania
- Professor Paul Leiderer, Konstanz University, Germany
- Associate Professor Vygantas Mizeikis, Shizuoka University, Japan
- Dr Yoshiaki Nishijima, Yokohama University, Japan
- Professor Andrei Rode, ANU, Australia
- Dr Kai Sun, Harbin University, China
- Professor Oliver Wright, Hokkaido University, Japan
Cell Biology (CB)

Group Leader: Professor Sarah Russell

Project: Using microscopy to determine how immune cell fate is controlled
Project leader: Professor Sarah Russell
Contributing staff: Min Gu and Ye Chen
Students: Kim Pham and Raz Shimoni

Objectives
This project is to develop and apply state-of-the-art microscopic methods to assess the mechanisms and consequences of polarity and asymmetric cell division in lymphocytes.

Achievements for 2011
The achievements for 2011 can be summarised as follows:
1. Group leader Sarah Russell received a NHMRC grant.
2. The CB in collaboration with Peter MacCallum cancer centre was successful in publishing three high impact papers, one Immunity, one Immunotherapy and nature family journal - Immunology and Cell Biology, respectively.

Aims for 2012
1. Apply super-resolution microscopy techniques to lymphocyte biology.
2. Continue elucidating the role of polarity and ACD in lymphocyte polarity and cancer.

Collaborative links
• Prof Steve Reiner University Pennsylvania, USA
• Dr Helena Richardson, Peter MacCallum Cancer Centre, Australia
• Professor Ellen Robey, University of California Berkeley, USA
• Dr Patrick Humbert, Peter MacCallum Cancer Centre, Australia
• Ms Sarah Ellis, Peter MacCallum Cancer Centre, Australia
Cell Biophysics Laboratory (CBL)

Group Leader: A/Prof. Andrew H.A. Clayton
Students: Alireza Lajevardi-pour
Project: Cell surface receptor biophysics
Project Leader: A/Prof. Andrew H.A. Clayton

Objectives
- To determine the activation mechanism of cell surface receptors by combining structural information from fluorescence microscopy with biochemical information using biochemistry and cell biology.

Achievements for 2011
1. Ligand-induced activation of an important receptor called the EGF receptor is thought to be initiated by a ligand binding event that causes a conformational change leading to dimerisation and activation. Using tryptophan fluorescence spectroscopy we demonstrated both ligand-induced and temperature-induced conformational transitions in the ligand-binding domains of the EGF receptor solution. However in the full length receptor in cells the ligand binding domains appear to be poised for ligand binding and are pre-dimerised. This work was published in the ACS journal Biochemistry and the IOP Journal Physical Biology.

2. Antibodies offer promise as therapeutics for cancer. We used a novel strategy to examine the effect of antibodies on EGF receptor using a combination of image correlation spectroscopy and polarization imaging. This work was published in ACS journal Biochemistry and received coverage in global medical discovery.com and Australasian Science Magazine.

3. G-protein-coupled receptors play an important role in the physiology of the brain controlling mood and appetite. We have shown for the first time that the serotonin receptor forms higher-order oligomers in living cells and the proportion of higher-order oligomers depends on drug treatment and cell integrity. This work was published in Biophysical Journal.

Project: Hyper-dimensional optical imaging
Project Leader: A/Prof. Andrew H.A. Clayton
Students: Alireza Lajevardi-pour

Objectives
- To utilise the many dimensions of fluorescence (lifetime, color, polarisation, fluctuations) to enable measurement of interactions and dynamics of multiple interaction partners in a cell signalling cascade.

Achievements for 2011
1. We demonstrated by theory and experiment for the first time that lateral motions of particles can be measured using frequency-domain lifetime imaging. Motions result in changes to the lifetime histogram that can be related to the extent of motion. This work is being prepared for publication.

2. We revealed that fixation of cells can influence the lifetime and polarisation properties of a fluorescently-tagged receptor. This work was reported in Biophysical and Biochemical Communications.

Project: Antimicrobial peptides
Project Leader: A/Prof. Andrew H.A. Clayton
Contributing staff: A/Prof. Andrew H.A. Clayton, A/Prof. Michelle Gee (collaborator), Mr. Matthew Burton (collaborator) and Mr. Andrew Rapson (collaborator).
RESEARCH PROJECTS

Objectives

- To use lifetime imaging microscopy to determine the interaction of helical peptides with model membranes and bacteria.

Achievements for 2011

1. We used time-resolved evanescent wave anisotropy decay spectroscopy to measure the rotational motions of melittin peptide associated with single supported lipid bilayer. The motions were highly restricted spatially and revealed a dependence on excitation polarisation direction. The data was consistent with a mixed surface/pore model for melittin. This paper was published in Biophysical Journal.

2. We measured the kinetics of the interaction of peptides with vesicles using time-resolved fluorescence, time-lapse lifetime imaging and time-lapse scattering. The data reveal for the first time critical kinetics which we attribute to the onset of a phase transition in the peptide-lipid system. This work was published in Langmuir, the leading journal for surface science.

Aims for 2012

- Begin new project- Cell Signalling Interferometry.

CBL teaches into following undergraduate programs:

- HET408 - Biomedical Imaging and Emerging Technologies. Contributed to curriculum development by adding advanced fluorescence microscopy to the course content, tutorials, exam preparation, exam marking and Lecturing.

- HET550 - Design and Development Project 1 (Semester 1 2011). Supervised two students in the area of image analysis.

- HET556-Design and Development Project 2 (Semester 2 2011). A continuation of HET550 and again supervised two students in the area of image analysis.
Nanotrapping and Super-resolution (NAS)

**Group Leader:** Assoc. Professor Xiaosong Gan  
**Project leader:** Assoc. Professor Xiaosong Gan  
**Contributing staff:** Min Gu  
**Students:** Jingzhi Wu

**Objectives**
- To develop novel optical trapping probes for optical imaging, sensing and manipulation, particularly in the near-field region.
- To develop super-resolution techniques for nanophotonic applications.

**Achievements for 2011**
- NAS were successfully able to show Vertical plasmonic nanowires for 3D nanoparticle trapping.
- Opto-thermal plasmonic trapping has been successfully demonstrated.

**Aims for 2012**
To develop:
- Three-dimensional super-resolution nanophotonic microscopy, for nano-fabrication and imaging.
- Further study into the thermal effect of the plasmonic structure as its impact has proven significant and may determine the outcome of the nanoparticle trapping.
- Publication of nanoparticle trapping approach based on plasmonic nanostructures. High impact journals will be targeted.
- Recruitment of high quality students.
- Further enhancing national and international collaborations.

**Collaborative links**
- Professor Kishan Dholakia, University of St. Andrews, UK.
- Professor Yunlong Sheng, Université Laval, Canada.
- Professor Barry Masters, MIT, USA.
- Professor Lei Xu, Fudan University, China.
- Professor Wendong Xu, Shanghai Institute of Optics and Fine Mechanics, China.

Laser trapping technology is taught in the Advanced optical imaging theory (HET505) undergraduate program. Assoc. Professor Xiaosong Gan is the Subject convenor and performs lecturing of this subject.

*Figure: Structure and surface plasmon resonance of vertical plasmonic nanowires for 3D nanoparticle trapping.*
Optical Nanoparticle Spectroscopy for Photonic Applications (ONSPA)

Group leader: Dr James W. M. Chon

Students: Adam Taylor, Timothy Chow, Arif Siddiquee and A. S. M. Mohsin

Objectives

• To understand the energy decay paths within optical nanomaterials using microscopy and spectroscopy methods at single particle level.

• To control and manipulate energy decay paths of optical nanomaterials for photonic device applications.

In 2011 Optical Nanomaterial Spectroscopy for Photonic Applications group (ONSPA) consolidated its activities. ONSPA was successful in securing further Australian Research Council fellowship funding, and the new PhD students continued to develop in line with the group’s aspirations. ONSPA has successfully been working on gold nanorod photothermal and luminescent properties and have made considerable progress on continuous wave operation and characterisation protocols.

Aims for 2012

1. Complete establishment of single particle laboratory
2. Further develop readout schemes for multilayered gold nanorod film.
3. Experimentally demonstrate the predicted coupled ICS theory
4. Further consolidation of results to be published in 2012

Collaborative links

• Professor Michel Orrit, University of Leiden, Netherlands
• Dr Jooho Kim, Samsung Electronics, Korea
• Prof. Byoungho Lee, Seoul National University, Korea

ONSPA teaches into following undergraduate programs:

• HET124A Energy and Motion for Aviation (Dr James Chon, Subject Convenor and Lecturer, Semester 1)
• HES7605 Research Design and Methodology (Dr James Chon, Subject Convenor Semester 1 & 2)
• HES1935 Internal Combustion and Gas Turbine Engines (Dr James Chon, Lecturer Semester 2)
CONFERENCE ORGANISATION

Dr James Chon

Mr Ben Cumming

Professor Min Gu
Program Committee on Multiphoton Microscopy in the Biomedical Sciences XI, Photonics West, San Francisco, USA, Jan. 22-27.

Program Committee on Optical Components and Materials (VIII), Photonics West, San Francisco, USA, Jan. 22-27.

International Advisory Committee, International Conference on Confocal Microscopy (FOM2011), Konstanz, Germany, April 17-20.

Program Committee, Topical Meeting of Optical Society of America: Digital holography and 3D imaging, Tokyo, Japan, May 9-11.

Program Committee on Medical and Biological Applications, CLEO, San Jose, USA, May 16-21.

Program Committee, The Fifth International Conference on Surface Plasmon Photonics (SPP5), Busan, Korea, May 15-20.

Program Committee, Optical Data Storage Conference, Kauai, Hawaii, USA, July 17-22.

Advisory Committee, First International Conference on Small Science (ICSS 2011), Sydney, Australia, August 15-18.

Program Committee on Optical Trapping and Optical Micro Manipulation, Optical and Photonics Conference, San Diego, USA, August 21-25.

Chair, Program Committee on Nanophotonics, International Conference on Quantum Electronics/The 9th Pacific Rim Conference on Lasers and Electro-Optics (QIEC/CLEO-PR2011), Sydney, Australia, August 29-September 1.


International Program Committee, the 10th International Conference on Correlation Optics, Chernivtsi, Ukraine, September 12-16.

Co-Chair, Program Committee, 1st Forum on Trends in Nano-manufacturing, Hefei, China, Oct. 10-14.

International Advisory Committee, 4th International Photonics and Optoelectronics Meetings (POEM 2011), Wuhan, China, Nov. 2-5.

Steering Committee, International Symposium on Bioelectronics and Bioinformatics (ISBB2011), Suzhou, China, November 3-5.

Co-Chair, Display, Solid-State Lighting, Photovoltaics and Optoelectronics in Energy, Asia Communications and Photonics Conference and Exhibition (ACP2011), Shanghai, China, Nov 13-16.

International Program Committee, International Workshop on Holography and Related Technologies, Yoto Campus, Utsunomiya University, Tochigi, Japan, November 16-18.

Co-Chair, SPIE Smart Nano-Micro Materials and Devices, Melbourne, Australia, Dec. 5-7.

Dr Boahua Jia
Organising committee, Asia Communications and Optics Conference - ACP 2011, Shanghai, China 13-16 November, 2011.

Professor Saulius Juodkazis
Co-Chair, SPIE Smart Nano-Micro Materials and Devices, Melbourne, Australia, Dec. 5-7.

Professor Sarah Russell
PROFESSIONAL SOCIETY MEMBERSHIPS

**Professor Min Gu**
Fellow, Australian Academy of Science  
Fellow, Australian Academy of Technological Sciences and Engineering  
Fellow, Optical Society of America  
Fellow, SPIE – The International Society of Optical Engineering  
Fellow, Australian Institute of Physics  
Vice-President, International Commission for Optics (a member of IUPAP and ICSU)  
Vice-President, Regional Council of the International Society of Optics within Life Sciences (OWLS).  
Member, Australian Optical Society  
Senior Membership, International Society of Electric and Electronic Engineers (IEEE)  
Member, American Association for the Advancement of Science (AAAS)

**Professor Sarah Russell**
Member, Australasian Society for Immunology  
Member, American Society for Cell Biology  
Member, American Association of Immunologists  
Member, Australia and New Zealand Society for Cell and Developmental Biology

**Professor Saulius Juodkazis**
Member, Australian Optical Society  
Member, Optical Society of America  
Member SPIE - The International Society of Optical Engineering

**Assoc. Professor Andrew Clayton**
Member, Biophysical Society, USA  
Member, American Association for the Advancement of Science, USA

**Assoc. Professor Xiaosong Gan**
Member, Australian Optical Society  
Member, SPIE - The International Society of Optical Engineering  
Member, Australian Institute of Physics

**Dr James W. M. Chon**
Member, Australian Optical Society  
Member, Optical Society of America  
Member, Australian Institute of Physics  
Member, American Chemical Society

**Dr Daniel Day**
Member, Optical Society of America  
Member, Australian Optical Society  
Member, SPIE – The International Society of Optical Engineering  
Member, Australian Institute of Physics

**Dr Baohua Jia**
Member, Optical Society of America  
Member of the Australian Research Council Nanotechnology Network (ARCNN)  
Member, ARC Australian Research for Advanced Materials (ARNAM)  
Member, ARC/NHMRC FABLS Network

**Dr Xiangping Li**
Member, Optical Society of America  
Member, Australian Optical Society

**Dr Lorenzo Rosa**
Member, Australian Optical Society  
Member, International Society of Electric and Electronic Engineers (IEEE)  
Member, Optical Society of America

**Mr Ricardas Buividas**
Member, Australian Optical Society  
Member SPIE - The International Society of Optical Engineering
Editorial boards

**Professor Min Gu**
Optics Communication – Netherlands
Journal of Microscopy – UK
Chinese Optics Letters – China
Optik – Netherlands
Imaging and Microscopy – Germany
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Nanoscropy – Germany

**Dr James W. M. Chon**
Board of Editors, Journal of Optical Society of Korea, Optical Society of Korea - Korea

**Professor Sarah Russell**
Journal of Biological Chemistry - USA

**Dr Daniel Day**
Associate Editor International Journal of Biomedical Imaging - USA

**Professor Saulius Juodkazis**
Editor: Journal Laser Nano-/Micro-Engineering – Japan
Int. Advisory Board: Lithuanian Journal of Physics – Lithuania
Editor: Advances in Optical Technologies – USA
Associate Editor: Optics Express - USA

**Dr Hongchun Bao**
World Journal of Gastrointestinal Endoscopy – China

**Assoc. Professor Andrew Clayton**
Editorial Board Member- Biology (MDPI)

Professional activities

**Professor Min Gu**
Australian Academy of Science, Sectional Committee on Applied Physical and Engineering Sciences.
President and Chair of the Advisory Board, The Federation of Chinese Scholars in Australia
Honorary Professor Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences, P. R. China
Advisory Professor Shanghai Jiaotong University, P. R. China
Chang Jiang Chair Professor, Huazhong University of Science and Technology, P. R. China.
Honorary Professor, Tsinghua University, P. R. China.
Member of Academic Advisory Board (2010-2013, SIST), Fudan University, P. R. China
Honorary Professor, Shizuoka University, Japan
World Class University Visiting Professor, Pusan National University, Korea
Guest Professor, Changchun University of Science and Technology, P. R. China
National Expert Professor, Zheijiaq University, P. R. China
Honorary Chair and Professor, the Overseas Chinese Scholar Advisory Committee, HuaQiao University, P. R. China
Honorary Professor, China University of Mining and Technology, China
Guest Professor, Wuhan University of Technology, P. R. China
Advisory Committee, Overseas Chinese Affairs Office of the State Council, China
Australia-US Science and Technology Joint Commission Committee, DIISR
Australia-China Joint Science and Technology Commission (JSTC), DIISR
PhD Thesis Completions

The Centre for Micro-Photonics is pleased to announce the recent awarded doctorate through research in the center’s photonic crystal project.

Advanced Nano-Biophotonics: CUDOS

Group Leader: Prof. Min Gu

Elisa Nicoletti
Awarded Doctor of Philosophy
Thesis Title: "Engineering and characterisation of chalcogenide-based photonic microstructures".

After completion of her thesis, Dr Elisa Nicoletti has continued her research with the Centre.

Figure: Professor Min Gu and Elisa Nicoletti.
GRANTS

ARC Discovery Projects

Dr. James W.M. Chon was awarded ARC Future fellowship 2011-2015 entitled “Image correlation spectroscopy on gold nanorod based plasmonic random media for nanophotonic applications”.

Associate Professor Clayton and M. Gee were awarded a Discovery Project (DP110100164) entitled “Imaging the mechanism of action of antimicrobial peptides”. Andrew is the Lead Chief Investigator on this project.

Professor Saulius Juodkazis was awarded a Discovery Project (via the Australian National University) entitled “Ultra-fast alchemy: a new strategy to synthesise super-dense nanomaterials”.

Dr. Baohua Jia was awarded a Discovery Early Career Researcher Award (DECRA).

ARC Linkage Grant

Professor Saulius Juodkazis was awarded an AC linkage grant entitled “Three dimensional nano-lithography: combined electron and ion beam fabrication”

NHMRC

Professor Sarah Russell has been awarded a NHMRC Project Grant for “Asymmetric Cell Division in T Cell Development: Consequences for Immunity and Cancer”.

Professor Sarah Russell and S. Ting have been awarded a NHMRC Project Grant for “Mechanisms of self-renewal in hematopoietic stem cells”.

Professor Sarah Russell and J. Oliaro have been awarded a NHMRC Project Grant for “Extracellular cues compete with TCR signalling to alter lymphocyte polarity, fate and function”.

Australian Academy of Science Travel Grant

CMP postdoctoral research fellow Dr Stefania Castelletto was awarded funding from the Australian Academy of Science under the Scientific Visits to Europe.
RESEARCH PUBLICATIONS

Journal papers
15. Benjamin P. Cumming, Alexander Jesacher, Martin J Booth, Tony Wilson and


30. Saulius Juodkazis, Shinji Kohara, Yasuo Ohishi, Norihisa Hirao, Arturas Vailionis,


45. Vygantas Mizeikis, Shinji Kohara, Yasuo Onishi, Norihisa Hirao, Akira Saito, Arturas Vailionis and Saulius Juodkazis, “Synthesis of high-pressure phases of silica by laser-induced optical breakdown”,


60. Matthias Saba, Michael Thiel, Mark D Turner, Stephen T Hyde, Min Gu, Karsten Grosse-Brauckmann, Dragomir N. Neshev, Klaus Mecke and Gerd E. Schröder-Turk, “Circular Dichroism in Biological Photonic
RESEARCH PUBLICATIONS


Conference abstracts


5. Dario Buso, Bachua Jia, Elisa Nicoletti, Jiating Li and Min Gu, “Sol-Gel inspired protocols to engineer the optical properties of 3D photonic crystals”, 9th Workshop of the Australian Research Council Centre for
Ultrahigh-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)


15. Zongsong Gan, Yaoyu Cao, Baohua Jia and Min Gu, “Theoretical modeling of doughnut beam based super-resolution lithography with photoinhibition”, 9th Workshop of the Australian Research Council Centre for Ultrahigh-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)


18. Gediminas Gervinskas, Philipp Trocha, Ricardas Buividas, Daniel Day, Elke Scheer, Paul Leiderer and Saulius Juodkazis, “Fabry-Pérot sensors:
Microfluidic channels and transparent membranes”, Proceedings of SPIE - The International Society for Optical Engineering, 8204, art. no. 82043Q (2011) doi: 10.1117/12.904898
22. Min Gu, “Nanophotonics under an optical microscope”, The fifth International Conference on Nanophotonics, 22-26 May, Fudan University, Shanghai, China (2011)
27. Min Gu, “Nanophotonics with super-resolution optical microscopy”, 4th International Conference on Photonics and OptoElectronics Meetings, (Plenary), 2-5 November, Wuhan, China (2011)
33. Min Gu and Xiangping Li, “Nanoparticle-enabled polymeric photorefractivity and their application in three-dimensional optical data storage”, SPIE Photonics West, (invited), 22-27 January, Moscone Center, San Francisco, California, USA (2011)
34. Min Gu, Yaoyu Cao, Zongsong Gan, Baohua Jia and Hongchun Bao, “Superresolution photoinduction-inhibited nanolithography (SPIN) in a microscope”, 2010 International Conference on Confocal Microscopy, (Invited), 17-20 April, Konstanz, Germany (2011)
36. Min Gu, Yaoyu Cao, Zongsong Gan, Baohua Jia, Hongchun Bao and Xiangping Li, “Direct laser writing: superresolution
37. Zhengguang He, Baohua Jia and Min Gu, “Three-dimensional hybrid photonic crystals with emission tuneable nanocrystal quantum dots for emission control”, SPIE smart nano-micro materials and devices”, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)

38. Zhengguang He, Alessandro Antonello, Baohua Jia, Alessandro Martucci and Min Gu, “Activating three-dimensional hybrid photonic crystals with emission tuneable nanocrystal quantum dots”, 9th Workshop of the Australian Research Council Centre for Ultrahigh-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)


41. Baohua Jia, Jhantu Kumar Saha, Xi Chen, Qi Qiao, Yongqian Wang, Zhengrong Shi and Min Gu, “Effect of back dielectric layer thickness between silver nanoparticles and silicon layer for tailored plasmonic enhancement in thin film amorphous silicon solar cells”, SPIE smart nano-micro materials and devices”, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)

42. Baohua Jia “Concept to prototype: VSASF story”, All Energy Australia 2011, (Invited), 12-13 October, Melbourne Convention & Exhibition Centre, Australia (2011)


45. Betty Kouskousis, Stefania A Castelletto, Xiangping Li and Min Gu, “Tailoring the photoluminescence of NV centres in nanodiamonds for superresolution imaging”, SPIE smart nano-micro materials and devices”, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)


48. Xiangping Li, Yaoyu Cao and Min Gu, “Photo-inhibition enabled super-resolution optical data storage in photoreduction polymers”, SPIE smart nano-micro materials and devices”, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)

49. Xiangping Li, Priyamvada Venugopalan, and Min Gu, “Nanos-2 photonics mediated polymeric photorefractivity”, The Fifth International Conference on Surface Plasmon, 15-20 May, BEXCO, Busan, Korea (2011)
50. Han Lin and Min Gu, “Dynamic generation of diffraction-limited azimuthal multifocal array for large area three-dimensional photonic device fabrication”, SPIE smart nano-micro materials and devices, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)


52. Han Lin, Baohua Jia and Min Gu, “Polarisation sensitive light localisation in chalcogenide glass nanogratings”, 9th Workshop of the Australian Research Council Centre for Ultra-high-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)


57. Elisa Nicoletti, Douglas Bulla, Barry Luther-Davies and Min Gu, “Metal coating of chalcogenide nanostructures”, 9th Workshop of the Australian Research Council Centre for Ultra-high-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)

58. Elisa Nicoletti, Douglas Bulla, Barry Luther-Davies and Min Gu, “High resolution fabrication in As2S3”, 9th Workshop of the Australian Research Council Centre for Ultra-high-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)

59. Elisa Nicoletti, Douglas Bulla, Barry Luther-Davies and Min Gu, “Planar defects in 3D chalcogenide photonic crystals”, 9th Workshop of the Australian Research Council Centre for Ultra-high-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)

60. Elisa Nicoletti, Douglas Bulla, Barry Luther-Davies and Min Gu, “Wide stop gaps in 3D chalcogenide photonic crystals”, 9th Workshop of the Australian Research Council Centre for Ultra-high-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)


65. Matthias Saba, Gerd E. Schroder-Turk, Klaus Mecke, Michael Thiel, Mark D. Turner, Min Gu, Stephen T. Hyde, Dragomir N. Neshov and Karsten Gross-Brauckmann, “Circular dichroism in biological photonic crystals and cubic chiral nets”, Geometry of Interfaces, 3-7 October, Primosten, Croatia (2011)


67. Jhantu Kumar Saha, Xi Chen, Baohua Jia, Qi Qiao, Yongqian Wang, Zhengrong Shi and Min Gu, “Reduced intrinsic layer thickness of thin film amorphous silicon solar cells enabled by the plasmonic effect from silver nanospheres”, SPIE smart nano-micro materials and devices, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)


70. Mark D. Turner, Dario Buso, Gerd E. Schröder-Turk and Min Gu, “Three-dimensional metallic gyroid microstructures with true cubic symmetry”, SPIE smart nano-micro materials and devices, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)


75. Michael James Ventura and Min Gu, “Fabrication of metallic fractal patterns using femtosecond laser ablation”, 9th Workshop of the Australian Research Council Centre for Ultrahigh-bandwidth Devices for Optical Systems, 14-17 February, Shoal Bay, Australia (2011)

76. Priyamvada Venugopalan, Xiangping Li, Stefania Castellato and Min Gu “Imaging nano-diamonds using a far-field plasmonic lens, SPIE smart nano-micro materials and devices”, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)

CONFERENCE PUBLICATIONS


79. Stephen Weber, Daniel Day and Min Gu, “Environmental sensing a microfluidic device via morphology dependent resonance”, SPIE smart nano-micro materials and devices, Swinburne University of Technology, 4-7 December, Melbourne, Australia (2011)

80. Jing Wu, Daniel Day and Min Gu, “Laser based fabrication and detection towards integrated optofluidics”, International Symposium on Optomechatronic Technologies, (Invited), 1-3 November, Hong Kong, China (2011)


BOOK CHAPTER

CMP member Andrew H.A. Clayton contributed a chapter “EGF receptor kinases and their activation in receptor-mediated signaling”, Chapter 48 in: Functioning of Transmembrane Receptors in Signaling Mechanisms, Elsevier (Editors: Bradshaw and Dennis) 2011.

Research Outreach

Saulius Juodkazis and Sajeev John “Photonic crystals approach visible-light functionality” Laser Focus World 47 (8), (2011) doi: NA

Andrew A.H. Clayton participated in the 1st Pico-quant South-East Asian Workshop on Fluorescence Techniques, Institute for Medical Biology, The Biopolis, Singapore (2011)

Zi Ouyang, Baohua Jia and Daniel Day have supervised a group of undergraduate students to conduct their final year project (HET550) for two semesters. The aim of the project is to construct a NanoPlas module with sun tracking system.

Jiabi Chen, Yan Wang, Baohua Jia, Tao Geng, Xiangping Li, Lie Feng, Wei Qian, Bingming Liang, Xuanxiong Zhang, Min Gu, and Songlin Zhuang, Negative index materials reverse the optical Doppler effect. 2Physics, 27 Mar (2011)

James W. M. Chon, “Surface plasmon resonance mediated optical properties in gold nanorods and its application to 5-dimensional...
optical storage”, Australian Nanotechnology Network Early Career Symposium, (Invited), 21-22 November, Macquarie University, Sydney, Australia (2011)

Professor Saulius Juodkazis was invited to Schizuoka University, Japan as tenure track symposium speaker and judge of the project progress.

Professor Sarah Russell, “Balancing career and family”, (Invited), Gender Equity Workshop, 17 June, WEHI GTAC – Gene Technology Access Centre, Parkville, Australia (2011)

Professor Sarah Russell, ASMR Professional Development Day, (Invited), 27 October, Melbourne, Australia (2011)

Professor Sarah Russell, Super Vision Postgraduate Teaching Workshop, (Invited), MCG, Melbourne (2011)

Professor Sarah Russell, Seminar, (Invited), AAHL, Geelong, Australia (2011)

Professor Sarah Russell, Seminar, (Invited), Burnet Institute, Melbourne, Australia (2011)

Professor Sarah Russell, Seminar, (Invited), School of Molecular Sciences, La Trobe University, Australia (2011)

Media Publications

Advanced Nano- Biophotonics group:
Chinese Minister for Science and Technology, Dr Wan Gang’s visit to the Green Photonics projects generated more than 13 media release world-wide.

Nature Communications “Three-dimensional orientation-unlimited polarization encryption by a single optically configured vectorial beam”

Media:
Research Gate
http://www.researchgate.net/publication/239671536_Three-dimensional_orientation-unlimited_polarization_encryption_by_a_single_optically_configured_vectorial_beam
NCBI
BioInfoBank
http://lib.bioinfo.pl/paper/22893122
The EDGE
Nature Asia-pacific
www.natureasia.com/en/
ATGC Checker
http://www.atgcchecker.com/pubmed/22893122
Phiscis News
http://www.physnews.com/physics-news/cluster317373741/
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i4u news
The Register
http://www.theregister.co.uk/2012/08/15/optical_polarisation_encryption_swinburne/
Silo Breaker
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Three-dimensional_orientation-unlimited_polarization_encryption_by_a_single_optically_configured_vectorial_beam.html
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RESEARCH PUBLICATIONS


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http://www.biomedsearch.com/searchlist.html?query_txt=xiangping&s.x=0&s.y=0

Cell Biophysics Group:

- Australasian Science Magazine; Article covering our work on how we combine physics and biology to learn how cancer drugs work.
- Cosmos; Andrew A.H. Clayton was interviewed to provide expert comment on the potential of a discovery in physics to impact on biology.

ONSMA Group:

CENTRE ACTIVITIES

Minister Wan Gan Visit

Figure: (Foreground) Chinese Minister for Science and Technology, Wan Gang (left) and Chancellor of Swinburne University of Technology Bill Scales (right) exchange a gift in the CMP's new ATC laboratory.

Figure: (right) CMP Director Professor Min Gu explains the Centre’s Peta byte Multidimensional optical data storage to Minister Wan Gang (Left).

Figure: (left rear) CMP members Jhantu Saha, Xi Chen, Zi Ouyang, Shouyi Xie, Qiming Zhang and Betty Kouskousis with Minister Wan Gang and Professor Min Gu admiring the capability of The Center’s VSASF solar technology.

Swinburne University Visit
Suntech, China

Figure: Suntech Chairman and CEO Dr. Zhengrong Shi with Swinburne University Vice-Chancellor Linda Kristjanson and CMP Director Professor Min Gu.

Swinburne University Visit the Chinese Academy of Engineering

Figure: Swinburne University Vice-Chancellor Linda Kristjanson and CMP Director Professor Min Gu with Professor Jiayi Cheng, Deputy Director General of the Chinese Academy of Engineering.
Shandong University Visit

Figure: CMP’s Dr Xiangping Li (left) highlighting the virtues of multidimensional Peta byte optical data storage to Professor Han Sen Shenghao, President of Shandong University (Weihai) (right).

National Taiwan University Visit

Figure: Professors Liang-Chia Chen and Kuang-Chao Fan from National Taiwan University, Taiwan with Xiangping during their visit to CMP’s Petabyte data storage facility.
CENTRE ACTIVITIES

Student Chapter

Swinburne Optics and Photonics (SOAP) is an Optical Society of America (OSA) student chapter located at Swinburne University of Technology and incorporates Honours and PhD students from both the CMP and the Centre for Atom Optics and Ultra-fast Spectroscopy (CAOUS). The chapter aims to support graduate students with their studies in the field of optics as well as providing outreach to the public and undergraduate students interested in optical science. Through regular meetings and events, students are able to network with other students and researchers from around the world to build connections for when they enter the workforce.

In 2011 the chapters major high light was the organisation of the international student Conference on Optics and Laser Applications IONS-KOALA 2011 (KOALA). The conference was organised and chaired by SOAP chapter president and CMP student Ben Cumming.

KOALA (Conference on Optics Atoms and Laser Applications) is an annual conference that is organised for students, by students, and brings together Honours, Masters and PhD students studying in any field of optics from Australia, New Zealand and the World. KOALA is a part of the IONS (International OSA Network of Students) project that is run by the OSA (Optical Society of America).

The primary goal of KOALA is to facilitate discussion and networking between students in different optics research fields who otherwise would be unlikely to meet. This gives students a fresh perspective, as well as the opportunity to learn about research beyond their own field in optics. Participants also learn the essential skill of how to communicate their research to people who are not experts in their field.

The first KOALA conference was run in 2008 in Brisbane by the University of Queensland OSA student chapter and was a great success. This was followed up with 2009’s meeting in Sydney, which was organised by the OSA student chapters at Sydney and Macquarie universities. In 2010, KOALA travelled across the Tasman to Dunedin, New Zealand with Otago university OSA student chapter playing host.

In 2011, the KOALA conference moved to Melbourne where the OSA student chapters of Swinburne, Melbourne and RMIT universities jointly hosted the event at Trinity College, The University of Melbourne. 56 students attended the conference from 11 Australian and New Zealand universities, which were combined into 26 oral presentations and 23 poster presentations across a full week of scientific and social activities.

Figure: Group photograph of the KOALA 2011 attendees at Trinity College
Two plenary speakers: A/Prof Joanne Etheridge from the Monash Centre for Electron Microscopy and Prof. Keith Nugent from the ARC Centre for Coherent X-Ray Science were invited to present alongside John Dyson from Starfish Venture Capitalists (thanks to the CUDOS entrepreneurship seminar series), who gave a seminar on the role of venture capitalists in entrepreneurship.

Two plenary speakers: A/Prof Joanne Etheridge from the Monash Centre for Electron Microscopy and Prof. Keith Nugent from the ARC Centre for Coherent X-Ray Science were invited to present alongside John Dyson from Starfish Venture Capitalists (thanks to the CUDOS entrepreneurship seminar series), who gave a seminar on the role of venture capitalists in entrepreneurship.

Four students were also invited to present workshops on key areas of optics that feature throughout the conference (plasmonics/metamaterials, laser fabrication, astrophotonics and x-ray optics) so that all attendees would gain a basic knowledge of other optics areas so they can better understand presentations from outside their own research fields. Several tours of local university laboratories were held alongside a tour of the Australian Synchrotron at Clayton.

Alongside the scientific program, the KOALA conference strongly encourages student networking by providing a number of social events throughout the week. A welcome reception, trivia night and conference dinner were all provided at no cost to attendees, as well as an entire day dedicated to social activities so that students could forge new relationships in a geographically isolated scientific region.

Thanks to our sponsors, registration for the conference was a flat $150 for both local and travelling students and included all accommodation, meals, social, and conference expenses. A 50% discount was available to AOS members. Several travel grants were also made available for those who had difficulty with airfares. Without sponsorship, the KOALA conference series would struggle to survive. The organising committee and attendees greatly appreciate the support of local businesses, organisations and research groups.

At the end of KOALA 2011, the baton was passed to the OSA student chapter at Griffith University back in Queensland. The conference is expected to once again be held at the end of
the year to make use of the host universities residential colleges. We encourage supervisors to support their students in attending this important scientific event, and hope that both new and existing sponsors come to support the 2012 conference.

Further information on the KOALA conference series, including reports on the four conferences to date, a copy of the KOALA 2011 program and photographs can be found at: http://www.koala2011.com

For information regarding KOALA 2012 to be hosted by Griffith University OSA student chapter in late 2012, contact President Ben Norton at: benjamin.g.norton@gmail.com
Achievements and Awards

- **Professor Min Gu** was awarded the Australian Optical Society’s WH (Beattie Steel) Medal in the IQEC/CLEO Pacific Rim, held in Sydney on 28th August to 1st September 2011.

- **Dr. Xiangping Li** received the Vice-Chancellor’s Research Award (Early Career) for research excellence for the development of a novel method for pioneering innovative storage technology - multi-dimensional optical data storage using a polarisation microscope.

- The VSASF research team, consisting of Professor Min Gu, Dr Baohua Jia, Dr Xi Chen, Dr Narges Fahim, Dr Zi Ouyang, Dr Jhantu Kumar Saha, Dr Nicholas Stokes, Dr Daniel Day, Ms Jia Lou, Ms Pierrette Michaux, and Mr Riaan Lourens received the Vice Chancellor’s Industry Engagement Award for providing cutting-edge technological services to industry and gaining industry endorsement of Swinburne’s research excellence.

- CMP postdoctoral research fellow **Dr. Stefania Castelletto** was awarded funding from the Australian Academy of Science under the Scientific Visits to Europe.

Student Awards

- The Centre for Micro-Photonics is pleased to congratulate Mark Turner for receiving student of the year award for 2011.

- CMP student Ms. Hong Kang was awarded a prestigious Chinese government scholarship for outstanding self-financed students studying abroad.

Figure: Award winner Mark Turner with his award certificates.

Figure: Scholarship award winner Hong Kang.
CENTRE ACTIVITIES

CMP at Faculty End of Year Function

*Figure:* A table CMP members (front right) enjoying the faculties hospitality at the end of year function.
Further information

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