



The Institute of Materials, Minerals and Mining

BACK TO SCHOOL AGAIN...

**School
Affiliate
Scheme's**
Issue 15
Autumn Term 2003

Well its the start of my third year in this position and it looks like its going to be another fun packed year. This term I have been very busy travelling around the country talking to you and your students and am now taking bookings for next term. Last year I spoke to over 5000 people in total!

The Autumn Open Day programme is taking place again as we speak and over 600 students and teachers have signed up for visits. For more information about visiting your local university department see page 4

The materials departments are generally very willing to host school visits throughout the year so in this issue there is a focus on how you can make use of your local university at any time of the year. Most will also have Open Days and some run taster courses for students.

Also in this issue are the usual careers information and materials case studies, along with a review of the free resource available from the Aluminium Federation.

Just before the end of term you should have received a pack and questionnaire about the proposed Advanced level course in Materials. Although the deadline for replies has now passed we would be really grateful if you could take the time to complete the survey and send it back to us. The more input we have at this stage the better.

The robot wars competition launched last term closed in September and prizes were awarded in London on World Materials Day. In addition to their prizes the winning teams were also treated to a flight on the London Eye.

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Takes you in All Directions....

In previous newsletters the careers page has focussed on people that have chosen to stay in the field of materials. However, a qualification in a materials, minerals or mining related subject opens more doors than it closes. In this issue are two people who are now not strictly working in materials, but the knowledge and skills they learnt as part of their degrees are proving invaluable...

Dr Pullen is the *Business Group Manager* for QinetiQ in Farnborough and although starting out as a Materials Scientist, has now been promoted to management level.

What did you study? BSc in Materials Science at UMIST (1987) and PhD in Materials at the University of Birmingham (1991)

What do you do? I manage a group of 45 materials scientist and engineers, run a budget of £3.5million and manage a full manufacturing facility and testing, design and failure analysis labs.

Favourite projects? I manage a number of product development / license exploitation projects:- helmet technology being a good example of MoD technology to civil markets.

Who do you work with? I work closely with our marketing team on the definition of projects and products and then with senior technical leaders in my group to deliver the products.

Why do you enjoy your job? My job is a balance of technical, resource and business management which allows me to have the control to deliver solutions.

Fiona Rutter is a *Materials Information Consultant* for Granta Design.

What did you study? Materials Science and Metallurgy (as part of Natural Sciences) at Cambridge (1992).

What do you do? Produce databases of materials properties, used in education and industry both for reference and to select the best material for an application. I research new materials to add to the databases and to produce customised ones for particular clients.

Favourite projects? I've only been working here six months and am starting a database of corrosion information for an American client which should make use of experiences from my previous job.

Who do you work with? Other materials engineers in a similar role, software engineers and the sales and business development people who have the initial customer contact.

Why do you enjoy your job? Its an interesting blend of the materials science which I already know and the IT which I am having to learn. Its a small company with a definite culture of its own...

Association for Science Education Annual Meeting

The 2004 ASE meeting, as many of you will already know will be held at the University of Reading from Thursday 8 January to Saturday 10 January. As in previous years we will be exhibiting at for the full duration of the event.

When you visit our stand you will have the chance to talk to us about the Schools Affiliate Scheme, your opinions are very important to us, see the resources we have available, book a presentation in your school and discuss the content of the talks I give, find out the latest on the A-level project and generally have a chat!

You will be able to find us on *stand C03* in the main exhibition hall, close to the covered walkway to the Students Union. Please pop along and say hello it is always nice to put names to faces.

COMPOSITES ON TOUR

From May to July this year, the EU-developed Composites on Tour mobile exhibition travelled over 3500 miles across Britain. The tour, funded by the EPSRC and organised by the UK Centre for Materials Education (UKCME), was aimed at raising awareness of the uses and properties of composite materials amongst the public, and in particular school children.

The tour exhibited at ten different venues, including the Glasgow Science Centre, RAF Museum Hendon, INTECH Winchester, Imperial War Museum Duxford, Earth Centre Doncaster, Satrosphere Aberdeen, Discovery Museum Newcastle, The University of Liverpool, RAF Museum Cosford and Techniquist Cardiff.

Around 3000 visitors enjoyed the interactive exhibits as well as the numerous parts on display, with 77 percent of the school children surveyed finding the exhibition good/great and expressing a desire to find out more!



Based mainly on fibre-reinforced composites, the displays included a futuristic racing bike, an elegant shopping trolley, automotive and racing car parts, aerospace components, as well as a wide range of natural composites. A great favourite with the younger visitors was the wheel rim lift, where people got to compare the difference in weight between an aluminium and composite truck wheel.

A good time was had by all, with comments such as 'cool' and 'wow look at that' from the younger generation and a response of 'the composites exhibition was surprisingly interesting' being passed on from a survey performed at the RAF Museum Hendon. It was not just about having fun though, and with posters and helpers explaining the uses and properties of composite materials everyone left having learnt something new. This was typified by a young boy at the RAF Museum Cosford, who on his third visit - this time with his grandparents - proceeded to give them a walk through explanation of the exhibits and materials.

A large number of contacts were made at each of the venues, ranging from centre staff, teachers and science educators through to scout and girl group leaders, all of whom showed great enthusiasm for the initiative of the tour. All venues expressed a willingness to host the Composites on Tour exhibition should it return to UK shores in the future or ventures of a similar nature, commenting that it had added something extra to each of the their sites.

Due to teacher requests and the obvious enthusiasm of the school children, a CD-Rom detailing the properties and applications of composites, including a series of simple experiments, is currently under development at the UKCME. This will be made available by the end of August; meanwhile further information can be obtained by visiting www.materials.ac.uk or by contacting s.doyle@liverpool.ac.uk

DIANE'S DIARY

Back to school with a vengeance!

09/09 Tonyrefail School, Mid Glamorgan

11&12/09 UCAS Fair, Abredeen

16/09 Millom School, Cumbria

18/09 King Edward VI Southampton

18/09 Wellington College, Crowthorne

19/09 Peter Symonds College, Winchester

24/09 Colfes School, London

01/10 Teeside High School, Stockton-on-Tees

02/10 Gosforth East Middle School, Newcastle

07/10 Sutton Valence School, Maidstone

10/10 King Edward VI Handsworth

13/10 Ampleforth College

15/10 Canon Slade School, Bolton

20/10 Birkdale School, Sheffield

21/10 Garstang High School

23/10 Aquinas College, Stockport

28/10 Queen Ethelburga's School

01/11 Scottish TTA Conference

03/11 Mount Carmel School, Accrington

17/11 Royal Institution Materials Day

24/11 Sir John Deans College

27/11 Varndean College, Brighton

03/12 Colfes School, London

04/12 Stowe School

10/12 Cleeves School, Cheltenham

11/12 Queen Ethelburga's School

As you can see this term has been pretty busy and am now taking bookings for the Spring term.

If you would like to discuss a visit please get in touch. E-mail is the easiest way and you can find me at diane.talbot@iom3.org

ACCESS TO MATERIALS AT IMPERIAL

At Imperial we have been pro-active and built on last year's Autumn Open Day series by writing to the schools that came to us and signing them to a date outside the November scheme this year. In other words we are unashamedly using the Institute's scheme as a feeder into our own schools initiative. The eventual aim is to have experiments running in our labs on each and every Wednesday afternoon during the school term. At this point, next year we are expecting to host over 180 pupils.

The programme we offer is similar to that you will find in materials departments around the country. There is an interactive, introductory talk by a faculty member for 20 minutes. Following this groups of 4 to 5 students are led away to rotate through a series of experiments demonstrated by a PhD student. Tea and biscuits are served half way through the afternoon and it is during this break that the Admissions Tutor is available to hand out departmental booklets and answer any careers questions.

We have developed literature for each stage of the course (ask and you will receive). Initially, a letter is sent to schools outlining the course with aims and objectives, hopefully generating interest amongst the teachers. Once interest has been established a health and safety booklet is sent to each teacher. When the students arrive they each receive a general information pack which includes an evaluation form. At each experiment the student receives an experiment booklet describing the background science and engineering - although the teachers also often want to be involved in the experiments. The teachers get a special form asking for suggestions to help us evolve the afternoon's activities. We feel that the teachers must have direct input into the content if it is to be of tangible benefit to the schools programme. We can read about the national curriculum, you have to teach it.

If you would like further information about visiting the Materials Department at Imperial you can contact the Admissions Tutor, Robin Grimes on 020 7594 6730 or e-mail r.grimes@imperial.ac.uk. Alternatively you can find out more by visiting the home-page of the materials department at www.mt.ic.ac.uk and follow the link for the schools page.

November Autumn Open Day Programme

A huge thank you to all of you who attended the November Open Days this year. Over 600 students and teachers signed up to visit universities across the country and so far feedback from all camps has been very positive. If you still have not returned your evaluation forms I'd be grateful if you would do so as soon as possible as this will allow us to improve the programme in future years.

University Contacts

If you are unable to make it to one of the November Open Days but would still like your students to benefit from the experience of visiting a university why not contact your local department? Most departments are more than willing to have groups of school students in to carry out experiments and have a look round. During term time you may find the times they are available pretty restricted due to lab classes (Wednesday afternoons are usually best). But there are usually a couple of weeks at either end of term when you are still at school but the universities have already broken up when the timings can be a bit more flexible.

<i>University</i>	<i>Contact name</i>	<i>Telephone</i>	<i>E-mail</i>
Birmingham	Miss Carolyn Green	0121 414 5175	c.a.green@bham.ac.uk
Cambridge	Miss L L Dann	01223 334300	Web-replies@msm.cam.ac.uk
Imperial	Prof Robin Grimes	020 7594 6730	R.Grimes@ic.ac.uk
Leeds	Dr Rik Brydson	0113 343 2369	Materials@leeds.ac.uk
Liverpool	Prof Paul Chalker	0151 794 5371	Admis.ug.met@liv.ac.uk
Loughborough	Dr Rebecca Higginson	01509 223161	IPTME@lboro.ac.uk
Manchester / UMIST	Dr Steve Eichhorn	0161 200 5982	Materials@umist.ac.uk
Newcastle	Prof Steve Bull	0191 222 7913	s.j.bull@newcastle.ac.uk
London Metropolitan	Dr Alicia Chrysostomou	020 7753 3218	Asc003@unl.ac.uk
Nottingham	Dr Brian Noble	0115 951 3745	Brian.Noble@nottingham.ac.uk
Oxford	Dr Martin Carr	01865 273710	Martin.Carr@materials.ox.ac.uk
Queen Mary	Dr Rick Ubic	020 7782 5160	r.ubic@qmul.ac.uk
Sheffield	Dr Emma Wager	0114 222 5999	E.C.Wager@sheffield.ac.uk
Sheffield Hallam	Dr D Eaton	0114 225 3409	Eng-marketing@shu.ac.uk
Swansea	Dr Steve Brown	01792 295284	Eng.recruitment@swansea.ac.uk



Resources from the Aluminium Federation

The Aluminium Federation produces an excellent resource called "*Aluminium - a modern metal*" which links in to the national curriculum and covers a wide variety of metal, earth science and energy related topics.

The resource, which is available as a CD Rom consists of a Guide for Teachers and Pupil Activity Sheets which relate to the discovery, extraction, alloys, uses, recycling and environmental impact of aluminium. Ideas are given for discussions and investigations related to the topics covered and the resource is suitable for key stage 3 and key stage 4.

The Aluminium Federation as part of the Non Ferrous Alliance will be launching a new resource at the 2004 ASE Conference, which covers a whole host of non-ferrous materials. There will be a presentation on this resource on Thursday 8 January at 1600hrs in room 125 of the HUMSS building. Alternatively you can visit their exhibition stand located at A33.

If you would like to receive free copies of either or both of these resources please contact the Aluminium Federation on 0121 456 1103, e-mail alfed@alfed.org.uk or write to Aluminium Federation Ltd, Broadway House, Calthorpe Road, Five Ways, Birmingham, B15 1TN. You can also find more information on their web-site: www.alfed.org.uk

Update on Advanced Level Materials Course

Since the last issue of the newsletter we have made considerable progress in the initial development of an Advanced Level course in Materials. We have now completed our feasibility study and thank you very much to those of you that completed the survey we sent out, your replies were very much appreciated. To sum up your responses:

- 80% of respondents were in favour of developing the course and 78% of respondents thought we were approaching the project in the right way.
- Most respondents felt their current materials knowledge was either quite in depth or moderate and 48% said they felt confident to teach the proposed course.
- 87% felt the case study model for teaching the course would be beneficial and 83% thought the course would be interesting to teach.
- In terms of teaching resources to support the course the most useful were felt to be artefacts, the internet, textbooks, handouts. Respondents also felt that external visitors were useful and that it is important to incorporate university visits.

The responses from school pupils have also been very useful and reiterated to us that it is very important to make the course relevant to everyday life and include lots of examples.

Alongside our discussions with schools we have also been talking to the universities to gain their support. Again the feedback has generally been very positive.

The next step is to develop the draft course into a full specification and develop the supporting resources. After the Christmas break we will be putting together an overall steering group and focus groups to look at each module. We will also be linking up with an awarding body.

If you would like further information about the course please contact Dr Peter Davies on 01302 320486 or e-mail peter.davies@iom3.org

Materials for Skiing



Its almost that time of year when its snowing outside and those lucky enough jet off to snowier climbs for their annual skiing holiday. So I thought it might be interesting to have a look at that materials used in skis and ski clothing.

Would you believe that skiing dates back to post-glacial, stone-age peoples in northern Europe and Russia who used skis as a method travelling around while hunting. The first written account of skiing is in Viking Sagas dating back to 1000AD which described certain kings as excellent skiers. Early Scandinavian skis, used by the Army, were made from wood and consisted of one long ski for gliding and a shorter one for braking and steering, which could be covered in leather. These skis were made from pine or spruce and were between 2m and 4m long, approximately 10cm wide and 1.5cm thick, weighing in at around 12kg! It was virtually impossible to turn in these skis and steering and braking were achieved using a single pole. In 1868 the first cut-away ski was developed. This had wide ends but was narrower under the foot area, allowing greater maneuverability and

control. Hickory started being used for skis in the early 1880's but it could only be machined using modern carbon steel tools due to its high hardness. The first laminate ski were made in Norway and consisted of a hickory or ash base with and spruce body. This gave the ski much greater flexibility and decreased the weight. However the early glues were not water proof and the skis quickly delaminated. A segmented steel edge increased the grip of the ski on hard snow, but fastening these on to the wooden body again caused problems. The screws could become loose or worse the edge segments could snap!

The development of waterproof casein glues increased the durability of laminate skis and three layer skis with a vertically laminated core were much lighter and more responsive than their predecessors.

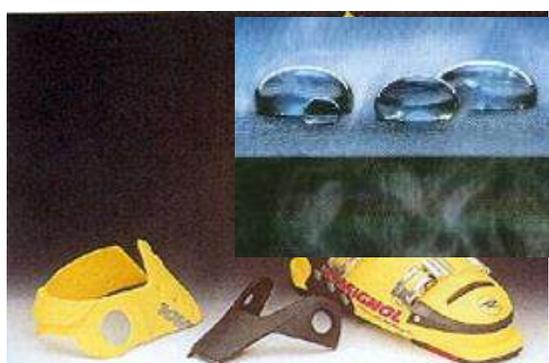
In 1945 the first aluminium containing skis were made and these were lighter and more flexible and durable again. These consisted of a layer of ply-wood sandwiched between two layer of aluminium.

The British team used a three layer ski at the 1948 Olympics in St Moritz consisting of a laminated wood core sandwiched between a bottom layer of aluminium and two top layers of plastic.



Glass-fibre reinforced plastic was first used successfully in skis in the late 1950's and composites were developed throughout the 1960's and 1970's. Fibre-glass was replaced by Kevlar fibres, carbon fibres and ceramic fibres allowing improvements in strength and damping to be made. Today skis are still multi layer and comprise of a wood core encapsulated within a layer of glass or carbon fibre reinforced plastic with metal edges bonded to the ski. Ski poles are now also made from carbon fibre reinforced plastic. The shape of the skis varies depending on the application, for example ski jumping skis are long, flat and wide whereas cross country skis are shorter and narrower.

The method of attaching the ski to the foot is crucial. Very early skis simply used one strap, but the introduction of a second willow ankle strap in 1868 allowed for greater control. Today the design and manufacture of ski bindings and boots plays an important role. The bindings are designed to hold the ski securely to the foot, but release it in the event of a fall. Bindings are made from both metal and polymers and the outer casings of ski boots are made from high impact polycarbonate.

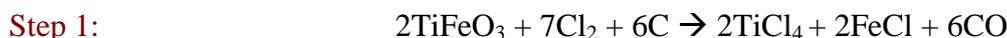


Ski clothing has also evolved over the years. In order to keep warm it is important to trap layers of air next to the body and in the past wool, cotton and silk have been used. However it is also important that the materials are waterproof and to an extent wind proof. Modern clothing is made from synthetic microfibre material which allows water vapour (from sweat) to escape but does not allow water droplets to pass through. These materials are also light and flexible allowing full range of movement.

So if you are going skiing this year just think of the materials you are using while whizzing down the piste!!

TITANIUM

- Titanium was first discovered as a new element in menachanite in 1791 by an Englishman, Reverend William Gregor. However, it was named in 1795 by Klaproth, a German chemist, who found the element in rutile and named it after the Titans (the sons of the Earth Goddess in Greek mythology).
- The impure metal was first extracted in 1887 by Nilson and Perterson but it was not until 1910 that pure titanium was produced by Matthew Hunter.
- Titanium has atomic number 22 and atomic mass 47.9, and is a silvery white metallic solid with a hexagonal close packed crystal structure.
- Titanium has been found in meteorites and is thought to be present in the sun. It is the ninth most abundant element in the Earth's crust and is generally found in igneous rocks and their sediments. Titanium can also be found in iron ores. The main deposits are found in N. America, Australia, Scandinavia and Malaysia.
- The main titanium containing minerals are *rutile* (TiO₂), *ilmenite* (TiFeO₃), and *sphene* (CaTiSiO₅).
- Up until 1946 the element was a laboratory curiosity. At this time Kroll prepared titanium commercially by reducing titanium tetrachloride with magnesium. The Kroll Process, as it became known, is still used to commercially produce titanium today. Firstly the titanium containing mineral (either ilmenite or rutile) is treated to produce titanium tetrachloride (Step 1). This is then reduced using magnesium, leaving a magnesium sponge which can be melted (under a helium or argon atmosphere) and cast into bars.



This reaction is carried out at 900 °C and the metal chlorides are separated by fractional distillation



This reaction is carried out at 1100 °C and then the magnesium chloride and excess magnesium are removed with water and hydrochloric acid.

- Titanium burns in air and is the only element that will burn in nitrogen.
- Titanium alloys are used extensively in aircraft both in the airframes and the engines, and in sport and medicine related applications. It is also starting to be used in jewellery.
- Titanium is coated in a thin layer of TiO₂ (like aluminium) thus making it quite inert. It is almost as corrosion resistant as platinum and so is used in some aggressive environments, particularly salty conditions. It is used in propeller shaft and rigging on ships and has the potential to be used in desalination plants.
- Titanium is as strong as steel but 45% lighter and twice as strong as aluminium but 60% heavier.
- Titanium is also an important alloying element in some steels as it helps to control the structure of the material during processing.
- By far the largest application on titanium is in its oxide form, TiO₂. This is a permanent white pigment which is used to colour paint, paper and plastics.
- TiO₂ is also produced artificially as a gemstone as it has a higher optical dispersion index than diamond.
- The presence of TiO₂ in sapphires and rubies causes asterism. The crystal structure of the TiO₂ is incompatible with that of the sapphire (which is Al₂O₃) thus is only forms on certain crystal planes. Light reflects from these TiO₂ crystals leading to a characteristic star shape within the stone.



- Titanium is also used in fireworks

This newsletter is written and edited by Dr Diane Talbot, Education Co-ordinator.

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