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

PhD Studentship: Influence of Collagen Structure on Cell Function and Tissue Regeneration.

Sponsor: Wolfson-Geistlich PhD Scholarship of £20,000 per annum is available to cover maintenance and experiment consumables.

The successful candidate must be or become a student of Wolfson College, Cambridge. Wolfson admits postgraduate and mature undergraduate students, and currently has 94 nationalities among its student body. Founded by the University in 1965, the College was the first in Cambridge to admit both women and men as Fellows and students. Wolfson is sited between the growth areas of the University in West Cambridge, North-West Cambridge and the Biomedical Campus around Addenbrooke's Hospital, while a short walk from the University Library and the Sidgwick site.

The student must be educated to Master's Degree level and have a background in Materials Science, Chemistry, Biochemistry or a related subject and have experimental research experience, including techniques such as in-vitro cell culture and materials production and characterisation (such as lyophilisation, electron microscopy, X-ray microtomography).

The project involves the development of collagen-based scaffolds and surfaces for tissue regeneration. The project will explore the interplay between surface biochemistry and material structure in determining cell function and tissue response to potential implants. Surfaces and three dimensional architectures will be produced and characterised using a range of different techniques at the Materials - Chemistry - Biochemistry interface.

To apply, please send a CV and covering letter to Dr Jane McLarty, Senior Tutor, Wolfson College at senior-tutor@wolfson.cam.ac.uk. Application deadline: 12 noon on Tuesday 18 April 2017.

Candidates should also make an application to the University through the University's usual system, and will need to meet all the requirements set on any conditional offer of admission before the award can be confirmed.

PhD Studentship: Generalization and Characterization Metal-organic Framework Liquids and Glasses

Sponsor: supported by the Royal Society, with a component from Australia's Commonwealth Scientific Industrial Research Organization (CSIRO). 'Home rate' students.
Supervisor: Dr Thomas Bennett (tdb35@cam.ac.uk)

https://tdbennettgroup.wordpress.com/

Applications are invited for a PhD studentship investigating the liquid and glass-forming ability of metal-organic frameworks, under the supervision of Dr. Thomas Bennett. The project is also being supported in part by Australia's Commonwealth Scientific Industrial Research Organization (CSIRO), with the successful candidate being based in the Department of Materials Science and Metallurgy at the University of Cambridge

Their stability and malleability means glasses and organic polymers are heavily employed across the materials spectrum, in strikingly diverse applications such as DVD re-writable technology, medicine and photovoltaics. Three categories of melt-quenched glass are currently accepted: (i) inorganic (non-metallic), (ii) organic and (iii) metallic. However, we are largely unable to accurately design amorphous materials with precisely defined properties, due to the limited chemical functionality that can be incorporated into glassy substances.

Such problems of chemical limitation are not encountered in a family of materials called metal-organic frameworks (MOFs), consisting of over 55,000 compounds. These three-dimensional structures are formed from the self-assembly of inorganic nodes and organic bridging ligands, into highly ordered networks with exceptionally high surface areas (>7000 m2g-1). Whilst opportunities in e.g. gas sorption and separation, drug delivery and harmful waste storage afforded by their chemically 'tunable' structures are extensively researched, their physical behaviours are poorly understood. This group has recently shown that a selection of MOFs can be melted to form liquids, with quenching yielding glasses of high chemical tenability.

This project aims to assess a new family of MOFs for their glass-forming ability, and produce functional liquids and glasses via altering the melting of known glass-forming MOFs. Candidates will gain experience in e.g. the synthesis of hybrid materials, characterization by high energy diffraction, pair distribution function measurements and differential scanning calorimetry. Characterization of mechanical and optical properties of the glasses produced will also be pursued. As part of the project, opportunities to travel to collaborators in China, Denmark, and Australia will be provided.

References:

Bennett et al, Nat. Chem., 2017, 9, 11-16
Bennett et al, J. Am. Chem. Soc., 2016, 138, 3484-3492
Thornton et al, Chem. Commun., 2016, 52, 3750-3753
Bennett et al, Nat. Commun, 2015, 6, 8079

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 science subject (e.g. Metallurgy, Materials Science, Physics,Chemistry) and should meet the criteria for UK/EU residency and be liable for 'home rate' fees.

Application forms and the Graduate Studies Prospectus are available from the University website (www.admin.cam.ac.uk/students/gradadmissions/prospec). Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk). Informal enquiries may be made by email to Dr Thomas Bennett (tdb35@cam.ac.uk).

PhD Studentship: Characterisation and modelling of mechanical instabilities in superalloys

Sponsor: EPSRC Industrial CASE award supported by Rolls-Royce plc
Supervisors: Dr Enrique Galindo–Nava and Prof Cathie Rae

Nickel-base superalloys are employed in high-temperature structural components in aeroengines due to their excellent mechanical properties. However, mechanical instabilities, such as dynamic strain ageing and the Portevin-Le Chatelier effect, can be responsible for premature failures. This project is aimed at understanding and predicting such instabilities in advanced nickel-based superalloys. The successful candidate will carry out microscopic characterisation to elucidate the rate-controlling mechanisms and apply existing simulation techniques to predict their occurrence as a function of deformation conditions.

The project is suitable for a candidate with background in materials science, engineering, physics, applied mathematics or related disciplines. The successful candidate would have interests in combining mathematical modelling with experimentation and should be able to start by September 2017.

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 science subject (Physics, Chemistry, Materials Science) and should meet the EPSRC criteria for UK/EU residency and liability for 'home rate' fees (<https://www.epsrc.ac.uk/skills/students/help/eligibility/>) to be eligible for a studentship.

Application forms and the Graduate Studies Prospectus are available from the University website and copies of these documents are available via www.admin.cam.ac.uk/students/gradadmissions/prospec. Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).

Informal enquiries may be made to Dr. Enrique Galindo-Nava and Prof Cathie Rae by email to eg375@cam.ac.uk or cr18@cam.ac.uk

PhD Studentship: Neutron and synchrotron X-ray studies of local structure in metallic and intermetallic alloys

Sponsor: fully funded for a UK student and will run for up to four years from October 2017.
Supervisor: Dr Howard Stone (hjs1002@cam.ac.uk)

Applications are invited for a PhD studentship studying the local structure in metallic and intermetallic alloys using neutron and synchrotron X-ray scattering. The studentship is fully funded for a UK student and will run for up to four years from October 2017. It will be co-located between the Rolls-Royce University Technology Centre in the Department of Materials Science and Metallurgy at the University of Cambridge and the ISIS Neutron Source at the Rutherford Appleton Laboratory in Oxfordshire.

The majority of commercially available alloys rely on solid solution strengthening, by which atoms of different size are embedded within and distort the crystal structure, in order to improve the alloy's mechanical properties. Historically, it has been assumed that solid solutions contain a random mixture of the constituent elements. However, this is an oversimplification and regions of short-range order may form under certain conditions that can have an enormous influence on material properties. Despite its importance, such short range order is rarely characterised, owing to the challenges in performing the necessary experiments and analysing the data.

Recently, total scattering, a powder-diffraction based technique in which both Bragg and diffuse scattering are measured and analysed simultaneously, has been developed to provide detailed measurements of short-range order in alloys. This PhD studentship will build upon this research to study local order in solid solutions, precipitation of superlattice compounds and order-disorder transitions in alloy systems. The research will require the development of the existing tools to enable the analysis of systems containing preferred crystallite orientations and multiple phases. This will require the creation of simple programs (using, for example, Python or Fortran). In parallel, experimental studies of alloys will be performed using international neutron and synchrotron facilities. These will initially focus on studying model alloy systems, before extending these techniques to commercial alloys with more complex chemistries. In addition to neutron and synchrotron X-ray scattering, this work will also require metallurgical sample preparation and both scanning and transmission electron microscopy.

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 science subject (Physics, Chemistry, Materials Science) and should meet the EPSRC criteria for UK/EU residency and liability for 'home rate' fees (<https://www.epsrc.ac.uk/skills/students/help/eligibility/>) to be eligible for a studentship.

Application forms and the Graduate Studies Prospectus are available from the Board of Graduate Studies web site and copies of these documents are available via www.admin.cam.ac.uk/univ. Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).

Informal enquiries may be made by email to either Dr Howard Stone (hjs1002@cam.ac.uk) or Dr Helen Playford (helen.playford@stfc.ac.uk).

PhD Studentship: Nickel-base superalloys for additive manufacturing

Sponsor: supported by Rolls-Royce plc through an iCase award. 'Home rate' students.
Supervisor: Dr Howard Stone (hjs1002@cam.ac.uk)

Applications are invited for a PhD studentship investigating the additive manufacturing of nickel based superalloys. The studentship is fully funded for a UK student, will run for 4 years and can start from October 2017. It will be run in close collaboration with Rolls-Royce plc and will be located at the Rolls-Royce University Technology Centre in the Department of Materials Science and Metallurgy at the University of Cambridge.

Additive manufacturing, in which engineering components are built in a layer-wide manner from alloy powders, is opening up the possibility of new, more complex component designs. In civil aviation this may be translated into more efficient gas turbine engines. However, many of the high performance nickel-based superalloys currently used in the hot sections of gas turbine engines are not amenable to processing by such techniques and modified compositions or new alloys are required. In this project, the microstructures of selected nickel-based superalloys processed by additive manufacturing will be studied. The results obtained will be used to guide compositional modifications that will improve the amenability of these alloys to processing by these methods and these will be assessed through processing trials.

The research will require examination of the alloys using a range of techniques including electron microscopy with EDS & WDS, X-ray diffraction and mechanical testing.

Applicants should have (or expect to be awarded) a good honours degree in a relevant science subject (Physics, Chemistry, Materials Science) and should meet the EPSRC criteria for UK/EU residency and liability for 'home rate' fees.

Application forms and the Graduate Studies Prospectus are available from the University website and copies of these documents are available via www.admin.cam.ac.uk/students/gradadmissions/prospec. Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).

Informal enquiries may be made to Dr Howard Stone by email to hjs1002@cam.ac.uk

PhD Studentship: Transformation Stability of Superelastic Titanium Alloys

Sponsor: supported by DSTL through an ICase award. 'Home rate' students.
Supervisor: Dr Nick Jones (ngj22@cam.ac.uk)
http://www.rrutc.msm.cam.ac.uk/directory/nick-jones

Applications are invited for a PhD studentship investigating the transformation stability of superelastic beta titanium alloys under the supervision of Dr Nicholas Jones. The project is being run in close collaboration with the Defence Science and Technology Laboratory, with the successful candidate being based in the Department of Materials Science and Metallurgy at the University of Cambridge.

Superelastic materials have great potential as the basis for high frequency damping systems as the martensitic transformation that gives rise to the phenomenon is fully reversible and occurs at near sonic velocities. However, room temperature testing of existing superelastic alloys has identified a drift in their behaviour when subjected to cyclic loading. Recent studies have shown an accumulation of permanent strain within the first few cycles, thought to be a result of defect generation necessitated by the transformation, but little is known about the long-term stability of the behaviour over several thousand cycles. Transformation stability is a key issue if these materials are to be successful in engineering applications, so identifying the source of the defects, characterising their generation and evolution, as well as understanding how they influence subsequent transformation cycles is extremely important.

Using a combination of electron microscopy and high energy diffraction this project aims to assess the build up of damage within superelastic titanium alloys as a function of cyclic loading, track the evolution of microstructure and identify the key mechanisms causing the degradation in properties. From this data, potential routes, both compositional and microstructural, to improve the stability of these materials will be developed.

Applications need to be a UK national and should have (or expect to be awarded) a good honours degree in a relevant subject (e.g. Metallurgy, Materials Science, Physics, Chemistry) and should meet the EPSRC criteria of UK/EU residency and liability for 'home rate' fees.

Application forms and the Graduate Studies Prospectus are available from the University website (www.admin.cam.ac.uk/students/gradadmissions/prospec). Further information on the application process is available from Dr Rosie Ward (remw2@cam.ac.uk).

Informal enquiries may be made by email to Dr Nicholas Jones (ngj22@cam.ac.uk).

PhD Studentship: Exploring new Chemically Processed, Scaleable and Stable Bi-based Inorganic Photovoltaics Films

Sponsor: EPSRC funded PhD Studentship.

A 4 year PhD studentship is available from October 2017 or earlier for this project which will be carried out under the supervision of: Prof. Judith Driscoll, Dr. Robert Hoye and Dr. Dan Credgingon, Departments of Materials Science, and Physics, University of Cambridge, within the EPSRC Centre for Doctoral Training in New and Sustainable Photovoltaics (https://www.liverpool.ac.uk/new-and-sustainable-photovoltaics/).

Applicants must meet the EPSRC residency criteria (<https://www.epsrc.ac.uk/skills/students/help/eligibility/>) to be eligible for this studentship.

The photovoltaics field has been revolutionised by the emergence of lead-based hybrid perovskites. These materials are high quality semiconductors that can be deposited cheaply, from solution, at room temperature. However, the toxicity of lead and stability issues for these perovskites are driving a new search for more benign and stable alternatives. We have been exploring BiOI as a possible lead-free contender material. To date, nanostructured BiOI has been explored in photovoltaic devices but has shown poor efficiencies (maximum 1.03%) as a result of low photocurrents,[1–3] likely because of high interfacial recombination and/or poor transport properties. However, film growth has yet to be optimised for achieving high efficiency. The growth of large-grained crystalline films combined with nanostructured geometries to give short transport lengths may reduce both of these effects and so represent a route to devices with improved performance.

We have recently deposited BiOI thin films by chemical vapour transport (CVT) at temperatures as low as 300°C, with the growth of phase-pure, micron-sized grains demonstrated (fig. 1a and b). Measurements of the photoluminescence decay indicate a bulk lifetime of approximately 3 ns (fig 1c), which well exceeds the 1 ns lifetime threshold need to potentially achieved 10% efficient [4]. The bandgap is measured to be 1.9 eV through absorption measurements and spectrally-resolved photoluminescence measurements. Although this bandgap is too wide for a single-junction device, it is ideal for a top-cell absorber in a four-terminal tandem with silicon. We have also found BiOI to be phase-stable in air over a 200-day test period, which is two orders of magnitude better than methylammonium lead iodide perovskite.

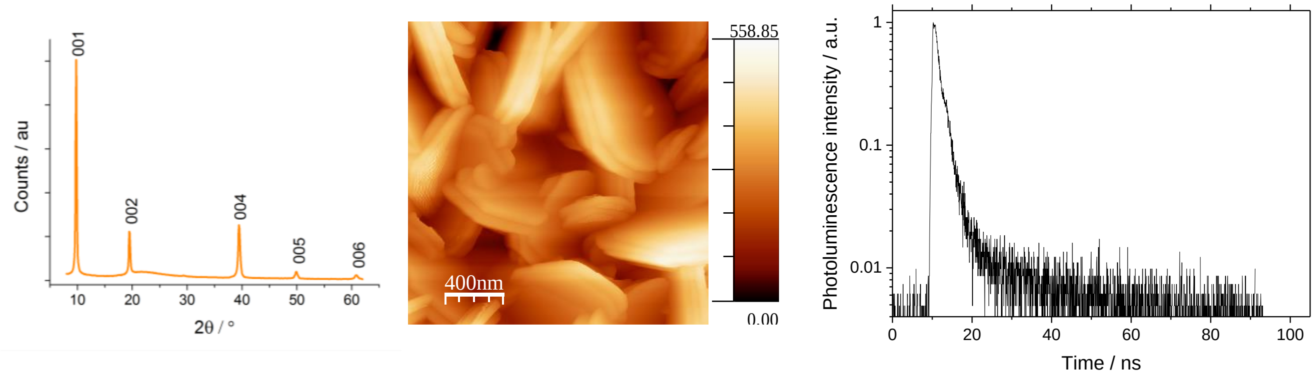

Figure 1 a) X-ray diffractogram b) AFM micrograph and c) time resolved photoluminescence decay of a BiOI film grown at 350°C by CVT on a fused silica substrate.

The proposed PhD project will study the effect of systematic doping of BiOI with chalcogenides S and Se on the optical and electronic properties of the films. Literature suggests that substitutional doping of O with other chalcogenides results in a reduced bandgap, making it more suitable for a single-junction device.[5] Growth will be explored initially by CVT, and also by liquid phase epitaxy (LPE). We have great expertise with both methods for Bi-based perovskites and other oxides.[6–8] The aim is to form idealised microstructures in large area, chemically grown thin films and in doing so optimise the physical properties (i.e. tune the bandgap in the range of 1.9 - 1.5 eV) and optimise transport properties (i.e. maximise the charge-carrier mobility and minority-carrier lifetimes in films) to give long diffusion lengths. XRD and AFM will be used to study the effects of doping on the structural properties of the films, as well as to determine deposition parameters leading to maximised grain sizes and high film crystallinity. UV-visible spectrophotometry will be used to measure the bandgap. Hall-effect measurements will be used to study film mobility. Minority-carrier lifetimes will be determined by time resolved photoluminescence measurements, while photoluminescence quantum yield measurements of films on a range of charge transport materials will be used to aid the choice of optimum charge transport materials for photovoltaic devices. The data will give insight into routes to improve the transport properties and minority-carrier lifetimes in BiOI and related films, and to maximise charge extraction at device interfaces, all of which should provide a route to more efficient photovoltaic devices.

References:

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2. K. Wang, F. Jia, Z. Zheng, and L. Zhang, Electrochem. commun., 2010, 12, 1764–1767.
3. M. Fang, H. Jia, W. He, Y. Lei, L. Zhang, and Z. Zheng, Phys. Chem. Chem. Phys., 2015, 17, 13531–13538.
4. R. Jaramillo, M. J. Sher, B. K. Ofori-Okai, V. Steinmann, C. X. Yang, K. Hartman, K. A. Nelson, A. M. Lindenberg, R. G. Gordon, T. Buonassisi, Journal of Applied Physics, 119.
5. N. T. Hahn, A. J. E. Rettie, S. K. Beal, R. R. Fullon, and C. B. Mullins, J. Phys. Chem. C, 2012, 116, 24878–24886.
6. X. Qi, J. Dho, M. Blamire, Q. Jia, J. L. MacManus-Driscoll, J. Magn. Magn. Mater., 2004, 283, 415–421.
7. M. Li, A. Kursumovic, X. Qi, and J. L. MacManus-Driscoll, J. Cryst. Growth, 2006, 293, 128–135.
8. K. P. Musselman, S. Albert-Seifried, R. L. Z. Hoye, A. Sadhanala, D. Muñoz-Rojas, J. L. MacManus-Driscoll, and R. H. Friend, Adv. Funct. Mater., 2014, 24, 3562–3570.

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.

Further information on the application process is available via
http://www.admin.cam.ac.uk/univ/gsprospectus/applying/ or from Dr Rosie Ward (remw2@cam.ac.uk).

Enquiries about the scientific nature of the work should be addressed to Professor Judith Driscoll (jld35@cam.ac.uk)

The University of Cambridge and the Department of Materials Science & Metallurgy value diversity and are committed to equality of opportunity. The University holds an institutional Athena-SWAN silver award and the Department is a bronze award holder.