The Institute of Materials, Minerals & Mining

Schools Affiliate Scheme

Issue 27
Autumn Term 2007

NEWS

Big changes in Education

Hello and welcome to the first SAS newsletter of the new academic year. I hope that you had a good summer and did not get caught up in the dreadful weather - we narrowly escaped the floods in Filey!

The big news in this issue is the recruitment of two new members of staff to the Education Team here in Doncaster. Toby White, Education Co-ordinator (Minerals and Mining) explains his background and the presentations that he is offering to members on pages 2 and 9 respectively. The new Education Co-ordinator (Materials) should be in post by mid-September and you will be able to find out more about them in the next issue.

Also featuring in this issue are details of the upcoming season of November Open Days. Don't forget to book early to ensure that you get your first choice of date and venue. You can see a full list of events on page 10. If you would like to arrange a visit outside of these events, most departments are willing to accommodate groups of students throughout the year. If you would like the contact details for a particular department please get in touch (diane.aston@iom3.org)

On page 11 you can find out about the Starpack Schools Competition for 2008 and on page 4 a reminder about the Institute's Local Groups and Societies. Local events are the ideal opportunity for you to do some valuable networking with representatives from potentially useful organisations in your area!

The main feature in the centre pages of this issue looks at Smart Materials, as I know that many of you have found it tricky to find useful information about this topic. Hopefully you will find this a useful pull-out-and-keep resource!

Finally, we are launching a new Education Award for that special teacher that has made a valuable contribution to teaching a materials, minerals or mining related element of the curriculum. If you know someone that has brought that all important spark to the classroom why not nominate them for this prize? You can find out all about it on page 3.

This newsletter is written and edited by
Dr Diane Aston, Education Co-ordinator.
If you have any comments or articles please contact Diane by e-mail at Diane.Aston@iom3.org or write to her at
The Institute of Materials, Minerals and Mining,
Danum House, 6a South Parade, Doncaster, DN1 2DY

Introducing Toby White - Education Co-ordinator (Minerals & Mining)

As most of you know, Diane has been extolling the virtues of materials science and engineering for several years. I have now joined her on a part-time basis, to increase the resources on offer to schools, to spread the word on the role of minerals and mining in our world, and the opportunities that this sector offers. But how did I end up in this role? Here's a brief summary.

Having been fortunate to be able to do Geology at school, I knew that was what I wanted to study at University. During 3 wonderful years at Hull (1980-83) I was always more interested in the applied aspects of this diverse subject than in fossils, so when I completed my degree I undertook a research project for British Coal Opencast (1983-85). After 2½ years, I then went to work for British Coal as a surveyor, environmental engineer and general dogsbody!

A further research project followed a few years later (1989-93), this time with the Blasting Research Group at Leeds University's Mining Department. Funded by British Coal Opencast, it involved monitoring a disused property in the middle of an opencast coal site as the blasting got progressively closer. It was actually very hard to cause damage – which was of course what British Coal hoped would be the case!

When I left Leeds University (1993) I joined a small consultancy company, and it was during this time that I managed to combine my work in the mining and quarrying industry with some of my other interests like youth work, sailing and mountain leadership. It also gave me my first experience of working in schools, when I joined the PSHE team of my local high school and also started helping out with the Duke of Edinburgh Scheme. In fact I am still involved with the local DofE Group as the trainer for the Gold and Silver Expeditions, which is hard work but great fun.

In 1997 I was invited to do some part-time lecturing back at the University of Leeds' Mining Department, and then in 2002, I took a full-time role as a Project Manager, responsible for a number of quarrying projects funded from the Aggregates Levy. These centred on the development of an open access website (www.goodquarry.com) describing the good practice that can be used to minimise the effect of surface mining on the environment.

During the last 2 years I have spent time visiting A-level Geology groups, delivering lessons on mining and the environment, and encouraging students to consider a Mining degree and career. Globally, there is a massive shortage of mining engineers which isn't likely to change in the next few years, so there are some wonderful opportunities. These lessons started with support from the Earth Science Teachers' Association, and now that I have joined the Institute for two days a week, I hope to develop them and visit a greater number of schools. Although my initial focus will be related to Geology, I will eventually be able to offer material on mining and minerals which is relevant to other science subjects and beyond.

I continue to work at the University for three days a week where I run a postgraduate distance-learning course for Quarry Managers from Lafarge Aggregates Ltd, and contribute to a number of other quarry-related projects. Oh, and I still do a little bit of teaching!

I'm really excited about the opportunity to extend the work I have been doing in raising the profile of Mining and Minerals. The work I have been doing up until now has obviously had a University of Leeds recruitment dimension to it, which will not now be the case. However, there are only two Universities that teach Mining or Mineral Engineering (Leeds and Exeter) so I hope my work will benefit both institutions.

If you would like further information on the subjects I can currently offer, then please take a look at page9 to contact me directly at Toby.White@iom3.org.

Education is Expanding (in more ways than one!)

You may recall from the last issue of the newsletter that the Institute has been planning to expand the activities of the Education Team based here in Doncaster. The Schools Affiliate Scheme has grown considerably over the past few years, the demands on my time for visits have increased and the remit of the organisation has widened through mergers with other Institutes.

Over the summer we have been busy recruiting two new members of staff and in this issue I am pleased to introduce Toby White as the new Education Co-ordinator (Minerals and Mining). Toby will be working part-time out of the Doncaster office and will be available to give a range of presentations in schools. You can find out more about Toby on page 2, the activities he will be offering on page 9 and the dates he is available on page 4.

The new Education Co-ordinator (Materials) should be in post by the middle of September and they too will be busy travelling around visiting schools. You will be able to find out more about them in the Spring issue of the newsletter which will be winging its way to you after the Christmas holidays.

The most obvious expansion at the moment (at least to me!) is that of my tummy! The youngest member of the Education Team is due to make his entrance in to the world on or around the 26th November and we are fully expecting him to come out knowing my presentation word perfect! As a consequence of this I will be taking it a little bit easier during the Autumn term and will stop doing visits mid-October in the run up to my maternity leave. If all goes to plan I will be back working part-time early in the New Year, but will not be doing visits for a while.

Finally, writing about the new members of staff got me thinking that it might be a good idea to remind you exactly who we all are and put some faces to the names that you see on a regular basis. So, Ladies and Gentleman I give you the Institute of Materials, Minerals and Mining, Education Team!

Dr Peter Davies
Education and Accreditation Manager

Dr Diane Aston
Education Co-ordinator

Toby White
Education Co-ordinator (Minerals and Mining)

Anita Horton
Education Administrator and Regional Assistant

Recognising Excellence in Teaching

I am pleased to announce the expansion of the Institute's premiere awards to recognise the contributions made by individuals and teams to the educational, training and professional development needs of the Materials, Minerals & Mining community and to young people studying the National Curriculum in schools.

The ***Colin Humphreys' Education Award*** is the first in a series of these new awards and recognises the contribution made to enhancing students' scientific/technological literacy by the teaching/support of the Materials, Minerals or Mining topics within 11 – 19 Learning, either in the Secondary or FE sectors. The award winner will have demonstrated the importance of our discipline in pertinent and relevant contexts, provided excellent and innovative teaching/support of the discipline or developed innovative teaching resources. The award will be a silver gilt medal, certificate and £150 and will be open to members and non-members. Nominations will require a statement of achievements by a proposer including evidence of the successful use of the teaching/support activity. Further information for nominations can be obtained from Rachel Brooks at Rachel.Brooks@iom3.org.

School Visit Diaries

The last academic year was the busiest ever and quite unbelievably I spoke to just over 8400 people. The Autumn Term is shaping up to be relentless too and I am fully booked until the start of half term when I will be slowing down a bit in the run up to my maternity leave and passing on the visit baton to the new Education Co-ordinator (Materials). Here is where I will be going…

September		October	
11	Stonyhurst College, Clitheroe	1	Bryanston School, Blandford Forum
13	King Edward VI School, Southampton	3	The Sixth Form College, Farnborough
13	Wellington College, Crowthorne	9	Marlborough College
14	King James I College, Bishop Auckland	10	Aquinas College, Stockport
17	St Clement Danes School, Chorleywood	11	Cleeve School, Cheltenham
19	King Edward VI High School for Girls' Birmingham	12	Colyton Grammar School, Devon
19	King Edward VI Handsworth School, Birmingham	12	Kings College, Taunton
20	Peter Symonds College, Winchester	15	Walthamstow Hall, Sevenoaks
21	Queen Mary's College, Basingstoke	17	Cyfarthfa School, Merthyr Tydfil
25	Chelmer Valley High School Chelmsford	18	St Edward's School, Oxford
26	Northgate High School		
27	Saffron Walden County High School		
28	Stowe School, Buckinghamshire		

If you have made a booking for a school visit after half-term then our new Education Co-ordinator (Materials) will be contacting you in due course to sort out the final details. There are still spaces available in their diary for the latter part of the Autumn term and the Spring Term. For an up to date list of available dates please contact Anita.Horton@iom3.org

In addition to the materials talks which I have been giving for a number of years Toby White will be giving talks on a mineral and mining theme (more on details page 9). The dates available for these visits in the Autumn Term are as follows:

September: 26, 27

October: 03, 04, 16, 18, 31

November: 01, 06, 07, 08, 13, 14, 20, 21, 22, 27, 28, 29

December: 04, 05, 06, 11, 12, 13

If you would like to book one of these dates or find out more about the presentations available please contact Toby.White@iom3.org

Regional Diaries Reminder

Just a quick note to remind you that as members of the Schools Affiliate Scheme you have an open invitation to attend the meetings of your nearest local society. There are around 60 local groups around the UK who host an informal programme of lectures throughout the year, generally speaking once a month. Attending these is an ideal opportunity for you to bring your own knowledge up to date and meet with people from local industry who might be able to help you. You can find the full programme of events for the 2007-2008 season at www.iom3.org/regions/

SMART MATERIALS

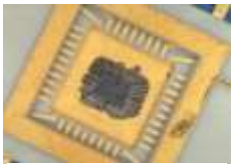
I am very aware that over the last twelve months many of you have been teaching smart materials for the first time. I have been inundated with requests for information, samples and presentations on this topic so I thought it would be worth exploring it here, so you can keep this for future reference.

What is a Smart Material?

Mankind has been using and developing materials throughout our history and in many cases advances in our technology have only arisen because of improvements in materials. For many centuries we have used materials because of their mechanical or structural properties, for example we use metals such as steel because they are strong and tough, or polymers because they are lightweight. These traditional materials can be described as structural materials, but in recent years we have started to use and develop functional materials too.

Millau Viaduct constructed from concrete and steel because of their mechanical properties

Functional materials are not usually used because of their mechanical properties, in fact they often have poor mechanical properties. These are materials that are used because of something else, perhaps their optical, electronic or thermal properties. Smart materials could be classified as a group of functional materials.



Silicon is used in microchips because of it's electronic properties

Smart materials have been around for many years and they have found a large number of applications. The use of the terms 'smart' and 'intelligent' to describe materials and systems came from the US and started in the 1980's despite the fact that some of these so-called smart materials had been around for decades.

A good place to start when trying to describe these materials is to look at what the word 'smart' actually means. One dictionary definition of smart describes something which is astute or 'operating as if by human intelligence' and this is what smart materials are. A smart material is one which reacts to a change in its environment all by itself. The change is inherent to the material and not a result of external electronics. The reaction may exhibit itself as a change in volume, a change in colour or a change in viscosity and this may occur in response to a change in temperature, stress, electrical current, or magnetic field. The change is also completely reversible and usually happens because the structure of the material (i.e. the way the atoms, molecules or crystals in the material are arranged) is changing. So, the coating used on spectacle lenses to turn them into sunglasses on a sunny day is a smart material because it changes according to the level of UV light, but Kevlar is not a smart material as it does not change with a change in it's surroundings. Kevlar is simply a very strong and tough modern structural material.

Smart Metals

Shape memory alloys (SMAs) are one of the most well known types of smart material and they have found extensive uses in the 70 years since their discovery.

A shape memory transformation was first observed in 1932 in an alloy made from gold and cadmium, and then later in brass in 1938. In 1962 an alloy of half titanium and half nickel was found to exhibit a significant shape memory effect and **Nitinol** (so named because it is made from ***ni***ckel and ***ti***tanium and its properties were discovered at the ***N***aval ***O***rdinance ***L***aboratories) has become the most commonly used smart metal. Other SMAs include those based on copper (in particular CuZnAl), NiAl and FeMnSi, but it should be noted that Nitinol has by far the most superior properties.

By changing how Nitinol is processed it can be trained or programmed to have one of three different properties.

In the **two-way shape memory effect** the material transforms between two different structures, one above and one below its transformation or memory temperature.

At the memory temperature the crystal structure of the material changes resulting in a volume or shape change The shape change may exhibit

(a) (b)

Two memory shapes of a memory metal wire coil or 'spring'. In (a) the spring is at room temperature and in (b) the higher temperature state has been activated by pouring on boiling water

itself as either an expansion or contraction. The transformation temperature can be tuned to within a couple of degrees by changing the alloy composition. Nitinol can be made with a transformation temperature anywhere between –100ºC and +100ºC which makes it very versatile.

Two-way shape memory metals can be used in a wide range of applications, many of which replace the traditional bimetallic strip. Coils of shape memory metal wire can be used as switches in temperature controlled circuits, such as the switch that turns off a boiling kettle or a central heating thermostat. They can also be incorporated into window hinge systems to open and close them at a particular temperature. Resistance heating may be employed to instigate the shape change by heating through only a few degrees and two-way shape memory wires could be used as artificial muscles which have an xpanded and contracted state.

If the material is processed in a slighty different way it can exhibit a **one-way shape memory**. In this case the material is flexible and can be bent and shaped to the desired geometry. However, when it is heated or cooled through it's memory temperature it reverts to its trained or programmed memory shape.

Smart bone plate

This one-way shape memory effect may be used in a number of medical applications ranging from bone plates to stents to dental braces. In a smart bone plate such as the one shown to the left, the surgeon receives the device in its deformed or stretched state (left). This is then attached to the two ends of the broken bone and heated to body temperature, at which point the memory shape returns and the plate contracts (right). As the bone plate shrinks it pulls the two ends of the bone into closer contact and this encourages faster bone growth and more rapid healing.

Tubes made from such a material may be used as couplings to join pipes of different materials or diameters. The coupling diameter is made slightly smaller than that of the tubes it is to join. The coupling is deformed so that it slips over the tube ends and the temperature changed to activate the memory. The coupling tube shrinks to hold the two ends together but can never fully transform so it exerts a constant force on the joined tubes.

The final useful property of these materials is their flexibility - these materials can be described as '**super-elastic**'. This property has been exploited in a number of applications such as mobile phone aerials, spectacle frames that can be bent and twisted without breaking and the underwires in bras. The kink resistance of these wires makes them useful in surgical tools which need to remain straight as they are passed through the body. Nitinol can be bent significantly further than stainless steel without suffering permanent deformation.

Smart Polymers

There are a number of classes of smart polymers which exhibit changes in a different property with different stimuli.

Chromic materials change colour with a change in one aspect of their environment and there are many types. *Electrochromic* materials literally change from transparent to opaque at the flick of a switch. Applying an electrical field to these materials causes a change in the structure and thus a change in colour. *Photochromic* materials change colour with a change in the level of UV light and have been widely used as coatings on spectacle lenses.

Photochromic spectacle lens which changes from clear to tinted when the level of UV light increases.

Probably the most well known group of colour changing materials are the *Thermochromic* polymers which change with a change in temperature. There are two types of thermochromic systems: those based on liquid crystals and those which rely on molecular rearrangement. In both cases a change in the structure of the material occurs at a particular temperature giving rise to an apparent change in colour. The change is reversible so as the material cools down it changes colour back to its original state. In both systems the thermochromic material does not generally produce two or more colours itself, the change is usually from coloured to transparent. As the thermochromic material changes it allows the base colour of the material underneath to become visible.

In liquid crystals the change from coloured to transparent takes place over a small temperature range (around 1°C) and arises as the crystals in the material change their orientation However, liquid crystals are relatively expensive and so where there is no need for the colour change to take place in a very narrow temperature window molecular rearrangement materials are employed.

Leucodyes change colour by molecular rearrangement and the colour and active temperature range of the dye can be controlled by changing the chemical groups on the corners and central site of the molecule. Leucodyes have a broader temperature range than liquid crystals and will usually change from coloured to transparent over approximately 5ºC.

Thermochromic materials have found a number of applications such as colour changing toothbrushes, baby spoons which indicate whether food is too hot and even kettles which change colour as the water is heated. The pigments can be incorporated in to dyes for fabric to produce clothing which changes colour with temperature.

Thermochromic inks can also be used for printing on to clothing and food packaging.

Thermochromic baby spoon at room temperature (left) and after immersion in boiling water (right)

Thermochromic thermometers consist of stripes of different colours representing the different temperatures, coated with a layer of thermochromic dye of varying thickness (it is thinner at the cool end of the thermometer than it is at the higher temperature end). As the thermometer is warmed the thin layer of dye warms up and becomes transparent first. The higher the temperature the thicker the layer of dye which can be warmed sufficiently to change colour. This principle is also employed in the tester strips which appear on the sides of some batteries, but this time the heat is generated by the resistance heating effect of a small electrical current flowing across the battery.

Thermochromic dyes with a higher temperature resistance and higher transition temperature have also been produced and incorporated in to pans. These pans have a small coloured circle in the bottom which changes colour when the pan has reached the optimum temperature for cooking.

Light emitting polymers are a relatively new group of materials which emit light when a voltage is applied. They are often called organic LEDs and the scope for their use is huge. Applications range from flexible lights for safety applications to roll-up televisions.

Shape memory polymers exhibit the same sort of behaviour as their metal counterparts, in that they will show a shape change with a change in temperature. Uses of these materials include couplings and linings for pipes.

Smart Ceramics

The piezoelectric effect was discovered in 1880 by Jacques and Pierre Curie who conducted a number of experiments using quartz crystals. This probably makes piezoelectric materials the oldest type of smart material. These materials, which are mainly ceramics, have since found a number of uses.

The piezoelectric effect and electrostriction are opposite phenomena and in both the shape change is associated with a change in the crystal structure of the material. Piezoelectric materials exhibit two crystalline forms, one form is ordered and relates to the polarisation of the molecules and the second is a non-polarised, disordered state.

If a voltage is applied to the non-polarised material a shape change occurs as the molecules reorganise to align in the electrical field. This is known as electrostriction.

Conversely, an electrical field is generated if a mechanical force is applied to the material to change its shape. This is the piezoelectric effect.

Although quartz has been used for the longest period of time, by far the most commonly used piezoelectric ceramic today is lead zirconium titanate (PZT). The physical properties of PZT can be controlled by changing it's chemistry and how it is processed. There are limitations associated with PZT; like all ceramics it is brittle giving rise to mechanical durability issues and there are also problems associated with joining it with other components in a system.

These materials have found a number of uses including air-bag actuators, earth quake detection systems, minute linear motors and damping systems. One exciting use of these materials is in flat panel speakers in which a voltage is used to make the material vibrate and produce sound waves.

Smart Composites

As with any other type of composite, smart composites are made by mixing different materials together. Quantum Tunnelling Composite (QTS) is made by adding a very fine nickel powder to a polymer resin and is interesting because the electrical resistance of the material decreases as pressure is applied to it, in an almost linear relationship. The change in resistance is not due to improved conductivity as the nickel particles are pushed into contact with each other, rather it arises because of a quantum tunnelling effect. Once the pressure is released the resistance increases again. Although this is a very new material there is a lot of scope for its use. Suggested applications include its use as a variable resistor, as a switch for power tools, a switch for lighting which can be laid under a carpet, an indicator in non-contact sports and even pressure sensor in the finger tips of robotic arms and prosthetic limbs!.

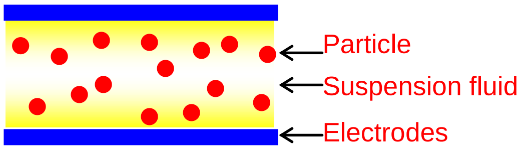
Smart Fluids

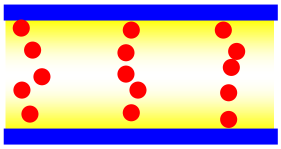
There are a number of different types of smart fluids, but in each case the viscosity of the material changes in response to the specific stimulus.

One of the most well known smart fluids is the toy Silly Putty which is a type of **non-Newtonian fluid**. The viscosity of Silly Putty is dependent on the rate at which it is deformed, the faster it is deformed the more viscous is becomes. Silly putty is actually a type of silicone compound called polyborosiloxane, which consists of long chain molecules with bulky side groups. When the material is deformed slowly the structure can flow, but when deformed rapidly the structure locks together and the material can become very brittle. *Dilatant* materials, such as silly putty can be used to damp out vibrations in structures or even in protective sports wear and as a polishing medium. You can easily make an example of a dilatant material using cornflour and water. The opposite of a dilatant material is a *thixotropic* material, in which case the viscosity decreases as the rate of deformation increases. Examples of thixotropic materials include non-drip paint, tomato ketchup and quick sand!

Other types of smart fluids rely on a suspension of very fine, micron-sized particles in a carrier liquid such as glycerol or mineral oil. In an **electro-rheological fluid** the viscosity increases in the presence of an electrical field. In a **magneto-rheological fluid** the viscosity changes in the presence of a magnetic field.

In both cases the smart fluid changes from a liquid to a solid with the application of the relevant field. The small particles in the fluid align and are attracted to each other resulting in a dramatic change in viscosity. The effect takes milliseconds to occur and is completely reversible by the removal of the field.





Particles in a smart fluid go from a disordered (top) to ordered (bottom) state in the presence of an applied field

Where can I find out more?

A wealth of information on the different types of smart materials exists out there on the internet, but you do need to be careful and search for the correct specific terms, e.g. thermochromic polymers.

Most of the information in this article was drawn from the presentation on Smart Materials that I give in schools and the Smart Materials resource that the Institute produced in 2002.

Samples of many types of smart materials can be obtained from the Science Enhancement Programme (SEP) and Technology Enhancement Programme (TEP), who also produce a couple of written resources on smart materials. You can find out more at www.sep.org, www.tep.org or www.mutr.co.uk

Mining and Mineral Lessons Currently On Offer

The lessons currently available are aimed primarily at meeting the requirements of the two A-level Geology syllabi. Both the WJEC and the OCR have sections that include aspects of Mining in their AS-level courses, and so a number of lessons have been developed using Power Point presentations that cover the relevant material.

I am also currently working on some lessons for WJEC's GCSE Geology syllabus and the A2 syllabi for both WJEC and OCR. I hope to have these available in the Autumn.

Existing Lessons

Hazards Associated with Mining

WJEC AS-Level Geology - GL3: Key Idea 3(c) Mining

This covers the problems associated with the extraction of rock and minerals – face, roof and slope stability (underground & surface mines), subsidence (difference between longwall and room & pillar methods), methane, AMD (related to coal and metal mines), waste including tailings dams failures (several examples) and tip failures (Aberfan), and other environmental impacts (water, dust, noise, etc). Several different examples are used.

As you can see, there is a lot of material here, and it is best covered in 90 minutes, but I have shortened it to 40 before!

St Aidans Extension OCCS: The River Aire Slope Failure, 1988

WJEC AS-Level Geology GL3: Key Idea 3(c) Mining

This is a detailed case study (as required in this section) of the St Aidans highwall failure, when the River Aire completely flooded the void, causing a 10 year delay in mining and a bill of over £20M. The presentation introduces opencast methods and describes how the effects of subsidence, limited exploration drilling, the presence of a well formed seat-earth (intra formational shear zone) and old workings, and a continual feed of water from the river through a fault zone, all combined to cause a massive slope failure. A mass of rock 350m long by 150m wide by 50m high slide up to 4m into the void, creating a fracture which allow the River Aire to flow into the site.

This is quite a technical presentation and needs time to describe all the different elements.

Coal Mining: Extraction and Geological/Environmental Problems

OCR AS-Level Geology Module 2833, Component 01: Economic and Environmental Geology

This introduces a number of methods of extracting coal (surface, pillar & stall, and longwall shearing) and describes the geological problems (structural problems, changes in character, washouts, stability, etc.) and environmental problems (water, AMD, subsidence, methane, waste, noise, dust, blasting, etc.) which can affect successful and acceptable operations

This lesson is best delivered over 90 minutes, but can be done in less.

Lessons in development

WJEC GCSE Geology - Topic 4: Earth Resources. Sub-section 4.1: Fossil Fuels

This presentation will cover the geological features involved in the mining of coal and the relative merits of underground and opencast coal mining methods in terms of productivity and the environment. It will probably also include information on exploration and on the formation of coal.

WJEC A2-Level Geology - GL5: Theme 2. Geology of Natural Resources

Key Idea 1(a) Formation of metalliferous ores

OCR A2-Level Geology - Module 2835: Petrology

5.5.1 Igneous Classification & Processes (k) the physical characteristics and origin of the hydrothermal vein minerals and the identification of galena, sphalerite, fluorite, barites and iron pyrites.

I am aware that there is quite a lot more than could be developed in relation to mining and minerals, and so I hope to add to this over the coming years. If you would like to discuss one of these presentations in more details or would like to suggest an area for development, please get in touch with me on 01302 320486 or e-mail Toby.White@iom3.org.

November Open Days update

By now you should have received the flyer giving details and dates for the 2007 Autumn Open Day Programme, but just in case you haven't here is all you need to know...

As usual these events have been designed to support the teaching of the materials topics in advanced level physics, chemistry and design technology courses and will give you and your students the opportunity to access equipment that is not readily available in school. Groups will typically get hands-on experience of materials testing and optical and electron microscopy on a wide variety of materials, and the chance to explore new materials developments. The open days are free to attend, you will just need to arrange your own transport to and from the venue. This year events will be held at the following locations:

University	*Date(s)*	*Time(s)*
University of Birmingham	07, 14, 21, 28 November	1300 to 1530
University of Cambridge	11 December	Tba
Imperial College	07, 14, 21, 28 November	1230 to 1630
University of Leeds	07, 14, 21, 28 November	1230 to 1530
London Metropolitan University	05, 19, 26 November	1330 to 1600
University of Loughborough	06, 08 November	1300 to 1530
University of Manchester	07, 14, 21, 28 November	1400 to 1600
University of Newcastle	14, 21 November	1330 to 1530
University of Oxford	06, 22 November	1000 to 1500
Queen Mary, University of London	14, 21 November	1300 to 1530
University of Sheffield	07, 21 November	1400 to 1600
University of Swansea	07, 14 November	1400 to 1600

In most cases there is some flexibility on the timing and if you would like to attend but cannot do so on one of these dates you may be able to organise an alternative at a more suitable time. Dates will be allocated on a first come first served basis and you may book more than one visit as the maximum group size varies from 20 to 40 depending on the venue. The only way to book a place on one of these events is to fill in the booking form on the back of the leaflet that has been sent out separately. If you have not got a booking form please e-mail me, diane.aston@iom3.org and I will get one out to you. You can also get in touch if you would like more information about specific dates or to check availability.

A match MADE in heaven?

The Materials and Design Exchange (MADE) was launched in 2005 to bring together materials scientists and designers. It has been recognised that the once very separate fields of science and art are becoming much more closely related with designers needing at least a basic understanding of materials.

The Institute is now publishing a magazine for the materials and design communities three times a year and we thought this might be of benefit to schools, particularly those teaching the various branches of Design and Technology. The last issue featured articles on smart materials, eco-friendly plastics and recycled resources.

You can find out more about MADE and join the community by registering on their website, www.iom3.org/MADE/index.htm. Once you have registered (which is free of charge) you will be able to access the magazine and take part in the one day seminars and workshops which are also being organised. The themes of upcoming events include 'Ceramics in the kitchen' and 'Another side to fashion'.

MATERIALS AND DESIGN EXCHANGE

MADE is just one node of the Materials Knowledge Transfer Network (KTN) which you may have read about in Materials World. You can find out more about the other nodes (including SMART.mat, which focuses on smart materials, surfaces and structures) on the KTN website, www.materialsktn.net.

Schools Starpack Awards

Recognising Packaging Innovation

The Schools Starpack Awards briefs provide excellent opportunities for Key Stage 3, 4 and AS level, individual or joint activities depending on the brief chosen. Packaging is an exciting industry and there is a growing demand for packaging designers. Not only does a pack have to be aesthetically pleasing, it also needs to meet the functional requirements to preserve the contents, and be produced cost effectively, with due regard to environmental issues.

2007 Schools Gold winners

The briefs for the 2008 schools competition are outlines below:

PET CARE STARTER PACK

Key stage 4 and AS level

Sponsored by Pro Carton

For this brief, you are asked to design and produce a 'Care Pack for a Small Pet' made from cartonboard. Choose a pet from the range of small animal, reptile or insect groups.

INSTANT PICNIC PACK

Key stage 3

Sponsored by British Polythene Industries (BPI)

Your brief is to design and produce an environmentally friendly 'Instant Picnic Pack'. The Pack is to contain compostable knives, forks, plates, cups and serviettes.

MATERIALS RESEARCH BRIEF - INTELLIGENT DISASTER AID PACK

Key Stage 4

Sponsored by the Institute of Materials, Minerals & Mining (IOM^3)

With the developments in new materials and in particular intelligent packaging materials, you are required to explore the potential of designing a piece of packaging and specifying the materials appropriate for a 'disaster situation'.

MESSAGE ON A CAN – ENVIRONMENTAL AWARENESS

Key Stage 3, Key Stage 4 and AS Level

Sponsored by The Can Makers

You are invited to design a graphic for a drinks can that illustrates the environmental benefits of recycling cans. The graphic can be either applied directly to the surface of a drinks can or with a wrap around label.

A Schools Starpack Awards Brochure will be sent to you shortly, but full details can also be found on the website – www.starpack..uk.com. For more information about the competition please contact *Rachel Brooks, Awards & Starpack Co-ordinator, email: Rachel.brooks@iom3.org*

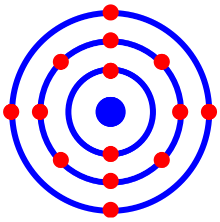
Are you looking for a special speaker?

Over the summer holidays I had the pleasure of meeting a really wonderful lady. Marie-Noëlle Barton MBE is the former Director of the WISE Campaign and is now an inspirational professional speaker, offering a range of presentations suitable for careers events, prize giving days and conferences. Her main focus is the promotion of science and engineering, in particular to girls, and her talks look at modern, relevant examples of science and engineering in action. For more information you can visit www.mnbarton.co.uk or e-mail speech@mnbarton.co.uk or look at the enclosed leaflet.

Silicon

Each and every one of us relies on silicon in many of the things we do everyday. But how much do you know about the eighth most abundant element in the Universe and second most comon element (by mass) in the Earth's crust?

- The basics: atomic number 14, melting point 1414°C, boiling point 3265°C, density 2.33gcm^{-3}
- Silicon is chemically very similar to carbon, having four electrons in its outer valence shell.
- At room temperature silicon is a bluish-grey lustrous solid that is quite strong, but brittle and easily chips.
- Silicon was first identified as an element in 1823 in Sweden by Berzelius. This was some thirty six years after Antoine Lavoisier had mistakenly idenified silicon as the compound silica.



Electron configuration in a silicon atom showing 4 outer electrons

- Silicon is obtained from silica (SiO_2), a mineral which has a number of forms including quartz, sand, amethyst, agate, flint and opal. In addition it is found in silicate minerals consisting of silicon, oxygen and another metal, such as feldspar, mica and asbestos which are found in rocks, clays and sand.
- Silicon is extracted commercially by reducing silica with wood, charcoal or coal in an electric arc furnace with copper electrodes at 1900°C, where the following reaction takes place:

$$SiO_2 + C \rightarrow Si + CO_2$$

- Liquid silicon is collected and tapped from the bottom of the furnace and is 98% pure. At this level of purity the silicon is termed 'metallurgical grade'.
- The high purity silicon used in the electronics industry contains impurities at a level of 1 part per billion, which means that the metallurgical grade material must be refined. This refining can be done either using either a physical process such as zone refining or chemical process in which an intermiediate silicon compound is purified before being converted back to the very pure element.
- 55% of all silicon produced is used in the production of aluminium-silicon alloys for manufacturing automotive castings. 40% is used in the synthesis of silicones. Silicon is also an important alloying addition in some steels and cast irons.

Al-Si automotive castings

- High purity silicon single crystals are extensively used in the electronics industry in the production of microchips. The crystals are grown using the Czochralski method in which a seed crystal is dipped into a molten pool of silicon and then slowly withdrawn. Silicon solidifies on the seed with it's atomic planes in a specific direction and this technique allows crystals with a diameter in excess of 300mm to be produced. By doping silicon with other elements in either group III or group V it's electronic properties can be controlled.
- Silicon can be used in lasers to produce cohert light with a wavelength of 456nm and transmits 95% of all infrared wavelengths.
- Silicon has a number of very important compounds. These include silicon carbide, which is used as an abrasive and silicones (polysiloxanes) which have found a wide range of applications ranging from bath sealant to cookware to artificial body parts. Silicones have good thermal stability, low toxicity and reactivity, and are flexible, resistant to sunlight and good insulators. They range from hard rubbery solids to viscous liquids and one of the best known silicone compounds is Silly Putty!
- Silica is an important ingredient in concrete and Portland cement. It is the main ingredient of glass and is used in optical fibres. Silica is an excellent electrical and thermal insulator and is used in the heat shield of the space shuttle.

The Institute of Materials, Minerals and Mining (Head office) 1 Carlton House Terrace, London, SW1Y 3DB Tel 020 7451 7300, www.iom3.org	Education Team, Doncaster Regional Office Danum House, 6a South Parade Doncaster, DN1 2DY Tel 01302 320486, Fax 01302 380900