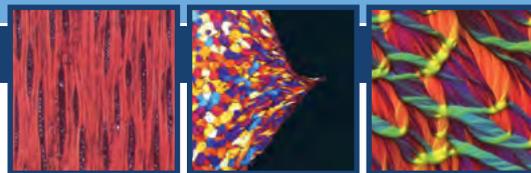


Cambridge material eyes

Winter 2019/20 Issue 34



Editorial

A very warm welcome to this edition of Materials Eyes. Starting on a sad note I must mark the passing of Rob Somekh and James Goodchild; both contributed hugely to the Department over many years.

The end of September marked the retirements of Bill Clyne, Mark Blamire and Zoe Barber. I'm delighted though that Bill and Zoe will remain strongly affiliated with the Department: Zoe will continue to undertake some teaching and Bill has an Emeritus Fellowship. Of course, as some people leave, others arrive and news of new appointments being made this term will be given in the next issue.

Despite the uncertainty of a new government and any consequence of the Brexit process, the Department continues to be remarkably successful, with prizes, awards, fellowships and a healthy research income, including significant grants (still) from the European Commission. We have record undergraduate numbers, a record that is likely to be broken again next year. We want now to build on that success by growing by around 25%, so that we can research new areas, and strengthen existing ones, and grow a broader teaching base to cover an ever-increasing curriculum. We therefore need more office and lab space; talks about a possible 'north wing' are underway.

Finally, as mentioned previously, in 2020/21 we will be celebrating the Department's centenary with events starting in October 2020 and running throughout that academical year. Once plans are complete we will contact alumni with the details.

**Professor Paul Midgley,
Head of Department**

Towards a circular economy

Several Departments and Centres in Cambridge along with others from outside are collaborating to investigate ways to change our economic model from linear (cradle-to-grave) to circular (recycle/repurpose). Those involved range from Engineering to Asian and Middle Eastern Studies; a recent discussion meeting focusing on the food industry is pictured. Our Department is playing a part in one strand of this work, specifically that to do with plastics. Useful plastics have been manufactured and used for many years. They were originally based on natural polymers, e.g. cellulose, but increasingly over the last 80 years synthetic polymers have taken over because their properties make them better suited to specific applications. Now recognition of serious disadvantages of materials based on current synthetic polymers is leading to increasing efforts to create materials to replace them. James Elliott is working with the inter-departmental Cambridge Creative Circular Plastics Centre (CirPlas) partly funded by UKRI (UK Research & Innovation). In this connection he says, I lead a research group studying polymeric membranes, carbon nanotube fibres and composite materials. My work frequently employs state-of-the-art computational modelling to complement experimental studies. I have a particular interest in creating materials which are easy to recycle by design, and degrade in

a predictable and controllable fashion to reduce impact on the environment. Many challenges lie in the way, not least achieving the durability and aesthetic properties that consumers desire whilst at the same time getting waste management companies and recycling centres on side, to say nothing of persuading manufacturing companies that these new materials can be made cheaply and in sufficient quantity!

Wider still...

Beyond the boundaries of our subject members of the Department display an impressive and very varied range of activities. Two examples are noted here and a third will be found in the profile of Simon Griggs on page 4.

In the run-up to last Christmas and again in the summer staff and members of the Department made much appreciated donations in cash or in kind to the Cambridge Food Bank. This generous development in Departmental activities has been initiated and overseen by Lianne Sallows with Susan Lomax, Charlotte Barker and Marcos Gutierrez.

In April two(!) of our graduate students, Tricia Smith and Larkin Sayre, rowed in the victorious Women's Boat Race crew, which beat Oxford by five lengths.

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Rob Somekh (1947– 2019)

From Head Boy at Burton-on-Trent Grammar School Rob Somekh came to Pembroke College to read Natural Sciences, specialising in Physics and going on to work for a PhD in low temperature Physics in the Cavendish Laboratory. In 1972 Rob began work in the Department, joining the then Superconductivity Group as a post doc. under Jan Evetts. He played a vital role in the group's development through the initiation of thin film fabrication techniques; designing and building novel equipment to produce the materials on which much of the science was performed. His was a major contribution to the evolution and broadening of the group into what is now Device Materials. And he was instrumental in bringing the Department to the forefront of research in the applied science of thin film deposition, a subject which has featured in both research and teaching ever since. Rob contributed seminal work on magnetic and superconducting materials, functional oxides, nitrides and carbides, metallic glasses, composites, multilayers, superlattices, and complex heterostructures for device applications. Precision film deposition, in ultra-high vacuum systems, included working with most of the elements in the Periodic Table.

Whilst remaining a true and dedicated research scientist, Rob was always aware of the importance of putting science into applications, to advance technology but also to provide financial support for further research, and he was involved with many commercial ventures. In 1997 he moved from University research to Plasmon Plc, one of the Companies which had benefited greatly, as a start-up, from his

input. He spent 11 very successful years working there, and the company benefited enormously from the breadth and depth of his scientific understanding.

Rob influenced many of us profoundly, demonstrating how to work hard, and with commitment, at scientific research; how to work collaboratively; and how to value the (different) input of many, in a successful research environment. As others have said, Rob was: "incredibly hard working, dedicated and enthusiastic, and absolutely brilliant at getting to the root of a problem with a back of an envelope calculation!"; and "a supportive and encouraging colleague from whom I, like many others, learned how to do science well."

He married Bridget in 1974, and enjoyed a close family life with her and her two daughters, Suzanne and Gillian. Rob also had many interests outside science including cooking, photography, travel, learning the piano and piano accordion, and theatre-going. These were pursued even more actively in retirement.

Zoe Barber

Rachel Hobson - pastures new

On 4 April, we bade farewell to Rachel Hobson after her long stint in the Department. Rachel worked for 3M (mainly) before and after gaining a PhD in Alan Windle's group while captaining the Emmanuel College squash team and playing polo for the University (one of the first women to do so). She returned in the late 1990s, to several roles, including Programme Manager for the Cambridge-MIT Institute. For the past 12 years she has been a very busy Research and Business Development Manager, advising on strategy and the ever-changing procedures for grant applications. She also played a vital part for the Armourers and Brasiers forum and the creation of almost 20 issues of *Material Eyes*.

Aiming to influence

Following its "My Science Inquiry" call for proposals of inquiries that it should undertake the Science and Technology Committee of the House of Commons received over 80 responses and selected ten to be presented to a meeting of the Committee in January 2019. One of the ten, with the title "Impact of science funding policy on equality, diversity, inclusion and accessibility", was headed

by Rachel Oliver with 203 supporting signatories including 21 other scientists and engineers from Cambridge. Prompted by recently revealed evidence their concern focused on unconscious bias against under-represented minorities in the allocation of support to STEM researchers and led them to urge the Committee to investigate the situation.

Rachel, like the proposers of the other selected responses, was invited to address the Committee briefly and then to answer questions. What was it like to contribute to such a discussion in a Committee Room in the House of Commons? Rachel reports that it was nerve-wracking, particularly because there was a strict time limit of five minutes for her "pitch", with the countdown displayed on a huge glowing digital clock at the front of the room. Nonetheless, the committee were friendly and asked apposite and helpful questions, drawing out the key issues. The Committee's formal report includes a summary of her contribution and concludes "We will launch an inquiry into the impact of science funding policy on equality, diversity, inclusion and accessibility, within the next 12 months." Clearly this is a satisfying outcome but, also clearly, it is only a start on a potentially long road! As Rachel said "I am thrilled that the select committee will be addressing the impact of funding policy on diversity. Research funding policy has a huge influence on the progression of women and members of minority groups along the STEM career pipeline. Addressing the biases and barriers experienced by minority scientists applying for funding is thus vital to improve the diversity of STEM and broaden the available talent pool."

Notable recognition

Dr Robert Hoyer, Royal Academy of Engineering Research Fellow, is one of Forbes' 2019's 30 Under 30 rising talent in Science and Healthcare in Europe, recognising his research on semiconductors and tandem photovoltaics. Later he, Megan McGregor, PhD candidate in the Rolls-Royce UTC, and alumna Louise Gale, now working at Rolls-Royce plc., were included in the "15 under 30" future talent to watch in STEM listed in the IoM3's 150th anniversary edition of *Materials World* magazine.

James Goodchild

It is with deep sadness that we report the death of James Goodchild, who worked as Buyer in the Department for nearly 22 years until his retirement in 2018.

ABC Forum 2019

Bill Bonfield opened the Armourers and Brasiers' Cambridge Forum by welcoming participants and thanking the sponsors for their generosity. He spoke briefly about the Company, its support for Materials Science and its 700th anniversary in 2022.

Sarah Haigh (Manchester) surveyed the frontier of scanning transmission electron microscopy (samples typically a few atoms thick, probe diameter little more than 0.1 nm, issues of radiation damage). Samples should be in a realistic environment, e.g. to make dynamic observations of liquids, graphene nano-capillaries have been devised, in which flowing water becomes ordered, displaying anomalies. 3D images of macromolecular assemblies are being constructed.

Turning to the macroscopic, Neus Sabaté (Barcelona) summarised the types of electric battery and the challenge of disposal. She described the single-use paper-based batteries now made by spin-out company Fuelium. Fully organic, compostable batteries, which biodegrade in about 100 days, can be made from sustainable materials. Applications abound, especially in the area of health care. The same approach can be used to make paper-based bio-fuel cells.

In a new development - Brief Encounters - nine young researchers from the Department described their work, each sticking punctiliously to their allotted three minutes. Their interesting presentations came from very different fields.

Róisín Owens (Cambridge) explained that the increasing interest in applying physical science techniques to biological materials has focused attention on interfacing with such materials; flexible electroactive polymers are very useful. With examples ranging from the possibility of an organ on a chip to wearable monitors, she summarised the field, noting the necessity of giving cells the right environment if they are to function correctly.

Addressing ways to help reduce the causes of global warming. Manish Chhowalla (Cambridge) focused on two contrasting ways based on atomically thin films of compounds such as MoS₂. Power consumption in global data centres is huge and rising; two-dimensional semiconductors, especially tunnel FETs, promise significant improvement. Other such materials catalyse hydrogen production from water for use as a fuel or to make a methane feedstock from carbon dioxide.

Bill Bonfield revealed that eight of the companies awarded a Venture Prize since its inauguration in 2007 are still operating viably. Christopher Weston-Simons, Master of the Company, then announced that the winner this year: Kalium Health are developing a finger-prick blood test for potassium with other analyses in prospect. Gratefully receiving

the award Professor Fiona Karet noted that the original stimulus came from patients' requests for a home-test method.

21st Kelly Lecture

Introduced by Lindsay Greer, Yves Bréchet (Grenoble) built on experience gained from advising the Council of Ministers of the French Republic on atomic and alternative energies to educate us about teaching science to politicians.

Bemoaning the "overflow of uncontrolled pseudo-expertise" with which experts must now contend, he recalled the recognition of the importance of science in nineteenth century France which had continued through much of the twentieth century. This included the transition to major reliance on nuclear power initiated under de Gaulle. This made use of mature technology and illustrated the importance of emphasising to politicians the difference between what is well established and what requires a lot of research and development. Scientists and engineers were in a position to advise but the politicians had to make the decisions.

Moving to the international need to reduce emissions of CO₂ he noted that Europe contributes around 10% of global emissions. Transport, buildings and industry (including electricity generation) each contribute roughly a third. We must think about how electrical energy is produced, stored and transported, and how usage can be reduced. In France production is a relatively small source of emissions so the focus must be on the other aspects but the situation is different in Germany where nuclear generation has been reduced and much power is generated using coal. Renovation of buildings and electrification of transport are urgently needed. He then analysed why this is not obvious to politicians. In France relevant ministers have been in office for only 1.5 years

on average and the scientific and engineering expertise in those ministries has declined. Not knowing easily leads to not caring.

He recommended that in giving advice to politicians: keep it simple; provide orders of magnitude; and promote a systemic technical and scientific approach before reaching a decision. Also keep an eye on what other countries are doing and remember that timing is important. Above all, seek to prevent irreversible mistakes.

Turning to the underlying materials challenges, he looked first at current nuclear power and identified: the ultimate shortage of uranium (needs long-term research); the problem of high activity waste (solved by deep geological storage but not accepted); the ageing of PWR materials; the decommissioning of reactors (has been done successfully but requires great care). Materials for prospective Generation IV reactors involve further challenges. He then summarised issues more generally for functional materials and structural materials. CO₂ emissions are not simply a problem of power generation; the manufacture of concrete is a huge contributor. Massive recycling is essential as is more consideration of materials used for wind and solar power generation.

In conclusion he recognised that in dealing with politicians one needs more than scientific analysis and, in true French style, signed off with a philosophical quotation.

In proposing the vote of thanks Norman Fleck congratulated Yves Bréchet on his common sense approach and on the important lessons presented while regretting that British politicians can be even more difficult.

Finally a prize for the best "Brief Encounters" talk was presented to Malavika Nair and the A&B AWE thesis prize was presented to Andy Hodgson of Imperial College.

The next Forum will take place on Tuesday 16 June 2020.





Ion beams, e-beams and light beams



The Department is justly proud of its range of electron microscopes - scanning and transmission - in the Wolfson Electron Microscopy Suite, which is also open to external academic and industrial visitors. Such a facility requires people to support users, particularly through training, to maintain the equipment and to deal with essential administration. One of those people is Simon Griggs, who joined the Department in 2007 under Dave Nicol and is now one of two Senior Microscopy Technicians. Simon came from Cambridge Instruments where he had been heavily involved with the electron

beam lithography tools. He built and tested systems through to acceptance, helping to install and look after them around the world. Inevitably he had much to learn on the job here, building on his qualifications in electrical and electronic engineering. Such learning never ceases as older instruments are replaced by new. Unsurprisingly the move to the new building was a particularly hectic period before a reasonably steady state was achieved. Simon's duties include training and supervision of new users, mainly postdocs and graduate students, in the use of the technical equipment, insuring that they obtain the high standard results needed for their work on a wide variety of materials. Simon and his colleague, Christopher Dolan run the EM suite and maintain the systems as needed. Maintenance ranges from very high tech to low tech.

Living in Sutton and commuting by bus gives Simon two substantial spells of time each day, which he uses for script-writing his latest Sci-Fi, action, adventure film, 'Dominance', which is currently in the development and early pre-production stages using world-leading professionals including award winning actors.

Recovering from one's surprise one learns that this is a natural extension of a

childhood interest stimulated by his mother's involvement in amateur dramatics although Simon soon realised that he preferred to work behind the scenes. This interest resurfaced strongly when his elder son was tackling his final-year major project at C.R.C., in which he had to make a film. Since then, their film production has gone from strength to strength with participation in many film festivals, winning eleven awards so far, and leading to the creation of a company, Mediascape Productions Ltd. One film, "The Parking Place" was filmed on the New Museums Site outside the Department's former buildings. Simon may have escaped administrative duties in the Department but very many administrative processes are involved in film production.



Congratulations

Thomas Bennett, Weyl International Glass Science Award
Angelo di Bernardo, Alexander von Humboldt Foundation Sofja Kovalevskaja Award
Serena Best, President of IoM3, Suffrage Science Award
Ruth Cameron, Rosalind Franklin Medal and Prize, IoP,
Manish Chowalla, Cambridge Royce Champion and Leader - Royce Materials for Energy Efficient ICT
Judith Driscoll, RAEng Chair in Emerging Technologies
Cate Ducati, Personal Chair
Rachel Evans, Readership, ERC Consolidator Grant
Jess Gwynne, a Pilkington Prize for Teaching

Louise Hirst, ERC Starting Grant
Robert Hoye, Research Fellowship, Downing
Vasant Kumar, Fellow of the Energy Institute
Jason Robinson, Personal Chair, Fellowship IoM3
Enrique Galindo-Nava, Winner Metals journal's Young Investigator Award
Samer Kurdi, selected Cambridge representative at the 69th Lindau Nobel Laureate Meeting
Megan McGregor, National Winner, IoM3 Young Persons' Lecture Competition
Tongtong Zhu, Winner, Cambridge Enterprise Postdoc Business Plan Competition

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