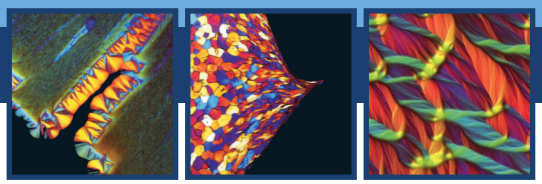
Cambridge
materialeyes

Summer 2010 Issue 19



SKF University Technology Centre

In May last year SKF, a leading global supplier of bearings, seals, mechatronics, services and lubrication systems, announced agreement with the University to set up the SKF University Technology Centre (UTC) on *Steels for Bearing Applications*, initially for five years. In liaison with SKF, research in the UTC is directed by Harry Bhadeshia, who has been known to Alan Begg, SKF Senior Vice-President, Group Technology Development and Quality, for many years. Since May, Harry has been joined by Pedro Rivera as Assistant Director of Research and several researchers.

Bearing technologies demand new materials to satisfy increasingly demanding requirements on energy efficiency, durability, cost and reliability. Success requires an improved understanding of high-performance engineering alloys. Research in the UTC focuses on steels and the heat treatments associated with advanced bearing technology. Specifically the aims are to develop concepts and technologies to:

- understand microstructure-property relationships in high-performance steels more fully;
- develop new heat treatments and compositions to produce steels satisfying the demands of new technologies.

Research in the UTC has already been complemented by visits to SKF facilities abroad and an intensive workshop in Cambridge.

David Duke MBE

2010 got off to the best possible start with the announcement in the New Year Honours List of an MBE for David Duke for services to science. Many of us have long known that Dave, our Principal Technician, is the real secret of the Department's happy spirit and research success, so it is excellent to see his hard work given appropriate recognition. He is responsible for all aspects of departmental infrastructure, and is head of the technical and assistant staff. He joined the Department in 1964, and took up his present post in 1993. Since 1964 our annual research expenditure has grown from £637k (at today's value) to £7,833k. This growth in volume

of research has been matched by increasing diversity. There has been an obvious increase in the importance and complexity of the role of the Principal Technician in providing the infrastructure to support this growth, especially given great constraints on accommodation. Dave's combination of resourcefulness, can-do spirit and indomitable good humour are appreciated at all levels of the Department. His efforts shine through also in his regular barbecues and his Christmas extravaganzas, all of which enhance the Department's reputation for cohesion. Dave has also deployed his energy and good humour to great effect in his home village of Teversham.

Editorial

We are especially pleased that SKF's foresight to invest in research has led to the inauguration of their new technology centre in our department. Other aspects of our thriving research feature in articles by two of our graduates (pp. 2 & 3). We are fortunate to sit in a supportive broader scene at Cambridge: avid readers of THE (issue of 11 Mar 2010), will have noted that Cambridge is the only UK representative in the ranking of the top 20 institutions in materials science. Comparing with other universities, Cambridge is behind only MIT and UC Berkeley, and is ahead of UC Santa Barbara, in numbers of citations, Jan 1999 to Oct 2009. To perform at this level requires excellent support from the technical staff, and we are overjoyed that David Duke's leadership has been recognised with an MBE. Of course, David and his colleagues have to work very hard indeed to maintain the infrastructure in our present accommodation. In this regard, we are all looking forward to our new purpose-designed building at West Cambridge. Our move, now mandated by the University, will cost roughly £46M. We are very grateful to the Wolfson Foundation for a generous donation of £2.25M, and are excited to be embarking on such a landmark project.

Professor Lindsay Greer, Head of Department

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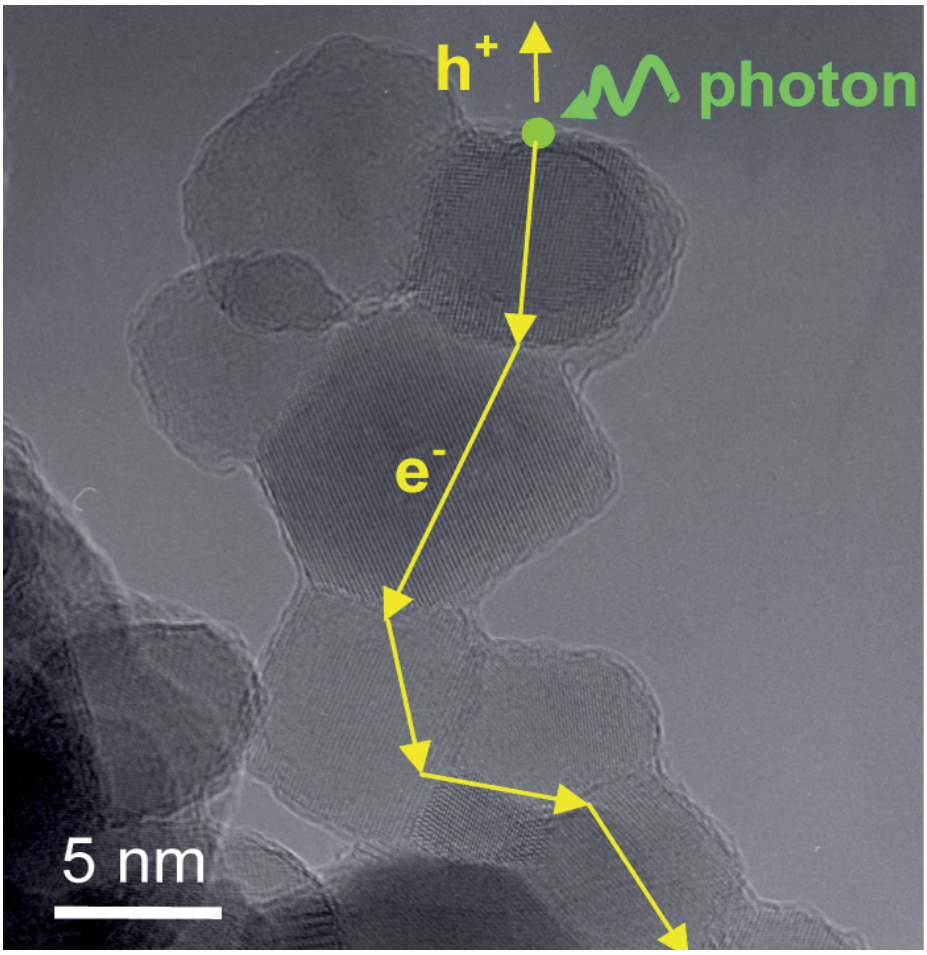
Inside:

Demanding New Materials

A growing worldwide interest in renewable energy has spurred research and development in many fields. The sunlight continuously reaching the earth is a tremendous source of energy (averaging roughly 1 kW m^2 at normal incidence). Photovoltaics (PVs), i.e. solar cells, are commercially available, and dozens of start-up companies have emerged to exploit their potential for energy harvesting. Nevertheless basic research must still be done to make PVs less expensive and more efficient. The Cambridge Materials Department is making significant contributions:

At present silicon PVs lead the market with impressive efficiencies of over 20%, but they are still too costly to compete with fossil fuels for large-scale power generation. Much (nearly 50%) of the cost of these devices is that of producing device-grade silicon (99.9999% purity). Using current technology, purification and refining take place above 1,900˚C and release 45 tonnes of CO_2 for every tonne of silicon produced. The CO_2 arises mainly from SiO_2 reacting with coke to produce Si and CO_2. Making Si PVs is also energy-intensive; their energy payback time is estimated to be up to a quarter of their useful lifetime of around 20 years. Derek Fray and Anthony Cox aim to produce device-grade silicon from lower-energy, lower-carbon processes. Their electro-deoxidation of SiO_2 at moderate temperatures results in Si that is 99.9% pure. They can then electro-refine this material, using low applied voltages and temperatures as low as 800˚C, to remove contaminants like boron and phosphorus, resulting in device-grade silicon. If successful, this method could slash the environmental impact of solar-cell production, reducing the energy cost by 75-85%, and the CO_2 output by over 93%.

Judith Driscoll's group approaches PVs from a different angle, using inherently inexpensive materials: metal oxides and polymers. Metal-oxide devices and "hybrid" organic/oxide devices are made using low-cost materials and low-energy techniques. Materials explored include n-type oxides, like ZnO and TiO_2, and highly-absorbing p-type oxides like Cu_2O; together these can form a p-n junction and function as a solar cell. This research on low-cost Cu_2O solar cells is supported by the International Copper Association. New atomic-layer deposition techniques, have allowed Judith's team to process high-quality material under atmospheric conditions. Semiconducting polymers are soluble at low temperatures and can be coated onto many kinds of surfaces. Judith's group has exploited her expertise on functional oxide materials to understand the impacts of defect chemistry, carrier concentration, and nanostructuring on their devices. They identify the factors that limit efficiency and employ novel nanostructures to improve performance. Others at Cambridge, such as the Optoelectronics group in Physics, Andrea Ferrari's group in CAPE, Mark Welland's group in Nanoscience, and Wilhelm Huck's group in Chemistry, have made great contributions in a related field: all-organic PVs, again a promising low-cost avenue.



Schematic of electron-hole photogeneration and transport in anatase TiO_2 nanoparticle photovoltaics (on a high resolution TEM image by Cate Ducati)

Dye-sensitized PVs offer another promising alternative to Si-based devices. They are made by adsorption of dyes onto a high-surface-area metal-oxide scaffold, often made by fusing nanoparticles together. Light excites the dyes, which inject electrons into the scaffold. The oxidized dye molecules are then reduced by an electrolyte and the process starts again. Electrons that have been injected are conducted through the scaffold and collected at an electrode.

Many factors contribute to the efficiency of these processes, which take place over a range of time and length scales. The nanoscale structural and electronic properties of the metal-oxide scaffold, for example, play a major role in device operation. How do the nanocrystalline grains come together to form the scaffold? What is the nature of the metal-oxide surface? What are the most common defects in these oxide crystals? Such questions determine how well charges will be able to enter and traverse the oxide, often "hopping" from one grain to the next, to reach an electrode.

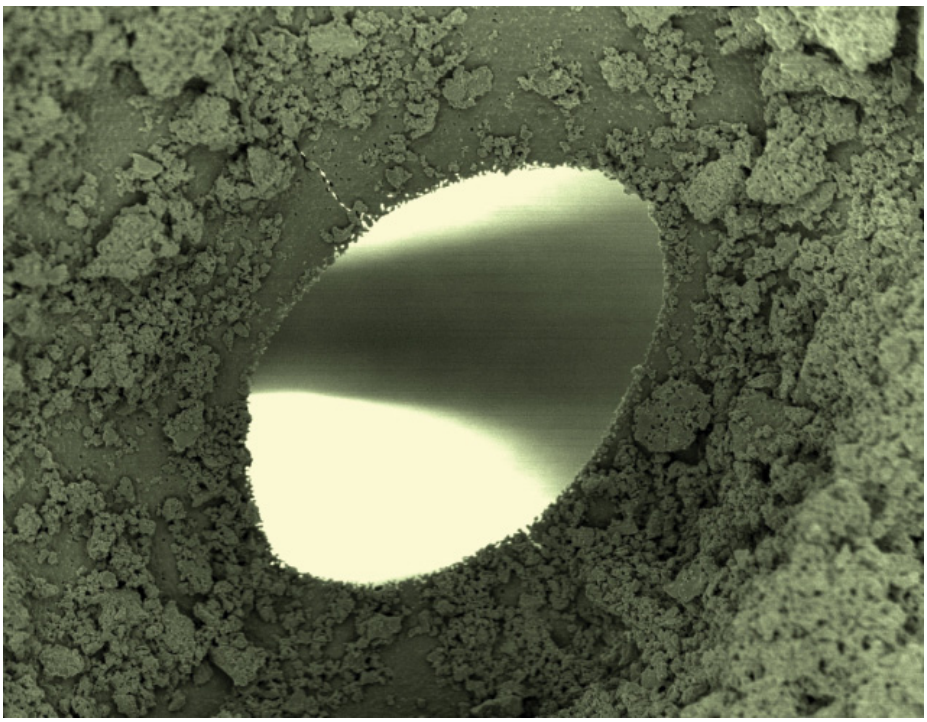
Cate Ducati is attempting to answer these questions. Her group exploits transmission electron microscopy (TEM) for sophisticated structural and electronic characterization of the oxide as it responds to light. Ultimately, she aims to map a PV device in situ in the TEM, comparing its behaviour in light and dark to show how it works. By correlating nanostructure properties with macroscale device operation, Cate and her group hope to demonstrate how to make more efficient solar cells.

As should be clear, researchers in the Department are tackling PV research from a variety of perspectives and with a variety of goals, focusing on making more efficient solar-cells with lower energy cost. With such minds at work, solutions to many problems are already in prospect.

Talia Gershon (2009-)

Successes in Biomedical Materials Science

Since it was established the Cambridge Centre for Medical Materials (CCMM) has developed significantly, directed initially by Bill Bonfield and now jointly by Ruth Cameron and Serena Best, whose personal chairs took effect in October 2009 (see *Material Eyes*, **9**, 2000 and **16**, 2007). Today the Centre has around thirty members including doctoral students, postdoctoral researchers and administrative and technical support. Fundamental to the Centre is research on bioactive ceramics and glasses for coatings and implants, polymers for cartilage and ligament repair and resorbable polymers and composites for bone fixation, tissue engineering and drug delivery. While CCMM members have an established record in these areas, under the direction of Serena and Ruth research has steadily expanded to address a wide range of new biomedical challenges, including nerve-regeneration scaffolds, artificial mammary tissue and the use of bioactive peptides for controlled cellular interactions. This continued advancement of CCMM's programme is demonstrated by the diversity of current projects, some of them highlighted here.



Biomimetic scaffolds for artificial mammary tissue

The most common cancer in the UK is breast cancer with more than 125 women diagnosed every day (*Cancer Research UK (2009): CancerStats report – Key Facts - Breast)*. Understanding the development of this disease and the effectiveness of drug treatments in a biological system can require the sacrifice of animals during *in vivo* studies. There is a national effort to reduce the number of study animals and to replace them with effective alternatives. Natalia Davidenko, a postdoctoral research scientist in CCMM, is working on an *in vitro* alternative to the use of animals, namely artificial mammary tissue. The engineering of a synthetic tissue is complex and Natalia notes it can be "difficult to achieve *in vitro* that which a living organism does normally". The project addresses this complexity through an inter-disciplinary collaboration with the Cambridge Department of Pathology and the Strathclyde Institute of Pharmacy and Biomedical Sciences in Glasgow. Natalia is developing and characterising a 3-D macromolecular matrix where a co-culture of cells can grow and differentiate. The resultant tissue could contribute not only to the reduction of animal studies, but also to replacement material for diseased breast tissue.

Biodegradable, bioactive bone-implant coatings

In orthopaedics, the rising number of hip and knee implants has stimulated worldwide efforts to develop improved bone biomaterials. Under the 6th European Framework Programme for Research and Technological Development, a multinational collaboration has been formed between bone-biomaterials researchers from the University of Cambridge and over sixteen other Universities and companies across the European Union. A member of this team, CCMM postdoctoral scientist Judith Juhasz is developing new hydrogel-ceramic nanocomposites to improve the interactions of inert implant surfaces with natural bone tissue. At a primary level, natural bone tissue consists of ceramic nanoparticles embedded in collagen fibres. Judith's nanocomposite coatings, mimicking nature, similarly consist of bioactive ceramic nanoparticles incorporated into biodegradable co-polymers. Her research benefits from CCMM's expertise in the areas of substituted hydroxyapatite, biodegradable polymers and *in vitro* bioactivity studies. Many of these *in vitro* studies are the result of an ongoing collaboration with the Orthopaedic Research Unit (ORU) of Addenbrooke's hospital. At ORU, Judith has been investigating the ability of cells to grow, proliferate and produce new bone matrix on the coatings. These cellular interactions contribute to the integration of natural bone into new implants, increasing implant longevity and reducing the risk of failure.

Orthopaedic soft tissue and industrial collaborations

Strong industrial connections are a key component of CCMM research. The collaboration with Orthomimetics (see more on p. 6), a company founded by CCMM alumnus Andrew Lynn has led to several research studentships and postdoctoral projects. For her postdoctoral work, Jessica Gwynne is developing a collagen-based artificial ligament to complement the successful product *Chondromimetic*™, a collagen-GAG scaffold for cartilage repair. Close attention and direct feedback from Orthomimetics coupled with connections with several projects supported by the company in the ORU and CCMM have made her experience with industrial collaboration a positive one.

At the forefront of biomedical materials research

Under the leadership of Serena Best and Ruth Cameron, CCMM has expanded into new areas of medical materials, as shown through the projects highlighted in this article. They have also fostered extensive collaborations with academic, clinical, and industrial researchers. The result of their efforts has been the establishment of an international, interdisciplinary and strongly collaborative centre of research excellence [**www.msm.cam.ac.uk/ccmm**]. Recognition of this effective leadership, among other factors, came in the form of promotions for both CCMM directors. Now in the professoriate, they continue to guide the CCMM towards the development of next-generation materials for medical implants.

Rose Spear (2006-)

Above left: Scanning electron microscopy image of a tri-calcium phosphate based porous tissue engineering scaffold structure for orthopaedic applications. (Alexander Woesz and Lisa Ehrenfried)

Buildings: Old and Not-so-Old

As plans for the Department's move to West Cambridge are about to be realised, it's timely to look back on our accommodation over the past century or so. Of course, as many readers of *Material Eyes* already know, much of this history has been covered in some detail by Jim Charles and Lindsay Greer in their book *Light Blue Materials**. This note is little more than a brief summary of their account with some updating and some reflections on what may be to come.

In the nineteenth century, much of the scientific research and teaching in Cambridge took place in College laboratories, which were set up before the University established laboratories of its own and so it was with early research in metallurgy, famously conducted by Heycock and Neville in a hut in the grounds of Sidney Sussex College.

Metallurgy as a recognised scientific activity moved into the University in 1908 when thanks to the generosity of the Worshipful Company of Goldsmiths, Heycock became a Reader and was granted research space in the Department of Chemistry in its then fairly new building on Pembroke Street. Again thanks to the Goldsmiths, a dedicated laboratory was constructed for Heycock and opened in 1920: this single-storey, north-lit laboratory is still very much in use. In 1931, Professor Robert Hutton became the first Goldsmiths' Professor and an independent Department of Metallurgy, albeit still housed in part of the Chemistry building, was created. By 1950, the Department was occupying over a dozen rooms in the basement of Chemistry and, in addition, had recently been provided with a purpose-built hut alongside the Austin Building of the Cavendish. With the opening of new buildings for Chemistry on Lensfield Road in 1958, the Department took over more space in the Pembroke Street building and relinquished the hut, which was then to be occupied by the molecular biologists from the Cavendish, forming the nucleus of what was to become the MRC Laboratory for Molecular Biology.

In the sixties, the University embarked on major modernisation of the New Museums Site, demolishing several Victorian buildings and erecting the Arup Building, of which the northern portion, including the in-site octagonal tower, was to be occupied by the Department.

Our part of the Arup Building was formally opened in 1971 but the space available was insufficient for the needs of a rapidly expanding department and so some space was retained in the old Chemistry building. Roughly half of that space, including the historical Goldsmiths' Laboratory, is still in the Department's possession. During the following four decades, the Arup Building has remained the headquarters of the Department but, as other departments have moved away or closed, we have colonised other parts of the site. After

Physics moved to West Cambridge in the early seventies, electron microscopy occupied one side of the basement of the Old Cavendish (dating from 1874). The hut, having decayed to a semi-derelict bike-shed, was returned to the Department and, by a very thorough refurbishment, miraculously transformed into the Rolls-Royce UTC, which opened in 1994.

With the demise of the Department of Applied Biology, space became available in the Austin Building and some came to the Department, a part being modernised to form the Gordon Laboratory, opened in 1999. When the Computer Laboratory moved to West Cambridge in 2001, we acquired part of the Corn Exchange Street tower of the Arup Building for the Pfizer Institute for Pharmaceutical Materials Science, an inter-departmental activity. Finally, we must not forget that in 2000 the space between the legs of the in-site tower was filled in to create a better small lecture/seminar room, allowing the old one to be converted into offices, and at last providing the Department with an airy, welcoming entrance foyer.

So what is to become of the space now occupied by the Department on the New Museums Site? Many very important developments in modern science took place in our current areas, ranging from physics to molecular biology, and many Nobel Prizes were won, so demolition, tidy though it might be, would be unwelcome. However the University cannot be left nursing unused buildings, especially not in the very middle of the city. Bearing in mind that the University's long-term plan is to move all or most remaining city-centre physical sciences and technology departments to join their close relatives already settled at West Cambridge, it seems most likely that some of the buildings on the New Museums Site, specifically those realistically adaptable to the needs of modern scientific research, will become laboratories for the biological sciences, while the less adaptable will be taken over by departments in the social sciences. The fate of the Goldsmiths' Laboratory will be of particular interest.

John Leake

Philip Dowson (architect of the Arup building) addresses a group in the foyer of the Babbage Lecture Theatre including Peter Tee, Sam Hoar, Graeme Davies, Brian Ralph and John Chilton.

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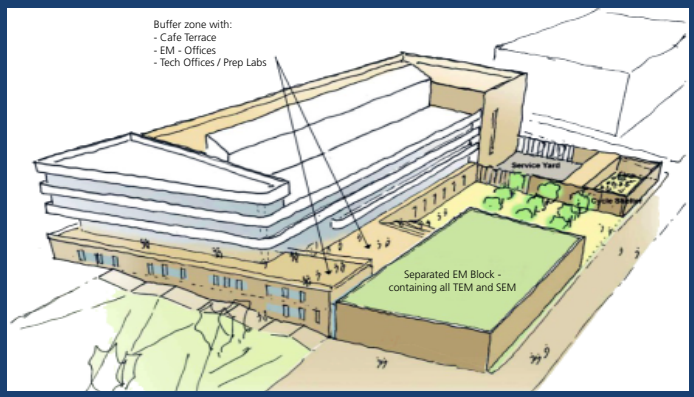
* Light Blue Materials, J.A. Charles and A.L. Greer, Maney for the IoM3 (2005). For details on ordering a copy, see: www.msm.cam.ac.uk/Department/DeptInfo/LightBlueAd.html

West Cambridge: DMSM arrowed, and possible future buildings in white

Plan of lower ground floor



Concept view looking NE

View SE towards the main entrance

Tea room at first-floor level above entrance

Grand Designs

For the first time in its 100-year history, the Department is to be housed in one building designed for the purpose. The University has approved the move and has commissioned the architects *NBBJ* to design the new laboratory at West Cambridge in the location shown to the left. Thus in summer 2012, we should be leaving our present rambling accommodation spread over five different buildings, some dating back to the 1870s, for a single building that will house all our research groups. Our new state-of-the-art building will be functionally effective, less congested, safer, and more welcoming, and should facilitate cross-disciplinary collaborations. The plan is to intertwine teaching and research, and the site has room for future expansion.

Dedicated to an intrinsically cross-disciplinary subject, the Department collaborates widely with other Cambridge departments. Its new location in West Cambridge will enable it to play a leadership role in integrating other sciences and engineering to harness the University's diverse strengths in materials science. Being close to researchers in the Department of Physics, the Nanoscience Centre, the Institute for Manufacturing, and the Centre for Advanced Photonics and Electronics, will bring great benefits through promoting cross-disciplinary interactions and enabling access to shared facilities. Cambridge Enterprise, responsible for licensing and encouraging business spin-outs from University research, is located on the West Cambridge site, thus facilitating the growth of entrepreneurial activity based on materials research.

Layout

The new building will house laboratories and offices, separated by an atrium. Teaching laboratories and study space for undergraduates are situated on the ground floor, while seminar rooms will be scattered around the building. We will retain our tea room, an important - even famous - feature of the Department that has moved from building to building over the years. This will look out over the West Cambridge site. A dedicated wing for electron microscopy is to be constructed on a state-of-the-art, low-vibration slab. To perform to their ultimate specification, the microscopes must be well shielded from acoustic noise, stray electromagnetic fields, vibration and temperature variations — difficult to achieve in a building with so many other things going on!

Key research facilities

In addition to facilities within individual research groups, and the electron microscopy suite already mentioned, the building will house: a cell-culture laboratory, a mechanical testing area, a process laboratory and workshop (with vibration isolation) and an X-ray diffraction facility.

New Building: Facts and Figures	
Total cost (including associated work)	£46M
Support so far is from the University's HEFCE Capital Investment Fund and a £2.25M donation from the Wolfson Foundation.	
Architects	*NBBJ*
Contractor	Willmott Dixon
Main construction starts	December 2010
Building ready for occupation	Summer 2012
Gross floor area	10,600 m^2

Spin Doctors

British universities are regularly exhorted to show enterprise, in particular to capitalise on their research results, and it is hardly surprising that Materials departments are significant players in technology transfer. A key mechanism is the establishment of spin-out companies, for which Cambridge is well reputed. Many of our graduates are employed in companies that originated in other Cambridge Departments. But of most interest are our home-grown companies: five so far, with more in the pipeline. The five operational companies (in alphabetical order in the following snapshot) all feature either clean technology to benefit the environment, or medical applications.

Camfridge Ltd *(est. 2005)*

Camfridge Ltd builds on research by Derek Fray and Karl Sandeman leading to practical refrigeration that does not use compression and expansion of a gas. As described in *Materials Eyes 15*, materials change temperature when a strong magnetic field is applied or removed, and this magnetocaloric effect is unusually large in recently discovered materials. Using solids rather than gases eliminates problems of leakage, while avoiding the need for compression reduces noise. Furthermore, equivalent cooling can be achieved with barely half of the energy consumption of gas-based systems. In 2008 Camfridge was identified as one of Europe's leading clean-technology companies and more recently it has announced a major project with well-known white goods manufacturer Whirlpool.

GreenPB *(est. 2008 by Vasant Kumar and a graduate-student team: Lei Wang from Judge Business School, Nigel Williams from Engineering and David Zou from our Department)*

GreenPB exploits a revolutionary method for recycling lead-acid battery paste using environmentally friendly and economic household chemicals to recover the lead content directly in the form of lead oxide. With overall energy consumption less than 10% that of existing technologies, the process will reduce carbon and sulfur dioxide emissions. In addition to winning the first-ever Armourers & Brasiers' Materials Venture Prize in 2008, GreenPB is attracting significant interest from environmental agencies, researchers and entrepreneurs. The process is proceeding to pilot-scale testing.

Inotec AMD Ltd *(est. 2005)*

Inotec AMD Ltd tackles the difficulty of administering the enhanced oxygen supply ("topical oxygen therapy") that is well known to promote healing of some common chronic wounds. The Inotec system combines a battery-powered oxygen concentrator, based on Derek Fray's input as Technical Director, that is small enough to be worn on a belt with a special pad dressing to deliver the oxygen uniformly over the wound. Initial clinical trials completed in 2009 involved patients "at the end of the road" who had failed to heal under conventional treatment. Assessments were made on wound area, wound pH and infection levels. High-frequency ultrasound imaging below the wound surface provided quantitative information on the regeneration of new tissue. All patients completed the trial and all showed good healing progress, with one completely healed during the trial and a further two healed within the following month. A second tranche of funding was triggered in May 2009 and compliance with quality standard ISO13485:2003 was confirmed in October.

Metalysis *(est. 2001)*

Metalysis was set up to exploit the Fray-Farthing-Chen (FFC) Cambridge process for extracting high-value metals, most notably titanium, from their oxides. The first patent was filed in 1998 and Metalysis, now based in South Yorkshire, thus has the longest history of our five spin-outs. Incorporating lessons learnt in laboratory-scale beginnings, semi-continuous pilot cells are now being designed and built. The electrochemical process works well, and the problematic overall cycle time will be improved by current developments. The FFC process uses far less energy than conventional titanium extraction, significantly reducing operating costs and environmental impact. In 2009, Metalysis was named as one of the world's hundred most promising private clean-technology companies in Global Cleantech 100 and is now recruiting more key individuals.

OrthoMimetics *(est. 2005)*

OrthoMimetics is the first spin-out company to emerge from the Cambridge-MIT Institute (CMI). The key CMI-supported research, working with Bill Bonfield and Serena Best in the Cambridge Centre for Medical Materials, was by PhD student Andrew Lynn, who then set up the company. His own and his company's successes have been recognised by the *2008 European Academic Enterprise Award for University Entrepreneurs in Chemistry and Materials* and a place in the *2009 MIT Technology Review TR35*, its annual list of 35 outstanding men and women under the age of 35 who exemplify the spirit of innovation in business and technology. Degenerative joint disease, whether the result of sporting activity or obesity or old age, is an increasing problem often leading to the insertion of artificial replacement parts. An alternative approach is to use a specifically designed material that facilitates and encourages natural regeneration. Pursuing this approach OrthoMimetics is developing and marketing products that will provide for regenerative repair in a range of (mainly) soft tissues. First of these onto the market is *Chondromimetic*™, a porous, resorbable implant designed to stimulate regenerative repair of damaged joint surfaces and bony defects. Very recently, OrthoMimetics has been acquired by the Belgian company TiGenix with Andrew becoming that company's Chief Business Officer.

Finally a lesson for us all: that Derek Fray features in three of these stories shows how a thorough understanding of chemical thermodynamics can contribute to wealth creation!

For further information contact Rachel Hobson, the Department's Research and Business Development Manager at rjh24@msm.cam.ac.uk or visit the individual company websites:

www.camfridge.com
www.inotecamd.com
www.metalysis.com
www.orthomimetics.com

For GreenPB contact Vasant Kumar at rvk10@cam.ac.uk

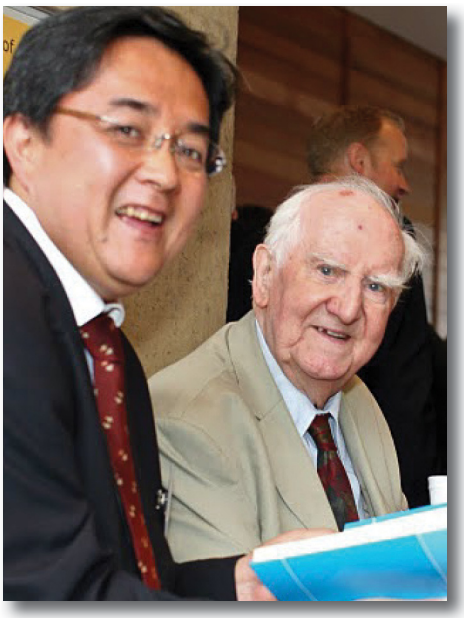
Alumnæ Leaders

Each year since 2006, the UK Resource Centre for Women in Science, Engineering and Technology has recognised six Women of Outstanding Achievement, with a set of photographic portraits being commissioned. It's a pleasure to record that this year's winners include our alumna Helen Atkinson. Helen, a speaker at this year's ABC Forum (see p. 7) is Professor of Engineering at the University of Leicester, and Head of the Mechanics of Materials Group there. Earlier winners include another of our distinguished alumnæ, Julia King, Vice-Chancellor of Aston University. Julia spoke at our Alumni Weekend event last year (see p. 7). Both Julia and Helen were cited in the Leadership section of these awards.
www.ukrc4setwomen.org

Cambridge Materials Science around the world in the 21st century

To celebrate the University's 800th anniversary, the Department held a meeting on 25 September 2009 highlighting the contributions made to Materials Science, and more widely, by some of our most distinguished alumni. We welcomed some 160 participants ranging from alumni from across the years, making a special return visit to Cambridge, to current members of the Department. In the Babbage lecture theatre a baker's dozen of speakers, appeared in reverse order of their date of arrival in the Department. With their year of entry, current affiliations and titles of their talks, they were: Andrew Lynn *(2002), OrthoMimetics* "Regenerative Medicine and Orthopaedics: Crossing new Boundaries", Seeram Ramakrishna *(1992)*, *NU Singapore* "Quest for Clean Water and Energy and Regenerative Medicine using Nature's Building Blocks", Neil Glover *(1988)*, *Rolls-Royce* "Future Aero-Engine Materials : Challenges and Barriers", Eilidh Bedford *(1985)*, *Cabot Corp.* "The Trials and Tribulations - and the Fun - of Materials Science in a Boston Start Up", Caroline Ross *(1982)*, *MIT* "Nanoscale Lithography using Self-assembled Materials", Anne Glover CBE FREng *(1973)*, *Amadeus Capital* "The Role of Venture Capital in Technology Exploitation", Julia King CBE FREng *(1972)*, *Univ. of Aston* "Low Carbon Transport: Urgent and Exciting", Rob Ritchie FREng *(1966)*, *UC Berkeley* "Bio-Inspired Structural Materials", Robert (Bob) Young FREng *(1966)*, *Univ. of Manchester* "Composite Micromechanics", Nigel Unwin FRS *(1965)*, *MRC Cambridge* "Experiments in Electron Microscopy: from Metals to Nerves", David Fyfe *(1963)*, *Cambridge Display Technology* "OLEDs – Materials Science at its Most Innovative", Srinivasa Ranganathan FNA *(1962)*, *IISc Bangalore* "New Geometries for Novel Materials", and John Knott OBE FRS FREng *(1959)*, *Univ. of Birmingham* "Materials - Power and Performance".

Above: Back row, l to r: Srinivasa Ranganathan, Neil Glover, Rob Ritchie, Lindsay Greer. Front row, l to r: John Knott, Seeram Ramakrishna, Eilidh Bedford, Anne Glover, David Fyfe, Caroline Ross. (absent from photograph: Andrew Lynn, Nigel Unwin, Bob Young)



During the morning a special highlight for many was a brief appearance by Sir Alan Cottrell (pictured on the day), whose 90th birthday was in July. The range of topics covered was indeed impressive, as were the illustrations - not least a film clip of a Rolls Royce "blade failure containment test" shown by Neil Glover. As one participant said of the day, " ...everything from national science policy to breaking things" whilst another looked forward to a similar event in 50 years' time!

Following a full and informative day in the lecture room, many reassembled in the evening on the Fellows' Lawn in Downing College for a reception before going into the Hall for a splendid dinner. Old friendships were renewed, reminiscences shared and food, wine and speeches enjoyed.

We are most grateful to Alstom, BP, *NBBJ* (architects for the new building) and TWI, whose generous sponsorship of this event helped make it all possible. Special thanks are due to Rachel Hobson, Christine Carey and many others in the Department who made the event happen.

Armourers & Brasiers' Cambridge Forum 2009

Rear Admiral Patrick Middleton opened the sixth annual Armourers and Brasiers' Cambridge Forum on 9th June 2009 with a timely reminder, given the prevailing economic conditions, that one of the key features of a robust economy is the ability to make things. For this to be successful, it must be underpinned by the type of scientific and technological innovation which is the subject the forum.

As usual, the programme included speakers from around the world, beginning with Clare Grey (formerly SUNY Stonybrook, now Cambridge Chemistry), who described her work on the development of lithium batteries for applications such as all-electric vehicles. Steve Rannard (Liverpool) spoke about techniques for synthesising dispersions of organic nanoparticles in water, and the opening session was rounded off by Chris Grovenor (Oxford) who gave an insight into the oxidation of zirconium alloys.

Following the tea break and poster session, Tridibesh Mukherjee (Tata Steel) described the process which develops an "idea" into an "innovation", and David Mackay (Cavendish) gave a most entertaining and convincing entreaty for the development of an energy policy in which the sums actually add up. Before more tea and posters, the Armourers & Brasiers' Materials Science Venture Prize was presented, this year's recipients being a team from the University of Liverpool headed by Rachel Williams.

The day was brought to a conclusion with the eleventh Kelly Lecture, delivered by Professor CNR Rao, FRS, of the JNCASR in Bangalore. Professor Rao has enjoyed a most distinguished career in India, Europe and the USA, during which he has authored a prolific total of around 1500 research papers. He gave a compelling account of the development of his research career over the last half-century and described in detail his recent and ongoing work on nanomaterials.

In addition to the generous sponsorship by the Armourers & Brasiers' Company, the Forum also enjoys the support of AWE, Corus, IoM^3, Johnson Matthey, Morgan Technical Ceramics, Ranier Technology, Rolls-Royce, the Royal Academy of Engineering, the Royal Commission for the Exhibition of 1851 and the Royal Society of Chemistry.

Please join us on Tuesday 15th June 2010 for the next Forum when the Twelfth Kelly Lecture will be given by Professor Ke Lu Chinese Academy of Sciences, Shenyang, China on "Nano twinned Materials". For more details, see **www.msm.cam.ac.uk/forum**

Making Waves: Neil Mathur

Neil Mathur is the latest member of the Department to be awarded a Rosenhain Medal by the IoM³ "in recognition of distinguished achievement in any branch of materials science, preference being given to candidates under the age of 40". In Neil's case, this is for work on magnetic and electronic materials in the Device Materials Group. As an undergraduate from 1987-90, Neil specialised in Physics in the Natural Sciences Tripos and subsequently completed a PhD in the Cavendish before joining our Department in 1996 as a postdoc with Jan Evetts and Mark Blamire, becoming a Royal Society University Research Fellow in 1999, a Lecturer in 2005 and a Reader in 2008. Neil has long been attached to Churchill College where he is currently a Senior Research Fellow.

About his research, Neil says "My aim is to understand interesting materials. Making devices is a way of studying such materials. My scientific goals are academic but reflect long-term technological challenges." Specifically he uses thin-film devices to study the physics of materials that display notable electrical and magnetic properties including magnetoelectric coupling (to interconvert electricity and magnetism inside materials), electrocaloric and magneto-caloric cooling (using ferroelectrics and ferromagnets), the complex magnetic and electronic textures that arise naturally in manganites (crystalline perovskite oxides of manganese) and "spintronics" using e.g. carbon nanotubes. This wide range of scientific interests extends well beyond the Department. A glance at some of Neil's papers will reveal a range of collaborations not just around Cambridge but also around the world; note, for example, a paper on "Ferroelectric control of spin polarization" in *Science* this February. Unsurprisingly invitations to scientific meetings arrive in considerable numbers so some selectivity is essential. Nevertheless, recent commitments outside Europe and the USA have included India, China, Korea and Argentina. Neil's research also emphasises the important links between research and teaching in a "research-led" university: one recent finding that a multi-layer capacitor serendipitously functions as a room-temperature magnetic-field sensor requiring no electrical power input has led not only to a provisional patent but also to a new first-year practical. With each new task that comes his way, Neil does not automatically accept existing practice but likes to think matters through from scratch and so it has proved with his undergraduate teaching to which he has brought fresh ideas in lectures and practicals.

When not creating and investigating tomorrow's device materials or cooking and spending time with his family – wife Britta, a business consultant in the Science Park, and five year old daughter Mia – Neil pursues a range of energetic activities. He is now playing his 23rd consecutive hockey season for Churchill College, he regularly runs long distances such as the Cambridge Boundary Run marathon, and he is Senior Treasurer of the University Hare & Hounds. When he is not running he sometimes jets out for skiing or windsurfing.

Congratulations

David Duke: MBE, New Year Honours list 2010
Serena Best and **Ruth Cameron**: personal Professorships from October 2009
Rachel Oliver and **Caterina Ducati**: University Lectureships from October 2009
Pedro Diaz del Castillo Rivera: Assistant Director of Research of the SKF UTC from October 2009
Amir Shirzadi: Lectureship at the Open University from October 2009
Tim Burstein: Honorary Fellowship of the Royal Society of New Zealand
Harry Bhadeshia: Honorary Membership of the Iron and Steel Institute of Japan, Honorary Chair at Wuhan University of Science and Technology, China.
Derek Fray: 2009 Materials Innovation Prize & Medal, Federation of European Materials Societies (FEMS)
Lindsay Greer: 2009 Griffith Medal & Prize, and Fellowship of the IoM³
Ruth Cameron: Fellowship of the IoP
Neil Mathur: 2009 Rosenhain Medal & Prize, IoM³
Bill Bonfield: Award of Merit for Biomedical Engineering, IUPESM, Honorary Fellowship of the Academy of Medical Sciences
Sir John Meurig Thomas: 2010 Bragg Prize Lectureship, British Crystallographic Assoc.; Honorary Doctorate, Bangor University; AH Zewail Gold Medal, Wayne State University
Xavier Moya: Junior Research Fellowship, Wolfson College and a Herchel Smith Postdoctoral Research Fellowship
Sohini Kar-Narayan: Junior Research Fellowship, Clare Hall
Sophie Harrington: Junior Research Fellowship, Downing College and a 1st Prize in the Poster Session of the MRS Spring Meeting 2010
Paul Saines: 2009 Gold Medal, Australian Institute for Nuclear Science & Engineering
Dominik Eder: Young Scientist Award, First Nanotoday Conference, Singapore
Ashley White: 1st Prize, Student Speech Contest, European Ceramics Society, Poland

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