Cambridge material eyes

Spring 1996 Issue 1

Fasten Your Seat-belts

A 1.25 million pound grant from Rolls Royce to set up a Technology Centre is probably the largest industrial funding the Department has ever received. Won in the face of strong competition from several other Universities, Professor Colin Humphreys regards this as one of the most important things to have happened while he was Head of Department.

Rolls-Royce decided that they needed to collaborate with a top University in taking Ni-based superalloys to their limits. Turbine blades run in the hottest part of an aerospace jet engine. The operating temperatures are above the melting point of the materials used and they have to be gas cooled using the elaborate system of channels that run through them. A further increase in operating temperature of 10-20°C would be sufficient to produce a competitive advantage, resulting in a reduction of fuel consumption, greater thrust and less pollution.

"This is very much a materials problem" explains Professor Humphreys, the Director of the Centre."The Ni -based alloys used at present contain as many as fifteen different elements and have been developed on a trial and error basis. Computer modelling now provides the major thrust in optimising the properties obtainable". The Ni-based alloys currently used for turbine blades are single crystal to eliminate creep, the stress on each rapidly rotating blade being equivalent to that produced by a double decker bus hanging on it.

The Centre, which was opened last October, already has twenty people working in it. Ninety percent of the work is based on optimising Ni-based super alloys and the remaining 10% is looking at the potential of new materials for future generations of aerospace engines. "This major partnership of a world leading company and a world class university department is a model for future industry-university links", says Professor Humphreys.

For more information, contact the Centre's Director: Professor Colin Humphreys T:(01223) 334457

A Cathay Pacific Airbus powered by Rolls Royce engines.

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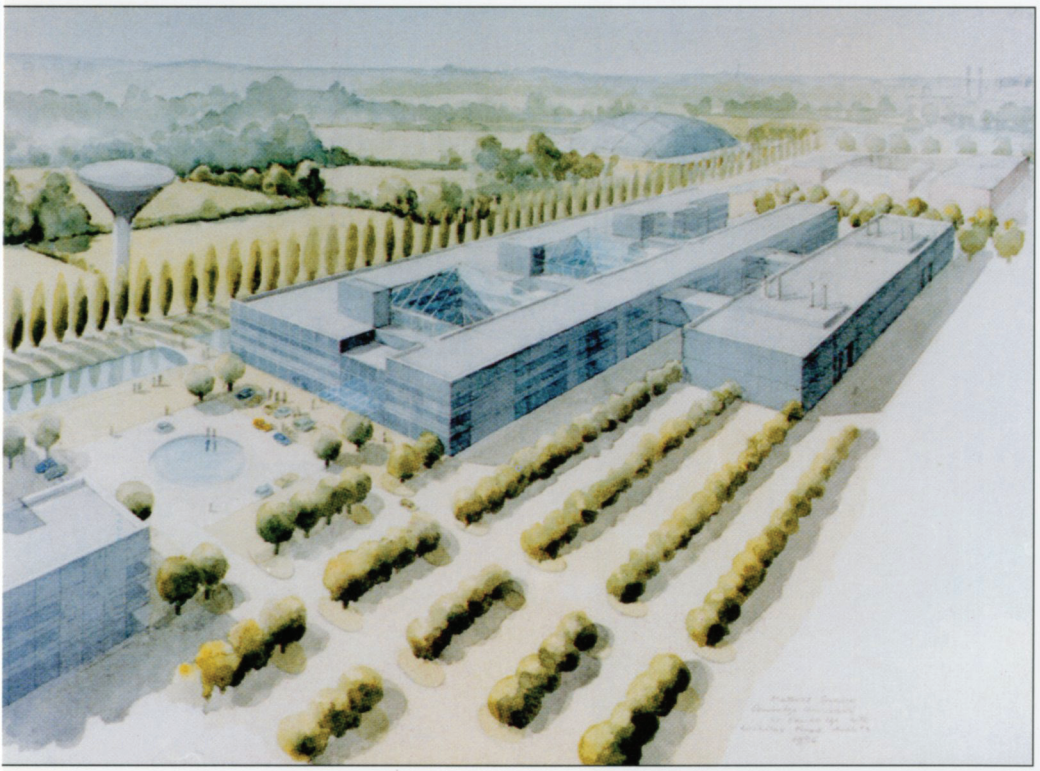
Alumni News

Happy Anniversary!

It was a delight to see over two hundred past and present members of the Department gathered together in September 1995, to mark the birth of the Department 75 years ago. The 75th anniversary celebrations combined a dinner at King's College with an Open Day at which current professors and readers gave presentations on the theme 'Progress towards 21st century materials'. For those wishing to see a full report of the event, it has been published in 'Materials World' the journal of the Institute of Materials, in their November issue, 1995.

The Goldsmiths' Professor of Materials Science, Colin Humphreys, addressed those attending the dinner and it was particularly pleasing that the last three Goldsmith's Professors: Sir Alan Cottrell, Sir Robert Honeycombe and Derek Hull were also able to be present. Alumni were able to see that the Department is continuing to build on its strong tradition, and remains a centre of excellence in the study and teaching of Materials Science. Now that the Department has expanded to occupy four buildings, with 150 research students and 50 post- doctoral staff, plans are underway to re-unite under one roof at a new site in West Cambridge. A daunting task as the Department has the responsibility for raising £25M. Plans include the setting up of an international materials centre, incorporating a number of industrial research units and a hands-on materials activities centre for schools. Developments towards this aim will be a regular feature of these newsletters. An Architect's drawing of the proposed development is shown in the accompanying figure. ***Further information from: Julie Trim, Venture Office, 01223 334479.***



Architect's impression of our new building in West Cambridge.

Mind Over Matter

Perhaps one of the greatest changes that alumni visiting the Department to celebrate its 75th anniversary will have noticed is the proliferation of computers. Professor Alan Windle believes that the impact of computers on our society and our commerce will be as significant and dramatic as the Industrial Revolution. He summarises below, some of the materials research areas within the Department where the advent of computer technology is having a huge impact.

Digital definition of materials is a current buzz phrase. There has been a realisation that the development of complex machinery is becoming prohibitively expensive because of the rise in unit costs. This is especially true when late changes in design are made. The thrust is therefore to do everything by computer simulation first, as design changes in virtual space are much less expensive. Simulation is as relevant to the development of new materials as it is to the design of expensive machinery, new buildings or anything else. This Department is at the forefront of such developments, which is highly appropriate for a field which demands so much concentrated intellectual energy.

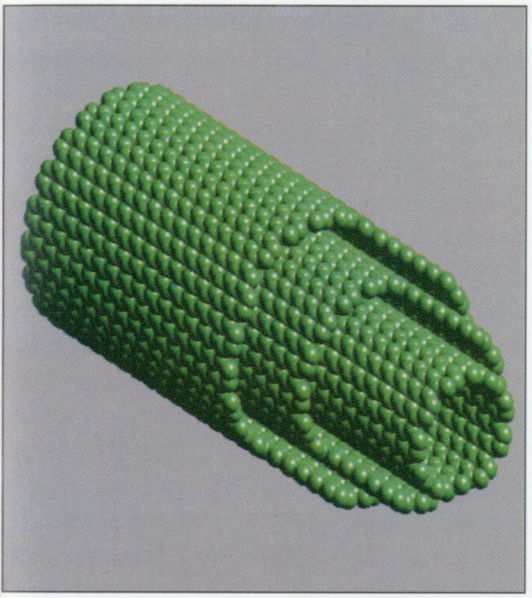
The Department's commitment to computer simulation of materials has recently been underlined by two appointments. Dr Paul Bristowe joined us from MIT and is a specialist in the atomistic modelling of grain boundaries in crystalline materials, and Dr Mark Manning who is the Department's first Computer Officer with a specific brief to integrate modelling activities across the research groups.

The development of metal matrix composites is also benefiting from modelling at the continuum level using finite element routines, a research area in which Dr Bill Clyne and Dr Phil Withers are making great strides. It is now possible to understand interface stresses as they develop after mechanical loading and thermal cycling.

Secure Knowledge

Modelling, which includes the application of neural networks to alloy formulation, is also central to the work of Dr Harry Bhadheshia's group which will be featured in an article on rail steels in the next issue.

The Polymer group is deeply committed to computational modelling. It is possible from basic descriptions of organic molecules to simulate structures at molecular and microstructural levels. It is thus possible to predict the behaviour of new types of polymeric



Concentric layers of graphite making up a carbon nanofibril. A computer model prepared using CERIUS software commercialised from research in the Department

molecule before taking the expensive decision to synthesise them. A Science Park company which spun off from Professor Windle's polymer modelling research is now (after three mergers) the largest materials modelling software house in the world, trading as BioSym/MSI, with bases in California and Cambridge. Critical input into this venture has come from the work on image analysis in the Electron Microscope group following the work of Dr Owen Saxton and Dr Mike Stobbs, and also from other departments in the University.

The whole area is growing explosively in its importance within Materials Science, and the Department is, as ever, in the forefront.

Jan Evetts explains the intricate nature of the magnetic tags to Prince Philip on a recent visit.

If you ever see Jan Evetts or Rob Somekh carefully peeling the sticky price labels off products in a shop, they will undoubtedly be looking for evidence that their work is being put to good use. Their involvement with the production of magnetic security tags started some years ago when they were approached by a Cambridge consultancy firm, Scientific Generics, to see if thin films with the appropriate magnetic properties could be produced. At that time, security tags were made using thin strips of amorphous metal with magnetic strips embedded. The major problem was to produce a thin film with a sufficiently low coercive force (2-4 amps/m are required, about a sixth of the strength of the Earth's field) with the appropriate low anisotropy and which could also be put onto a cheap plastic backing. "It was one of those projects with moving goal posts, and a succession of six month deadlines" recalls Jan Evetts. "We had to establish the science behind the process, so that the producers were able to successfully scale it up for industrial coaters. Now, rolls of magnetic thin films are routinely produced which are 1m wide by 6 km long."

Another major problem was producing sputtering targets of sufficient size and purity to deposit the thickness of coating required. "These coatings are quite thick at 0.8 microns " explains Rob Somekh. "We had to investigate the effect of composition, deposition parameters and stress on the properties of the film produced."

The magnetic layer of a-FeCoB is incorporated into standard supermarket price tags. When the tag is active this layer has an extremely non-linear response which is triggered as customers pass through detector gates. The tags can be de-activated at the check out when the goods are paid for. Tags are currently being produced at the rate of 10 million per week. The next step will be to incorporate the security tags with the bar codes that are now routinely put on all products at the point of manufacture.

Other applications for this type of magnetic thin film are constantly being assessed, varying from quality control procedures for the production of helicopter blades to coating of suture needles to prevent them being left inadvertently in patients' bodies following surgery. Prince Philip has even expressed an interest in adaptation of the idea to personal identification tags Wait 'til you see the words "By Royal Appointment" on the doors of the sputter coating team!

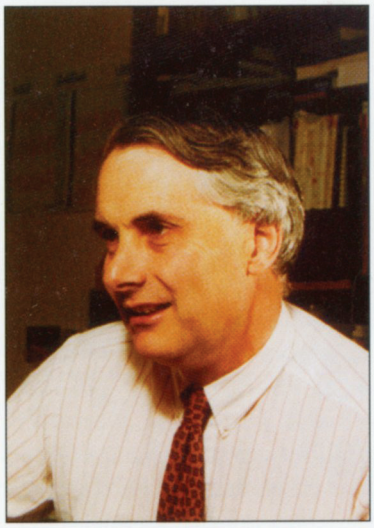
Enquiries to: Dr. Jan Evetts, T: (01223) 334364
Dr. Rob Somekh, T: (01223) 334374

Staff Profile

Professor Alan Windle

It is the intention, in these newsletters, to focus on various members of staff. It seems appropriate to start with Professor Alan Windle, who took over as Head of Department in January, from Professor Colin Humphreys. Although Alan is now well known for his work in polymers, he graduated with an Engineering degree in Metallurgy from Imperial College, London. He then studied for his PhD in Cambridge, working on the hydrogen embrittlement of nickel under Gerry Smith. His interest in polymers was sparked by spending 8 months in the Physics Department at Bristol, working with Andrew Keller. After another spell at Imperial, he moved back to Cambridge in 1975, where he built up the Polymer Group, concentrating initially on the structure of non-crystalline polymers. Computer modelling, particularly of diffraction patterns, has been an important theme in Alan's work over the past 25 years. (Yes, there was a computer around in those days! - just one for the whole University). The emphasis on modelling research in the polymer group is now moving from the molecular to the microstructural scale, and is a component of the rapidly growing co-ordinated programme into materials modelling in the Department.

Alan Windle was elected to the Chair of Materials Science at Cambridge in 1992. He is a fellow of Trinity College and played a central role in the formation of the Melville Laboratory, an interdepartmental laboratory devoted to polymer synthesis and one focus for polymer research throughout the University. He holds the Bessemer and Royal Society of Arts silver medal from Imperial College. In 1988 he was awarded the Rosenhain Medal by



the Institute of Metals and in 1992 the Swinburne Gold Medal and prize by the Plastics and Rubber Institute, both citing his research into liquid crystalline polymers. The author and co-author of over 150 papers and two books, he lives in Cambridge with his wife and family.

In his spare time (what spare time?) he flies light aeroplanes which he describes as "probably the most time efficient method possible of getting away from it all".

As the incoming Head of Department, Professor Windle sees his main objective as "steering a happy ship in a way which befits the quite exceptional talents of its crew". He says that "a major challenge in the years ahead will be to thrive as financial constraints become more real while the parameters which determine them become ever more mobile and subject to political manoeuvourings. We also have the challenge of financing our vision of a new International Materials Centre in West Cambridge, which is timed to coincide with the new millennium. But the key to all is never to take our eyes off the only target which really matters, which is the maintenance of absolute excellence in teaching and in research".

As this is the first edition of the Newsletter we would be grateful for any feedback with regard to presentation, content and to correctness of our address database. Please get in touch with Julie Trim at the address below or call on (01223) 334479, Fax (01223) 330590, email JT215@cam.ac.uk

University of Cambridge,
Department of Materials Science & Metallurgy,
Pembroke Street,
Cambridge
CB2 3QZ
http://www.msm.cam.ac.uk/

Thank you for your help with this.

This newsletter is edited by Sue Jackson, produced by Julie Trim and printed by Elitian Printers, Mill Road, Cambridge

Murder from Memory

Some people may remember Dr. Bill Welland who studied for his PhD way back in the early 70s under Professor Honeycombe. Bringing his wife, Sarah, at that time a budding novelist, to a Department Open Day had a surprising consequence. She was so inspired by the idea of the shape-memory metals that were being demonstrated, that she came up with what was possibly one of its first unexploited applications: an Untraceable Weapon. Those of you who want to know more should read the book:

'Dying Breath' by Sarah J.Mason. Berkley, USA-publ.1994 ISBN0-425-14245-0.