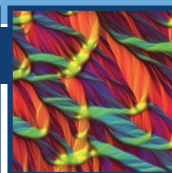
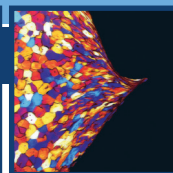


Teaching Matters



Now that two terms have passed since the move west, it is time to report on teaching and our new teaching facilities.

There had been concerns that moving out of town would adversely affect student numbers. On this year's evidence all is well, with first to fourth year numbers of 268, 83, 33 and 22 respectively. To the fourth-year Cambridge undergraduates must be added three incomers taking Part III as a graduate course for the Master of Advanced Studies degree.

Given the multi-subject nature of the first two years of the Natural Sciences Tripos undergraduates have to be able to get from lecture to lecture in very little time, so our lectures in those years are still given in town. This year Part IA lectures are being given in the Physiology Department and Part IB in Chemistry. On the other hand, practical work for all years takes place in the new building and this has required major changes in Part IA. For over 50 years first-year undergraduates took two two-hour practicals each week, with many of the two-hour sessions slotted into mornings amongst lectures. Ahead of the move it was recognised that this would no longer be viable; instead students take a single three-hour, afternoon session per week. In higher years the new building becomes "home", and a

good choice of lunch-time sandwich deliveries has proved essential.

All the new teaching facilities are on the ground floor. The seminar rooms, where Part II and Part III lectures take place, form the Goldsmiths' Suite, partially funded by the Goldsmiths' company, where, incidentally, one can now find the plaque from the old Goldsmiths' Laboratory. The Anne Glover IT Suite offers facilities for private work as well as examples classes and small group teaching. On one wall of the corridor leading to the Practical Class, where Dave Saul is now senior technician, is a series of strength-density Ashby charts kindly donated by Granta Design showing the development of materials from 50,000 BCE to the current day. The student reaction to working in the brand new Ann D Foundation labs (pictured on day one for Part IA) has been very positive. The Library, close to the Practical Class, contains the collection of books useful for all Parts of the Tripos (much of the collection of advanced books and journals has been moved to the Moore Library under the University's policy of centralising printed collections now that so many publications are available electronically).

For information about current courses, including Master's and Doctoral courses for graduates, visit:

www.msm.cam.ac.uk/teaching/index.php

Editorial

At the time of writing, we have been in the new building somewhere between six and nine months (depending on when each move was scheduled). At the same time the surroundings have changed from a construction wasteland into something resembling a campus with lots of formal planting and some new, improbably green, turf. While most of the building is fully operational, there still remains a long list of faults to be fixed and problems of reliability. Despite this, there are clearly many positives associated with being in the new building, not least the new undergraduate teaching space described here.

The Department is now also getting to the point where we can start to think about hiring new academic staff to replace those who have retired in recent years. Recruiting academics is inevitably a slow process, but hopefully forthcoming issues of *Material Eyes* will be able to introduce some new staff.

Professor Mark Blamire,
Head of Department



UNIVERSITY OF
CAMBRIDGE

Department of Materials
Science and Metallurgy

27 Charles Babbage Road
Cambridge CB3 0FS

msm.cam.ac.uk

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Novel Nano-Interfaces

Issue 22 two years ago led with a brief description of the kinds of grant available from the European Research Council and outlined the Department's success in obtaining "Starting Grants" and "Advanced Grants". Here we report on progress with one example, the ERC Advanced Grant awarded to Professor Judith Driscoll to investigate nanoscale oxide materials for novel electronic functionalities under the title *NOVOX*, Perfectly interfaced materials – the key to next generation oxide electronics. The grant runs for five years, and has a year and a half left to run. Judith reports that she has found the ERC grant to be wonderfully flexible allowing her to do blue skies research and change directions as new discoveries have been made. Her main focus has been in the area of self-assembled nanocomposite structures in oxide thin films.

Judith has set out the principles of self-assembly in composite films, to predict systems which should have strongly enhanced functionalities, and then grow and measure them. The forms of the structures and their length-scales can be tuned from ~3 nm to over 50 nm by choice of the appropriate compositions and conditions. This is an entirely new



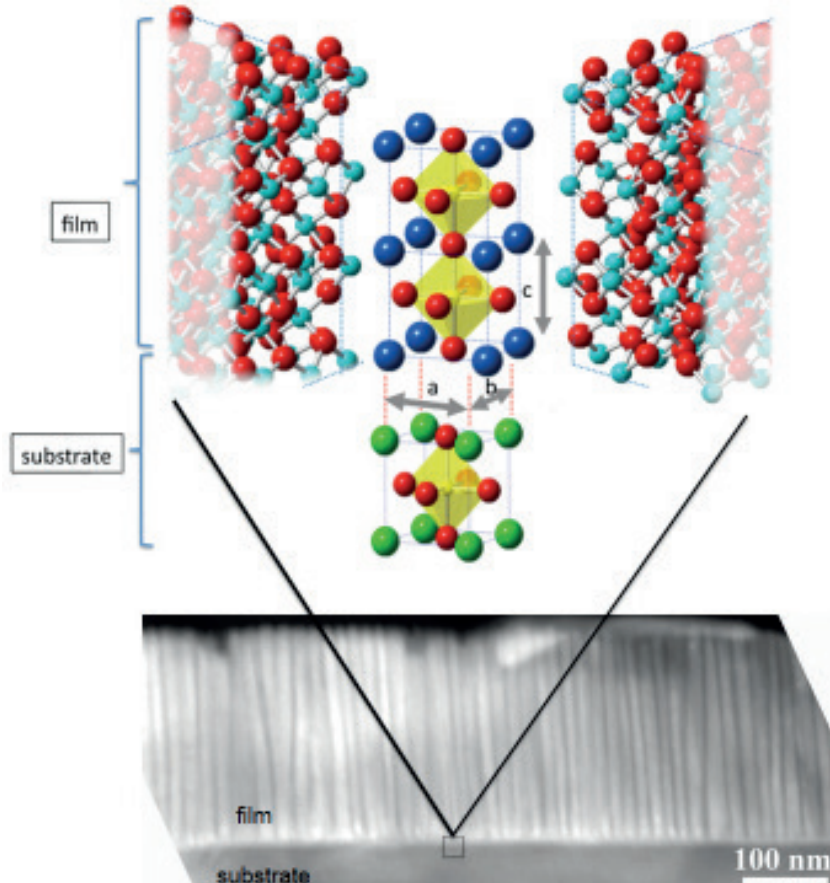
HRH The Duke of York in conversation with PhD student Claire Armstrong and Professor Judith Driscoll during a visit to the Department on the 31 October 2013

playground in thin film research which could have a major impact in a number of technological areas in future. Indeed she says, "We have already demonstrated unprecedented functionalities/multifunctionalities in several functional systems, including ferroelectric, magnetics, superconductors and memristive systems. For example, in ferroelectric BaTiO_3 we have increased the operation temperature of the material from 120°C to ~800°C and have subsequently demonstrated

an actuator device which has better high temperature performance than any other known material, while also being environmentally friendly. In a related system, we have also demonstrated the highest tunability, low loss dielectric thin film system. The property improvements arise both from the new strain mechanisms which are created in the composite films, as well as from interface coupling effects."

Considering the wide range of functional materials whose properties can be enhanced, there is very wide applicability in a number of high technology areas, from electronics to energy. Hence, the work could have a major impact in future. At present, the work is quite radical and Judith believes that it will take time for people to digest it fully. On the other hand, there is already industrial involvement in one area, and it is hoped that the several patents she has filed on this work will lead to new licences in the near future. In addition, several groups in the Far east have taken it on board and so the number of publications in the field is growing rapidly.

Judith adds "Focusing on just one of the applications areas, random access memory (RAM), very recently we have innovated composite films showing radically improved memristor behaviour, with the first ever electroforming-free devices made by creating a perfect, self-assembled nano-comb architecture (see figure). New kinds of RAM are also possible when the magnetic properties of materials can be tuned by application of an electrical field. Here, we have designed several different nanocomposite film structures and compositions with unprecedented properties. This work opens a new window on materials combinations and self-assembly approaches for novel kinds of non-volatile magnetoelectric RAM devices."



Schematic cross section of crystal structures of nanocolumn composite thin films on substrate, plus real image of film below

World Rankings

Cambridge was pleased to be placed second equal for Materials Science in the World University Rankings by Subject recently announced by QS. Furthermore we were pleased that graduates from this Department occupy senior positions in MIT, the first-placed department, where Caroline Ross (BA 1985, PhD 1989) is Associate Head and in Stanford, joint second, where Robert Sinclair (BA 1968, PhD 1972) is Department Chair.

Welcome to

Erica Bithell: Affiliated Lecturer to the Department for two years; Erica is also Academic Director for Physical Sciences at the Institute for Continuing Education and a Director of Studies at Murray Edwards College.

Paul Mantle: Knowledge Transfer Facilitator

Tony Fox: Health and Safety Technician

Landmines to Diplomacy



Already in the Royal Engineers when he entered St John's, Jon Mullin graduated from the Part II Class in 1981 and returned to the Army, eventually retiring with the rank of Brigadier in December 2012 after 37 years

of service. On hearing of his retirement from what these days is a relatively unusual career for our graduates we asked him to reflect on how his Cambridge education in Metallurgy and Materials Science (as our subject then was) had been applied over those years? Had it been of practical benefit? Where had it been of use? In reply he kindly provided this account of his career.

"On reflection, I am inclined to say that I drew on my Cambridge legacy on a daily basis. The reservoir of knowledge gained from the breadth of the Natural Sciences Tripos and the developed ability to solve wide-ranging complex problems through both getting into the ballpark and then seeking elegant solutions has been invaluable.

As a Royal Engineer, I was involved in managing many projects again aided by the rigour and structure taught in the Department. Indeed, it was less than

a year after graduating that I had my first technical test with the non-metallic landmines that we encountered in the Falklands War. After the surrender, I was responsible for making safe the extensive minefields laid by the Argentinians and I would like to think that my reference document from 1982, which is still in use today, would have gained me some credit as a Part II project. It included initial experimental work to determine detectability, documenting of records and methodologies, and mapping of the actual locations.

Commanding the Royal Engineers Parachute Squadron and my Regiment in Hameln Germany were great highlights. They were fun times, but quite demanding as the commander is personally responsible for such a breadth of activities. Here again, Cambridge taught me to always think through the wider implications and at worst I had a good damage limitation strategy prepared before others had considered things fully! At best, I would like to think that it helped in saving many lives during the ethnic cleansing in Kosovo in 1999.

Nevertheless, the bulk of my staff jobs were in Defence Acquisition and in mid-career I attended a year of specific technical education and training at the Royal Military College of Science at Shrivenham. It was after this time that I became involved with industry and one of my projects was setting the requirements for bridging systems utilising a wide range of materials from high strength steels to age hardened aluminium alloys. In several appointments I was involved with balance of investment decisions for composite materials for bridging, vehicles and novel armours. Similarly, protection and detection techniques for explosives and specific devices featured high on the agenda in more than one staff appointment. At a later and more senior stage, I was even the operational focus for Porton Down's force protection research programme.

In all of these areas, and in the making of a number of risk management decisions on operations, being scientifically literate was vital and hopefully enabled me to make good judgements.

My last job in the Army – as a director of the European Defence Agency – saw involvement with prioritisation of defence research and linkage with the European Framework Programme for research amongst many other projects and the rigours of diplomacy. It was a great finale to a career that so frequently fell back on the priceless gift of a Cambridge education and the specific teachings of the Department for which I remain eternally grateful."

New Year's Honours 2014

We are delighted to report that two of our graduates gained recognition:

Professor Helen Atkinson (Bavister) (BA 1981) CBE for services to Engineering and Education and **Estelle Rowe** (Wenble) (BA 1979) MBE for services to Education.

Sad Farewell

We were greatly saddened to learn of the death of Gareth Thomas (PHD 1956, ScD 1969) on 7 February. Gareth was a very distinguished electron microscopist and a great character. A brief obituary is available at

<http://goo.gl/4I3LV4>

A Tale of Two Rooms

We are delighted to report that on 29 November 2013 the Prime Warden of the Goldsmiths' Company, Richard Agutter, formally opened the Goldsmiths' Company Teaching Suite (pictured below with Sir Colin Humphreys).

And on 19 March 2014, the Armourers and Brasiers Meeting Room was opened by Master of the Company, Jonathan Haw (pictured below).



The Department is always pleased to hear from alumni, especially ones in materials-related companies, who are keen to make contact with our undergraduates through industrial visits or sponsorship or coming to give talks. Anyone interested should contact Noel Rutter, Director of Undergraduate Teaching at: nar20@cam.ac.uk



Cornwall, Campinas and Composites

In 1976 Bill Clyne completed a PhD on solidification cracking in aluminium alloys supervised by Graeme Davies and then, for nine years, pursued a peripatetic academic career. In the 1970s, Graeme had established strong links with Brazil and this led to Bill taking up a post in the University of Campinas where he lectured for three years - in Portuguese - and supervised several PhD students. He then joined the EPFL in Lausanne, now giving some presentations and classes in French, before moving in 1981 to a lectureship in the University of Surrey, where Tony Kelly was then the Vice-Chancellor and Peter Goodhew was a Departmental colleague. It was in Guildford that his and Gail's two daughters were born. In a final move, he returned to Cambridge in 1985 as a University Lecturer and Fellow of Downing. Since then Bill has maintained vigorous activity in research and teaching in the Department, being promoted to Professor in 1999, and has filled several rôles in Downing. Not infrequently some of the many national and international contacts made between 1976 and 1985 have proved of benefit to the Department.

In research, his interests include composites and coatings, especially plasma-sprayed thermal barrier coatings where Kevin Roberts' expertise in the Process Lab has proved invaluable. About 70 students have successfully gained PhDs in Cambridge under his supervision. With Bill Clegg he established the Gordon Lab in the



Department, initially funded by DERA but now providing a framework for industrial collaboration. Internationally he has been involved with the Federation of European Materials Societies for a decade, serving as its President for a time. In teaching, he has given a wide range of lecture courses and, as Deputy Head of Department, he chaired the Teaching Committee for seven years up to summer 2013. Of particular note he has played a major part in the creation of web-based teaching resources in Materials, nationally with Peter Goodhew in Liverpool and locally with the DoITPoMS project. In Downing he served for 10 years as Dean and five as Admissions Tutor. In the latter capacity, he was instrumental in initiating the scheme by which different Colleges target different geographic areas of the UK within the Access Initiative and Downing

took on the South West of England, Bill's home territory!

From Saltash Comprehensive School in Cornwall, Bill came up to St John's in 1970 where he admits to being (admirably) influenced in his choice of route through the Natural Sciences Tripos by Jim Charles and John Leake. He also played soccer for the College over a six-year period; as a result he was elected to – and remains a member of – the College's Eagles Club. Since then Football has been replaced by skiing and punting; for many years an annual skiing trip was a major feature of his research group's social activities, now summer punt parties promote group bonding.

Congratulations

Paul Midgley, Fellow of the Royal Society

Harry Bhadeshia, Belgian Francqui Chair 2013-14, Katholieke University, Leuven

Bartek Glowacki, the Order of Polonia Restituta

Colin Humphreys, Honorary Fellowship of the Royal Microscopical Society

Tony Cheetham, The American Institute of Chemists 2014 Chemical Pioneer Award

Lindsay Greer, Max Planck Lecture 2014 (Stuttgart)

Xavier Moya, Senior Research Fellow, Churchill College, from 1 October 2014

Rowan Leary, Junior Research Fellow, Clare College from 1 October 2014.

Kai Xi, Shuai Cao and Xiaou Peng, 2013 Grand Prize of the DOW Sustainability Innovation Student Challenge Award (SISCA) for their work on Li-S batteries

Editorial team: John Leake, Mark Blamire and Rachel Hobson **Comments to:** rjh24@cam.ac.uk

The Department has networking groups on *LinkedIn* and *Facebook*.

If you would prefer to receive your copy of *Material Eyes* electronically please email rjh24@cam.ac.uk