PhD Studentships in the
Dept of Materials Science
University of Cambridge

This document lists project studentships which are fully funded and usually available immediately, if not then usually they are available from the start of the next academic year. The majority are available to ‘home rate fee’ paying students only.

For other information, please contact:
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Please include a CV and state your project(s) of interest.
PhD Studentships

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PhD Studentship: Lorentz Electron Microscopy and Analysis of Magnetic Skyrmions

Sponsor: EPSRC studentship – see below exact detail of awards available.
Supervisor: Prof Paul Midgley
Start date: October 2020
Duration: 3 years in the first instance

Magnetic skyrmions are an extraordinary magnetic phenomena that can be thought of as topological defects in the magnetic texture of certain materials. Cambridge is a key member of the EPSRC-funded UK-wide magnetic skyrmion project (https://www.skyrmions.ac.uk/) which aims to understand at a fundamental level the structure and dynamics of skyrmions and to develop novel magnetic devices. The project student will be an integral part of the Cambridge team collaborating with four other UK institutes to investigate the fundamental physical behaviour of magnetic skyrmions.

The project will involve TEM-based Lorentz imaging of skyrmion materials and devices using the FIB to create prototype structures. Low temperature in situ microscopy will correlate structures and composition with skyrmion lattice development and understanding better the dynamics of skyrmion motion and order/disorder transitions using applied magnetic fields and electrical bias. The project will also involve micromagnetic simulations, image processing and big data analysis. Skyrmionic materials will be readily available through the Programme grant consortium.

False colour image showing the in-plane magnetisation of a lattice of FeGe skyrmions. Field of view ca. 1um.

The minimum academic requirement for admission is an upper second class UK honours degree at the level of MSci, MEng, MPhys, MChem etc, or a lower second with a good Master’s, (or overseas equivalents) in a relevant subject.

The studentship provides a maintenance grant at the minimum Research Council UK rate and tuition fees at the UK/EU rate for students who fully satisfy the residence requirements of the UK Research
Councils. A fees-only award will be available to EU nationals who are not ordinarily resident in the UK. Students who are liable for fees at the ‘overseas’ rate are not eligible for these studentships.

An on-line application form is available at https://www.graduate.study.cam.ac.uk. Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk). Informal enquiries may be made to Prof Paul Midgley by email to pam33@cam.ac.uk

PhD Studentship: Towards Sustainable Plasmon-Enhanced Catalysis: Synthesis and Characterization of Earth-Abundant Plasmonic Nanoparticles

Supervisor: Dr Emilie Ringe
Sponsor: ERC
Start date: October 2020
Full studentship, available to ‘home rate’ fee payers only

Industries creating inorganic, organic, and agricultural chemicals use a staggering 4.2% of the worldwide delivered energy, mainly from unsustainable fossil fuels. Meanwhile, the sun provides energy that could be utilized to power photochemical reactions sustainably and cleanly. Recent advances revealing how localized surface plasmon resonances (LSPRs), light-driven electron oscillations in metal nanoparticles, can concentrate light at the molecular scale made the dream of efficient photochemistry one step closer [1-3]. However, plasmonic materials are almost exclusively constructed from the rare and unsustainable metals Ag and Au. In addition to being incompatible with current industrial practices relying on catalytic surfaces to lower energy barriers and guide reactions, Ag and Au cause prohibitive cost challenges for real-world applications. But there is hope: several of the few metals predicted to sustain LSPRs and become potential alternatives to Ag and Au are amongst the most abundant, i.e. sustainable, elements on Earth (Al, Mg, Na, K).

The plasmonic behavior of Al has been experimentally demonstrated over a decade ago, and created a new era for high energy plasmonics. Last year, we have published the first report on the plasmonic properties of colloidally synthesized Mg nanoparticles [4] and envision a plethora of discoveries and applications for this exciting new materials.

The goal of this project is to unravel and control the fundamental plasmonic properties of magnesium nanoparticles and decorated nanoparticles. As this is a completely new tool in the plasmonics toolbox, questions to answer range from very fundamental (how do we control particle shape?) to very applied (how does the plasmon-enhanced reaction rate vary with decoration by a platinum-group metal?).

A background in materials science, chemistry, experimental physics or closely related disciplines is required, however previous experience on plasmonic nanostructures is not. The student selected for this project will be trained on air-free chemical techniques, optical spectroscopy, and electron microscopy, and join a growing interdisciplinary group. Applicants should have (or expect to be awarded) an upper second or first class UK honours degree at the level of MSci, MEng (or overseas equivalents) and should be eligible for ‘home rate’ fees.


For more information contact Emilie Ringe (er407@cam.ac.uk)

Application forms and the Graduate Studies Prospectus are available from the Graduate Admissions Office at https://www.graduate.study.cam.ac.uk/. Further information on the application process is available from Rosie Ward (remw2@cam.ac.uk).
PhD projects for which funding is available from the Department on a competitive basis

New oxide interface electronics
In the last few years, there have been very exciting reports about the new functional properties which can be achieved at the interface between oxide films, e.g. there is the possibility to achieve new kinds of fast, energy efficient semiconductor processors and even possibly room temperature superconductors. This project involves exploring such phenomena. It will involve growth of ultrathin, single crystal thin films using a world leading, state-of-the-art advanced pulsed laser deposition system with in-situ diagnostic tools (XPS, UPS), followed by their measurement using a variety of means including electrical measurements, synchrotron studies, and atomic force microscopy (scanning probe) techniques.

For further information contact Prof J Driscoll (jld35@cam.ac.uk).

Applicants should have (or expect to be awarded) an upper second or first class UK honours degree at the level of MSci, MEng (or overseas equivalents) in a relevant subject (Materials Science, Physics, Chemistry) and should be liable for 'home rate' fees to be eligible for a studentship from the Department. Other competitive studentship schemes available to overseas fee paying students, deadline 3 December 2019, are described at https://www.graduate.study.cam.ac.uk/finance/funding/graduate-funding-competition.

Applications can be made on-line via http://www.graduate.study.cam.ac.uk/courses/directory/pcmmpdsm.

Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).

Oxide memristors for next generation non-volatile memory in computing
Non-volatile memory (NVM) is critical for all aspects of modern computing, as well in future generation digital technologies like the Internet of Things (IoT) and neuromorphic computing—technologies that will penetrate into many realms of society. Among NVM technologies, resistive random access memory (RRAM) based on metal oxide (MO) films as the resistive switching (RS) layers has the potential of high-speed, low operation voltage, low power consumption, and good endurance that enables the highest performance at the lowest cost possible. There are a number of challenges which need to be addressed with these materials, relating to their nanostructuring and composition. We have solved these problems in a model system and now wish to take this forward to more simple systems. This project will develop such systems. We will collaborate with a number of groups on testing and implementation of industry prototypes.

For further information contact Prof J Driscoll (jld35@cam.ac.uk).

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Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).
Three dimensional nanoscale structure of novel nitride materials and devices

The Cambridge Centre for Gallium Nitride is developing a range of photonic devices which exhibit complex three-dimensional structure. These include micro- and nano-cavities for the confinement of light and the exploration of light-matter interactions. Furthermore, we are developing nanoporous gallium nitride and incorporating it into a range of photonic architectures. For these photonic device developments to succeed, it is vital that we fully understand the three-dimensional (3D) structure of these materials and devices at the nanoscale, and this represents an exciting and challenging microscopy problem. In this project, the student will develop characterisation techniques based on focussed ion beam microscopy and transmission electron microscopy which provide detailed quantitative insight into the 3D structures of such devices. The structural insights will be incorporated into models of materials and device properties to understand what structural factors enhance or limit the performance of photonic devices and to drive the future development of improved fabrication techniques.

For further information contact Prof RA Oliver (rao28@cam.ac.uk).

Applicants should have (or expect to be awarded) an upper second or first class UK honours degree at the level of MSci, MEng (or overseas equivalents) in a relevant subject (Materials Science, Physics, Chemistry) and should be liable for ‘home rate’ fees to be eligible for a studentship from the Department. Other competitive studentship schemes available to overseas fee paying students, deadline 3 December 2019, are described at https://www.graduate.study.cam.ac.uk/finance/funding/graduate-funding-competition.

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Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).

Time-resolved cathodoluminescence measurements of carrier drift and diffusion in semiconductors

Time-resolved cathodoluminescence imaging in the scanning electron microscope is an exciting new technique for assessment of the properties of light emitting materials at the nanoscale. It gives access to the time-scales on which the process of light emission occurs, down to resolutions of a few tens of picoseconds, whilst providing a spatial resolution down to about 10 nm. In this project, we plan to extend this astounding capability still further by developing methods to allow the measurement of carrier diffusion lengths and drift velocities and the impact of local nanoscale features such as defects on these processes. The aim is for the project to assess a range of semiconductor materials, starting by using materials whose properties are well known and whose diffusion lengths are relatively large as a test system for the new technique. Thereafter – having validated the technique – the student will apply the same methodology to poorly understood semiconductor systems and push the limits of its resolution in materials with short diffusion lengths.

For further information contact Prof RA Oliver (rao28@cam.ac.uk).

Applicants should have (or expect to be awarded) an upper second or first class UK honours degree at the level of MSci, MEng (or overseas equivalents) in a relevant subject (Materials Science, Physics, Chemistry) and should be liable for ‘home rate’ fees to be eligible for a studentship from the Department. Other competitive studentship schemes available to overseas fee paying students, deadline 3 December 2019, are described at https://www.graduate.study.cam.ac.uk/finance/funding/graduate-funding-competition.

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Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).
Structure-property relationships in nitride high electron mobility transistors

Power switching devices based on gallium nitride have the potential to offer much greater efficiency than well-established silicon-based devices and to handle higher powers. However, the performance of such devices is limited by the defects and inhomogeneities arising in the nitride materials on which they are based. Device processing and the overall device architecture are also key to achieving optimal device characteristics. This project will use a range of microscopy techniques including electrical characterisation in the atomic force microscope, cathodoluminescence in the scanning electron microscopy and advanced transmission electron microscopy to explore the vital structure property relationships in nitride high electron mobility transistors intended for power switching applications. A range of device architectures will be addressed including devices transferred from their original substrates onto diamond heat sinks to reduce the negative impacts of device heating on performance.

For further information contact Prof RA Oliver (rao28@cam.ac.uk).

Applicants should have (or expect to be awarded) an upper second or first class UK honours degree at the level of MSci, MEng (or overseas equivalents) in a relevant subject (Materials Science, Physics, Chemistry) and should be liable for ‘home rate’ fees to be eligible for a studentship from the Department. Other competitive studentship schemes available to overseas fee paying students, deadline 3 December 2019, are described at https://www.graduate.study.cam.ac.uk/finance/funding/graduate-funding-competition.

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Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).

Nitride materials and devices for transfer printing and heterogeneous integration

The rapidly developing technique of transfer printing on the micro and nanoscales allows the manufacture of high quality, high performance devices on a wide range of substrates in almost any location. This highly versatile capability features a high-precision mechanical pick-and-place assembly technique that utilises the adhesive properties of soft stamps. In the context of nitride devices, micro-transfer printing has recently delivered micro-LED arrays that feature in flexible displays and provide inorganic analogues of flexible organic light-emitting diodes (OLEDs) - something that was previously thought to be extremely challenging if not impossible. However, to optimise devices and systems based on transfer printing of nitride materials, it is necessary to both optimise the nitride material for separation from its original substrate and optimise the device design so that its performance is unaffected or even improved by its integration into a heterogeneous system. This project will explore both the development of materials which allow the transfer printing of a wide range of different nitride devices, both electronic and optoelectronic, and the design of those devices to achieve enhanced performance.

For further information contact Prof RA Oliver (rao28@cam.ac.uk).

Applicants should have (or expect to be awarded) an upper second or first class UK honours degree at the level of MSci, MEng (or overseas equivalents) in a relevant subject (Materials Science, Physics, Chemistry) and should be liable for ‘home rate’ fees to be eligible for a studentship from the Department. Other competitive studentship schemes available to overseas fee paying students, deadline 3 December 2019, are described at https://www.graduate.study.cam.ac.uk/finance/funding/graduate-funding-competition.

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The University of Cambridge and the Department of Materials Science & Metallurgy value diversity and are committed to equality of opportunity.