

Optofluidics and Plasmonics

a new generation of adaptive all-optical circuits

Optofluidics – the marriage of two exciting new fields of science, microphotronics and microfluidics – and Plasmonics – “light on a wire” – are the building blocks of the science and technology that we pursue in our group. Our team is part of CUDOS, the ARC Centre of Excellence for Ultrahigh bandwidth Devices for Optical Systems, which is doing exciting research at the forefront of modern photonics. Our topics include fundamental physics projects such as the study of “slow light” in microfluidic photonic crystals through to outcomes-focused projects in new technologies for next generation optical communications and sensor systems. There are exciting opportunities for postgraduate study leading to a Masters or PhD within the group commencing in 2008. Below is a short description of potential projects, but the list is by no means exhaustive.

Reconfigurable nanofluidic photonic crystal circuits

Christian Karnutsch, Ben Eggleton

In this highly innovative project, students will combine the technology of nanofluidics together with photonic crystals, creating a platform for an advanced optofluidic technology based on integrated reconfigurable optical circuits. This new technology will lay the foundation for future innovative devices with an unprecedented level of functionality. The students will simulate, design, fabricate and experimentally investigate a suite of nanofluidic optical components, realised in silicon photonic crystal structures. A fluid infiltration process will be employed that enables the selective filling of single, nanometer-scale pores of the photonic crystal. In this way, a variety of optical functional geometries such as light-confining nanocavities and waveguides can be realised, enabling complex photonic circuits.

Plasmonic sensors

Christian Karnutsch, Ross McPhedran

Metals are typically strong absorbers of light. However, by miniaturization of photonic circuits, metallic structures can provide exceptional methods of manipulating light at length scales smaller than the wavelength – “light on a wire”. An interface between a dielectric (e.g. glass) and a metal (e.g. Silver or Gold) can support a surface plasmon, which is a coherent electron oscillation that propagates along the interface together with an electromagnetic wave. What distinguishes plasmons from “normal” photons is that they have a much smaller wavelength at the same frequency. The short-wavelength plasmons enable the fabrication of nanoscale optical integrated circuits, in which light can be guided, split, filtered, and even amplified using plasmonic integrated circuits that are smaller than the optical wavelength. These have many possible applications, including (bio-)sensing, increasing the efficiency of LEDs, nanolithography, optical storage, solid-state lighting, and optical interconnects and waveguides.

In this project, students will design, fabricate and experimentally investigate plasmonic structures for a wide range of the above mentioned applications. Additionally, students will combine the devised plasmonic devices and sensors with optofluidics to create highly versatile optical sensor systems.

Students will join the Optofluidics and CUDOS team at the School of Physics, University of Sydney and work under the supervision of senior academic staff while at the same time enjoying the benefits of close collaboration with other students, postdoctoral fellows and senior scientists. Students will also work closely with researchers at our collaborative partner Universities – the Australian National University, Macquarie University, the University of Technology Sydney, Swinburne University of Technology and RMIT University.

To join the CUDOS postgraduate program, you should have, or expect to achieve, a first class honours in Physics, Electrical or Telecommunications Engineering (or similar fields). You will hold a scholarship such as an Australian or University Postgraduate Award (scholarship support may also be available on a competitive basis from the School of Physics to students eligible for an APA/UPA award with a first class honours degree).

Other student benefits during the degree include travel support for the collaborative project as well as to local conferences and at least one overseas conference for PhD students.

Please contact Professor Ben Eggleton (egg@physics.usyd.edu.au, +61-2-9351 3604) for further information or to discuss application procedures.