schools affiliate scheme

CONNECTING TEACHERS TO THE WORLD OF MATERIALS, MINERALS AND MINING

news

Issue 33

Autumn Term 2009

Hello and welcome to the new look newsletter!

The Schools Affiliate Scheme is celebrating its tenth anniversary this year and we thought that the logo could do with a bit of a face lift! We hope you like the new look and remember to watch out for the new logo on all our publications.

This newsletter is packed with useful information as usual and features a reminder of the events we are busy organising at the moment. The remaining Autumn Open Days and a reminder of how to apply are on page two and details of our next conference on nanotechnology and a review of the Flying High with Materials Conference are on page three.

It is getting to that time of year when I am sure you are busy helping your new year 13 students fill in their UCAS application forms. This issue features two articles looking at undergraduate courses in materials and minerals and mining engineering.

Over the summer the Institute of Wood Science merged with IOM3 to further broaden the range of materials in which we have expertise. To this end I thought it might be a nice welcome to include the centre page feature on one of nature's most useful and varied materials.

Finally, you can also find the usual SAS update, diary and element focus contained within these pages. As you can see from the diary this is going to be a hectic term and I look forward to seeing many of you and your students on my travels.

In this issue:

IOM3 The Institute of Materials, Minerals and Mining

This newsletter is written and edited by Dr Diane Aston, Education Co-ordinator. If you have any comments or articles please contact Diane by emailing Diane.Aston@iom3.org or write to her at The Institute of Materials, Minerals and Mining, Grantham Regional Centre, The Boilerhouse, Springfield Business Park, Caunt Road, Grantham, Lincolnshire, NG31 7FZ

Colin Humphreys Education Award 2010

Nominations are now open for the 2010 Colin Humphreys Education Award. This award recognises the contribution made to enhancing students' scientific / technological literacy through the teaching or support of the materials, minerals or mining topics in the 11-19 curriculum, within the secondary or FE sectors. Nominations are open to members and non members and will require a statement of achievement. The recipient will receive a medal which will be presented at the Institute's main awards dinner in summer 2010.

For more information and a nomination form please contact Rachel Brooks on 01476 513885 or email Rachel.brooks@iom3.org.

The winner of the Colin Humphreys Education Award for 2009 was Jim Jenner a D&T teacher at Northgate High School in Ipswich. The judging committee felt that Jim had repeatedly gone above and beyond the call of duty to enhance his students' experiences of materials.

Autumn Open Day Programme

Just a quick reminder that the Autumn Open Day programme will soon be upon us. There was a steady flow of bookings before the summer and a number of venues are already fully booked. However there are still places available and there is still time to book. A list of the dates remaining at the time of writing is below. If you would like to book one of these please return a completed registration form (sent out before summer) or alternatively email me (diane.aston@iom3.org) with November Open Days in the subject line and include the following details: your first, second and third choice of date and venue, your school and address, your contact telephone and fax numbers and your email address, your name and position and the course you are teaching (e.g. OCR Physics, syllabus B) and the number of students and teachers in your party. The final deadline for bookings is Friday 23 October.

Venue	**Dates and time**	**Venue**	**Dates and time**
Birmingham	11/11, 18/11 1330 to 1530	Exeter	11/11, 18/11 1300 to 1700
Leeds	04/11, 11/11, 25/11 1230 to 1600	Newcastle	11/11, 18/11, 25/11 1330 to 1530
Liverpool	04/11 1200 to 1530	Swansea	03/11, 1300 to 1600

New CD Rom from MATTER

About 10 years ago the MATTER team, based at the University of Liverpool, created an interactive CD Rom which was designed to help pupils at key stages 3 and 4 with a number of important materials-related concepts in the national curriculum for science. This proved very popular with schools around the country and following on from its success MATTER, with the support of the Worshipful Company of Armourers and Brasiers', IOM3, the RSC, the Salters' Institute and UKCME, have updated and re-launched this excellent resource.

The CD Rom is free to all schools and I am pleased to enclose a copy for you with this newsletter. I hope that you find it useful and relevant to your teaching, but if not, please pass it on to someone who can use it!

Student Starpack Design Awards for Schools 2010

NOW OPEN FOR ENTRIES

Cash prizes of up to £500 for the award winning schools and up to £50 for individual students!

It is pretty unlikely that any career-conversations have ever included packaging as an option, although packaging is in constant discussion in regard to materials and waste in the environment, and in retailing where most consumer goods advertise product using pack images.

The Schools briefs are aimed at Key Stage 3, 4 and AS level, individual or joint activity, depending on the brief.

Insect/Small Reptile Pet Carrier - design and produce a new style functional and safe travel pack for insects and/or small reptiles.

New 'Ribena' Drink in a Bottle - design a new shaped bottle to replace the current carton packaging on sale.

Materials Research Brief – Interactive POS/Display Unit for Apple i-phone - design an interactive Point-Of-Sale / Merchandising Unit to display and promote the phone and this new product.

Themed/Fun Chocolate Gift Pack - design and produce a new distinctive and fun chocolate pack to contain between 4 and 6 specialist chocolates

For more information or a brochure contact rachel.brooks@iom3.org or alternatively details will be available from 1st October at www.starpack.uk.com.

Nanotechnology – small world, big ideas

October 2010, IOM3 Grantham

At a recent meeting where teachers were present we were told that some schools need nine to twelve months notice of events in order to be able to book them in to the school calendar and get permission to have time out of the classroom. So here is your advance notice!!

In October 2010 we are planning to run the next in our series of conferences for teachers on Nanotechnology. We know that this is a pretty hot topic at the moment and have had many requests for information from science teachers in particular. The idea of this full day event is to give you all the information you need so that you can teach this area of the curriculum confidently. Lectures will describe exactly what nanotechnology and nanomaterials involve, the hazards associated with them and where they are already used and might be used in the future.

The event will be held at our new facility in Grantham and will once again be free for any teacher from a SAS member school to attend.

The full programme and exact date will be launched at the ASE meeting in January and these will also be given in the next newsletter.

The **Flying High with Materials** conference on 07 October was a great success. Fourteen teachers from schools all over the country attended and all agreed that it had been a very worthwhile endeavour. I particularly enjoyed the talk on ceramics, as it gave me lots of ideas! The practical activity in the afternoon was well received and the delegates appreciated the opportunity to take resources away to use back in the classroom.

Things to look out for...

- Check that the course you are studying is accredited. Materials courses will be accredited by the Institute of Materials, Minerals and Mining, but some may also be accredited by other Institutions such as the Institution of Mechanical Engineering
- If you would like travel during your time at university, look for a course with the option of working or studying abroad.
- Look for a course with an industrial placement scheme. Employers like graduates with some experience.
- Look for a department with a good research rating. Most lecturers also have active research interests.
- Look for a department with research activity in the areas of materials that you are interested in.
- Look for scholarship and bursary opportunities linked to good entry qualifications.
- Look for a department with good industrial links. Many research groups work closely with companies and look to employ good graduates from linked departments.

Undergraduate courses in Materials

It is that time of year again when I expect your new year 13 students are trying to decide what to do with the rest of their lives, or at least which course to study at university. Hopefully some of them will consider applying to do materials or a materials-related course, which let's face it covers just about everything! There is no doubt about it, materials are everywhere! Any student undertaking a course in any engineering discipline, design, or physical science will at least have the option of studying some materials during their course; however, there are courses that focus entirely or mainly on materials.

Students serious about becoming a professional engineer (Chartered Engineer) must now study a four year MEng course which is accredited by the relevant institution on behalf of the Engineering Council. BEng courses lasting three years are also available and it is often possible to transfer between the two at the end of the second year. However, make sure your students apply for a four year course if they think they might want to transfer from a BEng, as this may avoid problems with funding later on.

Courses accredited by IOM3 are currently run at the following universities in the UK: Bradford, Birmingham, Cambridge, Cranfield, Exeter, Heriot-Watt, Imperial College, Leeds, Liverpool, Loughborough, Manchester, Napier, Nottingham, Oxford, Queen Mary (University of London), Sheffield and Swansea. The materials courses will all cover the structure, properties and processing of the main material groups and they may also look at materials used in particular applications such as medicine, aerospace or sport. Courses generally feature a mixture of lectures, lab classes, small group and individual project work and case studies and tutorials. Any science or engineering course will have more hours of contact time with staff in the department than an arts or humanities based course and this can make the transition from school to university that bit easier for some students.

I have always said that the accredited materials courses are very similar in terms of content, but the departments and universities vary greatly. Some students will prefer to be in a campus environment, others in the middle of town. I think it is really important that students have the opportunity to visit the different places they are applying to as they will ultimately have to spend three or four years of their life studying there. The choice of final course is likely to depend as much on their gut feeling for a place as the course itself!

Materials at Leeds

The Materials Science and Engineering course run in the School of Process, Environmental and Materials Engineering (SPEME) at the University of Leeds is being re-launched for 2010 entry and offers an excellent place to study surrounded by world-class research facilities - SPEME is ranked number three in general engineering in the UK after Cambridge and Oxford (2008 Research Assessment Exercise). The teaching labs in Leeds have recently been refurbished to provide a stimulating environment in which to study. A selection of the modules taught in the four year MEng course includes:

YEAR 1
Engineering materials
Materials Science
Materials Technology & sustainability
Topics in nanotechnology

YEAR 2
Materials properties & performance
Materials structures and characterisation
Nano and micro structural control
Laboratory and project assignments

YEAR 3
Individual research project
Materials design and selection
Metals and alloys
Polymers, ceramics and composites
Organisational and professional studies

YEAR 4
Interdisciplinary industrial design project
Advanced materials and processes
Failure analysis
Materials modelling
Sustainability and process efficiency

The course offers students the opportunity for industrial placements of up to 12 months duration without extending the 4-year programme together with the option to live and study abroad for up to one year. The department has excellent links with industry on both a local and international level and their graduates are highly sought after by employers.

The course is assessed through a mixture of formal examinations, tests and coursework distributed throughout the year and the department has an excellent team of tutors and support staff to help those students that may be struggling. For those who excel both on entry and during the course, a number of prizes, scholarship and sponsorships are available.

Like many materials departments, Leeds is small and friendly and new undergraduates soon get to know all the staff and students. Outside the department there is a thriving social scene both within the university and the city. The university has over 260 clubs and societies and one of the most active students unions in the UK. The City of Leeds is very student friendly and in additional to all the benefits of living in a big multicultural city, the Yorkshire Dales are only a short distance away.

Entry requirements

The entry requirement for the MEng / BEng course in Materials Science and Engineering is AAB at A-level including two from Maths, Physics, Chemistry or Design Technology. Other qualifications are also accepted.

For more information

Contact SPEME Undergraduate Admissions Team by emailing ugspemeadmissions@leeds.ac.uk or phoning 0113 343 2535. Alternatively visit www.engineering.leeds.ac.uk/speme.

The SAS Page...

Visit diary

After a very hectic summer term and a busy summer holiday we are about to hit the road again. I am afraid that this term has already pretty much booked up as far as materials visits are concerned, but Toby still has dates available for geology visits. If you would like to book for Toby to come to your school and work with your geology students please get in touch with Sarah Harrison (sarah.harrison@iom3.org) and she will be able to give you the most up-to-date list of available dates. So far this term we will be visiting:

September		13	Hymers College
15	Physics at Work Exhibition	16	Merchant Taylors Girls
18/19	ESTA Conference	17	St Mark's School
23	Sussex Downs College	18	Blacon High School
28/29	School tour of Ireland	23	Clyst Vale School
29	Hymers College	24	Cirencester College
30	Northgate High School	25	The Sixth Form College
October		26	Altrincham Boys Grammar
05	Bedwas School	**December**	
07	Flying High with Materials	01	Chipping Campden School
08	Ampleforth College	03	Marlborough College
09	St George's Tech College	03	Wells Cathedral School
12	Moulton School	04	Kings College Taunton
14	Kings of Wessex School	04	King Edward VI, S'hants
15	King James I School	08	NSLC, York
19	John Masefield School	08	ESEF Meeting
20	St Edward's Middle School	09	QEGS, Horncastle
21	Walthamstow Hall	10	Hills Road Sixth Form Coll.
November		10	Lutterworth College
03	Sutton Coldfield Girls	14	Larbert High School
04	Balcarras School	15	Thomas Rotherham College
07	TTA Conference	16	City of Portsmouth Boys
10	Sir John Deane's College	17	Queens Park School
11	Shaftesbury School	Visit by Diane Aston or Toby White	

We are already taking bookings for visits in the Spring Term and still have a few dates available. For a list of dates or to book either myself or Toby to come and visit your school please contact Sarah Harrison.

2009 – 2010 SAS Resource

'Bridges – spanning the gap between construction and materials' is currently in the final stages of writing and should be going down to our design team to be turned into something really professional very soon. I would hope that this will be out to those of you that are renewing your membership this term as soon as possible. Thank you for your patience and I hope you find the book worth waiting for!

Local Society News

As I am sure you are aware, as members of our SAS you have an open invitation to attend the meetings of the local societies in your region. There are some 60 or so groups located all over the UK, some specialising in particular materials, some in mining, others in packaging or clay technology. Each year the societies put on a varied lecture programme for their local members and although some of these talks may be quite specific and technical many are often entertaining and of general interest to all. On average the societies put on one lecture each month in venues ranging from university departments to company conference centres and sports grounds to hotels.

You can find out the calendar of events in your area by visiting www.iom3.org/content/local-societies.

A number of local societies are also keen to build links with schools in their area. If you would like more information please contact diane.aston@iom3.org.

WOOD – The ultimate natural material

Wood has been used by Man for many thousands of years; fallen logs made crude bridges over streams and gorges, branches were used as simple tools, wood was used to construct simple shelters and of course logs were used as fuel to provide heat and warmth. Over the centuries we have learned to shape wood into complex instruments and change its growth habits through coppicing to provide a ready source of material.

Wood is still one of the most commonly used engineering materials, in fact with an annual consumption of 10,000,000,000 tonnes its use is comparable to that of iron and steel. It is a relatively cheap material (about 1/60th of the cost of steel per tonne), it has a high strength to weight ratio and it is both strong and tough. The properties of wood are, however, anisotropic; that is to say that they are not the same in all directions. It is important when describing the mechanical properties of wood to specify whether these are parallel or perpendicular to the direction of the grain. The properties of wood are also dramatically altered by changing the water content; generally increasing the water content decreases strength.

In this article the structure, properties and uses of this very versatile natural material will be discussed.

Types of Wood

There are many individual types of wood available with unique properties that make them suited to particular applications. Generally the wood we see and use around us can be split in to three categories: softwood, hardwood and processed wood which can be made from either of the two former types.

Softwood

Softwood is a term used to describe wood obtained from conifers. These are a family of typically evergreen trees which grow at a relatively fast rate. These trees are particularly useful as they tend to grow tall and straight without branches on the lower part of the trunk producing a very straight and regular grain. The most commonly used softwood by far is pine, though larch and cypress are also used and about 80% of the worlds timber production is in the form of softwoods.

Hardwood

Hard wood trees tend to be broad leaved and are mostly deciduous, though some growing in subtropical and tropical environments are evergreen. These trees are generally much slower growing and produce a more irregular grain pattern. Hardwood does not refer to the mechanical properties of the material in any way, in fact some hard woods are softer than some soft woods!

Common hardwoods include oak, beech, mahogany, ash, maple, cherry, holly, teak, and balsa.

Processed wood

This includes a whole range of products that are manufactured from either soft or hardwoods. Processing the wood means that improved properties can be acheived and in particular the properties become less anisotropic. Processed woods include plywood, made by laying up thin sheets of wood with the grain running at different angles, medium denisty fibreboard (MDF) made by bonding wood dust with a resin and block board, made by gluing pieces of wood together. Wood is also used in the manufacture of paper and board.

Timber Production

Timber comes from trees (no really!), which must first be felled before they can be transported to be processed. There are a number of techniques for this initial logging stage. Tree-length logging involves felling the tree and then removing all the branches before transportation, the branches and wood debris are left on-site where they provide valuable nutrients as they rot and a habitat for wildlife. In full-tree logging the whole tree is taken to be processed close by. Again the branches are removed and these can be chipped and taken away to use as mulch or fuel. In both of these cases the tree trunks will be cut into manageable logs before being loaded on to trucks. In the final method the trees are cut into manageable logs at the felling site and the waste material (branches etc.) are left on-site.

The logging site is often quite some distance from roads so moving the cut trees to trucks can often be difficult. Traditionally heavy horses were used to transport the logs but now specially designed vehicles are used.

Timber Processing

The cut logs are transported to a saw mill for primary processing. On arrival the logs are scaled. This involves measuring them to determine how much useable timber can be produced. The logs then move on to a debarking machine that removes the bark and evens out their surface. Then they move on to a primary saw which either cuts the long logs into shorter sections or cants, or slices then into planks. Once the shape of the planks has been evened out they must be dried. Green wood or freshly cut wood has a high water content and for most applications, must be allowed to dry out before it is used. This seasoning process can be carried out naturally by leaving the wood out in the open or by gently warming it in a kiln to speed the process up. It is important to season the wood before use, particularly for structural applications as it will shrink as it dries out naturally and this can cause splitting or warping. In some woods this shrinkage can be as much as 10% in the direction perpendicular to the grain.

Once dried the wood can be cut to its final dimensions and the surface planed to give a better finish.

Uses of Wood

Over the centuries wood has been used in many applications from tools to cooking vessels, to frames for houses and as a fuel. Here just some of these applications will be considered.

Wood as a structural material for buildings

The earliest evidence of wood being used in the construction of a domestic dwelling in Britain dates back to 7000BC! This was a tent-like structure which used wooden supports. For many centuries wooden framed houses have been constructed and indeed many of these have are still standing! Medieval timber buildings were constructed from a frame made from green oak. Each individual part of the frame was individually carved so that the pieces fit together perfectly like a three dimensional jigsaw. The spaces between the oak frames would be filled using wattle and daub. The wattle is made by weaving thin branches or slats together to create a framework on to which daub is applied. The daub is made by binding together an aggregate and reinforcement. The binder could be clay, lime or chalk dust, the aggregate crushed stone or sand and the reinforcement some kind of fibrous material such as straw or hair. This technique has been adopted in modern architecture as lath and plaster.

Wood as a structural material for boat building

Wood has been used for building boats and ships for hundreds of years. It is used because it is cheap, easy to work and buoyant. In order to make the hull water resistant woods with a close grain such as oak and cedar are used as they are naturally more resistant to rotting. The outside of the hull is also coated in an epoxy resin.

Wood – a sustainable material

Wood is probably the most well know material which comes from a renewable source. The trees pull carbon dioxide from the atmosphere as they grow and lock the carbon in to their structure, and they release oxygen back in to the air as part of the photosynthesis process.

Many species of wood, particularly the conifers are relatively fast growing and new trees are planted as mature trees are felled. Wood can also be recycled with relative ease. Many hardwoods, on the other hand, are relatively slow growing and cannot be easily replaced.

However, care should be taken when choosing wood products to ensure that the material does originate from a sustainably managed forest. Deforestation in rain forest regions can have catastrophic effects on the ecosystem.

The best way to identify whether wood or wood based products originate from a sustainable source is to look out for the FSC logo. The Forest Stewardship Council certifies wood, paper and other tree products that have come from sustainably managed sources.

Where can I find out more?

There are a large number of books and websites available which look at the many aspects of wood, from detailed analysis of its structure to its use in design. Over the summer the Institute of Wood Science merged with IOM3 to create a new technical division - The Wood Technology Society The Institute is also taking over the running of the various wood related training courses offered by the former IWSc. For more information visit our website.

The Structure of Wood

Wood is an organic material that can be described as a fibre composite with a complex cellular structure; it consists of cellulose fibres in a lignin matrix. The cells in a tree vary in diameter between 10μm and 100μm and these are surrounded by a rigid cell wall. 90 to 95% of the cells are elongated parallel to the trunk and the remaining 5 to 10% are arranged radially giving rise to the anisotropic properties. The trunk consists of three distinct sections: the physiologically inactive heartwood in the centre of the tree is surrounded by sapwood where all the storage and conduction takes place; the bark protects the interior of the tree.

Softwoods and hardwoods have different internal structures. In softwoods the elongated vertical cells are 2mm to 4mm long and 30μm wide and these are used to carry fluids and support the structure. The storage cells are found in the radial direction. The thick walled vertical cells in a hardwood are typically 1mm to 2mm long and 15μm wide and these are only used for support. Phloem and xylem vessels which are much smaller are used for conduction purposes.

The trunk of a tree is pre-stressed as the heartwood in the centre is in compression and the exterior sapwood is in tension. This happens as the inner sapwood is converted to heartwood by drying out and shrinking.

The characteristic ring pattern across the diameter of a tree trunk is produced as the cells grow in the spring and summer when moisture is available and then dry out and die off in the winter. In a good growing year the growth ring is wider than in a bad year when there is less water available.

Exam question master class - Alloys part 3

The idea for this article came from a question in the AQA GCSE Science A, Unit C1a Higher Tier paper from June 2007. The multiple choice question was as follows:

"Pure copper is quite soft. It can be made harder by mixing it with zinc. This is because...

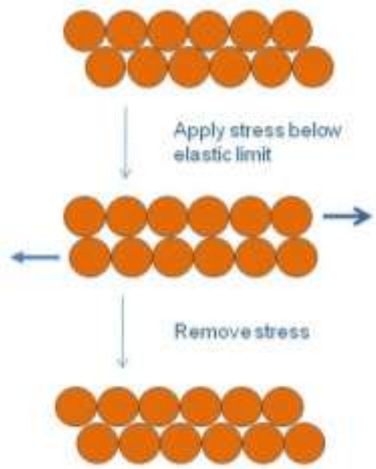
1 the copper atoms cannot now easily slide over each other.
2 the zinc atoms attach themselves strongly to the copper atoms.
3 the zinc atoms form strong bonds with the copper atoms.
4 zinc is harder than copper."

The Education Committee felt that this opened the door for an important and wider discussion on metals and alloys and how they can be strengthened.

In this final article in the series strengthening mechanisms in alloys will be discussed. However, in order to understand how these mechanisms work, deformation in metals must first be addressed.

Deformation in metals and alloys

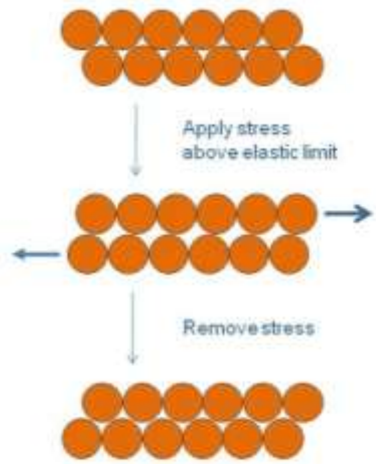
Deformation in metals and alloys can be split into two stages. During elastic deformation the crystal lattice undergoes limited distortion when a stress is applied. However, the stress is not sufficient to move the atoms permanently from their ordered position and when the stress is removed the distortion disappears as the atoms return to their original places (see schematic diagram top right).



Schematic diagram showing movement of atoms when a stress below the elastic limit is applied

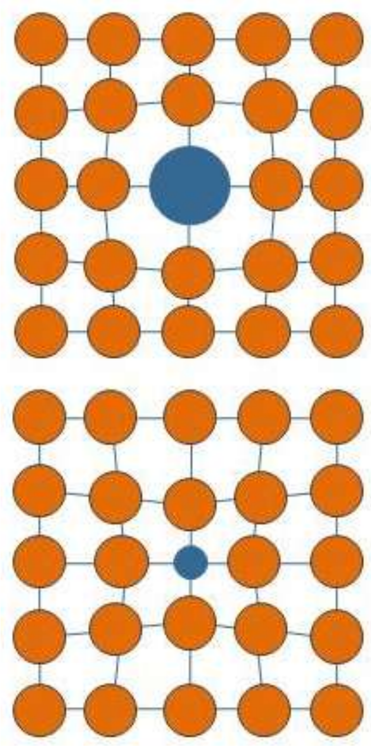
If a stress is applied which exceeds the elastic limit of the material permanent or plastic deformation occurs. In this case the applied stress provides enough energy for the atoms to move to a new position and the material remains distorted when this is removed (see schematic diagram bottom right).

Plastic deformation occurs by a process called **slip** in which one close packed plane of atoms slides over another. Slip occurs most readily in crystal structures with many close packed planes, thus metals such as copper and aluminium which have a face centred cubic structure are more malleable and ductile than metals which are hexagonal close packed such as zinc. The force required to produce slip by simultaneously moving a whole plane of atoms is very high and in practice it takes place in a number of steps by the movement of **dislocations** through the lattice.

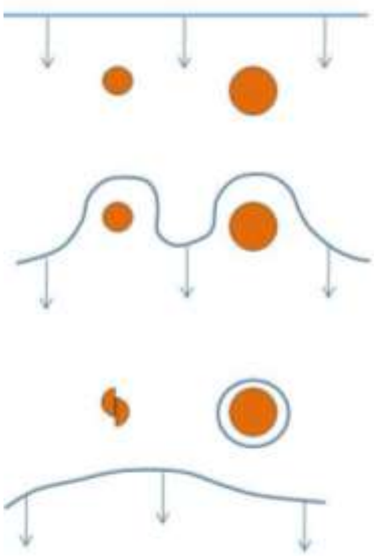


Schematic diagram showing movement of atoms when a stress above the elastic limit is applied

A dislocation is a distorted region or fault in a perfect crystal lattice and plastic deformation is facilitated by the movement of these defects. Dislocations are produced on grain boundaries as the metal solidifies, where planes of atoms are not perfectly aligned, and on other imperfections within the growing crystals. They may also multiply during cold work. Metals and alloys can be strengthened by making it more difficult for the dislocations to move through the structure by the introduction of strain in the lattice or physical obstacles.



Schematic diagrams showing strain induced in the lattice of a substitutional alloy when the solute atoms are larger (top) and smaller (bottom) than the solvent atoms.



Schematic diagram showing the interaction of a moving dislocation (blue) with a small particle and a large particle. The dislocation cuts through the small particle but loops around the large one.

Solid solution strengthening

In the first part of this discussion in Issue 31 substitutional and interstitial alloys were considered. In both of these cases the presence of the alloying addition, or solute atom, introduces strain into the crystal lattice.

In a substitutional alloy a compressive stress is introduced around the solute atoms if they are larger than the solvent atoms and a tensile stress is introduced if they are smaller than the atoms of the base metal (see diagram top left). The presence of the strain field around the solute atoms will either attract or repel dislocations. This allows the strain associated with the dislocation to be relieved thus putting it into a lower energy state. The solute particle effectively pins the dislocation. In order to get the dislocations moving again a greater stress is required to overcome the attraction / repulsion to the solute atoms, this makes it more difficult to deform the material and therefore the yield and tensile strength are increased.

A similar story is true with interstitial alloys. The solute atoms in this case sit in the octahedral gaps or interstices between the solvent atoms. This also induces a strain in the lattice which hinders the movement of dislocations and provides strengthening.

Precipitation strengthening

Some alloys are designed to facilitate the precipitation of a second phase. This second phase may vary in shape and size, depending on its type and the processing conditions. The presence of a second phase in the form of small, finely dispersed particles may induce precipitation or dispersion strengthening since the particles can pin dislocations in a similar way to solute atoms. The degree of strengthening depends on the size of the particles, the distance between them and the strength of the bond between the particle and the matrix. A dislocation will cut through a small particle thus increasing the particle / matrix interfacial energy and making it more difficult for following dislocations to pass. Dislocations will tend to bow around larger particles creating loops which further impede the movement of following dislocations (see diagram bottom left)

Microstructural control through processing

In reality alloys can be designed to gain strengthening both by solute atoms and precipitates. By carefully controlling the processing conditions, e.g. cooling rate from the liquid state, hot working where deformation is applied whilst the alloy is at a temperature above $0.6T_m$ and cold working, the optimum microstructure for improved strength may be achieved.

Undergraduate courses in Minerals and Mining Engineering

When thinking about courses connected with Mining and Minerals, it is important to realise that these divide up into engineering degrees and science degrees.

On the engineering side, there are now very few places where you can study a Mining or Minerals Engineering degree. The University of Leeds currently offers a three or four year course (BEng/MEng) in Mining and Quarry Engineering, while the University of Exeter offers a three year BEng in Mining Engineering. Both of these courses cover similar material and will equip the student for mine management and mine design, as well as a host of other areas such as environment, finance, health & safety, etc.

Currently, the only university that offers a degree in Mineral Engineering is Leeds, where it is offered as an option combined with Chemical Engineering. This course focuses on the physical and chemical processes required to separate the useful material from the raw material that is recovered in the mines.

Mining companies will also employ or use mechanical engineers, electrical engineers and structural engineers amongst others, so it is possible to get into the mining industry through one of these subjects. However, it is the mining engineers who understand how all these disciplines fit together, which explains why there is such a thing as a Mining degree.

All engineering subjects require a reasonable level of numeracy, so often Maths and/or Physics are required at A-level. Geology is not required but can be an advantage for Mining Engineers particularly, as it means that the students will already have started to develop the ability to think in 3-D, which is crucial for designing and running a mine. It is the engineering branches of the mining industry where the greatest opportunities and rewards currently exist. There is still a global shortage of mining engineers which doesn't look like it will be resolved in the short term.

Many mining companies will also employ or use consultants who are engineering geologists, and there are a number of Universities who offer this at undergraduate level. The focus here is on ensuring that as rock is excavated from surface or underground mines, the faces or tunnels remain stable and do not collapse unexpectedly! Engineering geologists will also work on major construction projects in civil engineering.

The most obvious relationship between geology and the mining industry is in the exploration for natural resources such as oil, gas, coal, metals or industrial minerals. Most undergraduate courses in geology or earth sciences will contain some element of exploration geology, but some universities offer courses which focus on petroleum exploration or mining exploration or even both. The job markets in these areas have recently dipped, but they seem to be picking up again. It's worth bearing in mind that although there are a lot of jobs, there are also a lot of geology graduates competing for them.

The best advice to students is to search the UCAS website using some key words like mining, quarrying, mineral, applied geology, engineering geology, exploration geology, resource geology, etc. But it's also worth bearing in mind that some general geology, geosciences or earth science degrees can also have a strong element of mining related geology, so it's worth looking at the modules contained in the different courses and asking where graduates end up working.

So to summarise, there is still a strong demand for engineers in the mining industry. The demand for geologists in the mining industry has always been cyclic (reflecting economic conditions), but we will always need them, because we depend on them to find the resources we still rely on.

The Minerals and Mining page...

As expected, the end of the summer term was relatively quiet, although I did visit a number of schools and colleges who were starting the A2 material before the summer. I was also involved in both of the Smallpeice Trust taster courses in Mining and Mineral Engineering; one at Leeds and one at CSM in Cornwall. Over 60 Year 11 & 12 students heard about and experienced many different aspects of the mining industry, including the salaries and opportunities that are still available, even in the current economic climate. These courses are well worth publicising to your students and are heavily subsidised, so check out their website (www.smallpeicetrust.org.uk).

September sees my first trip to Dublin, visiting three schools and two INSET type events. Although this is mainly for lessons in material science, I hope to find out more about the geology education scene in Ireland while I am there.

As I write this, I have just returned from two very different conferences. The first was in Granada, Spain, called Fragblast-9: 9th International Symposium on Rock Fragmentation by Blasting. As some of you know, my research interest at the University of Leeds is the environmental impact (on people and structures) of ground vibrations from rock blasting. If you haven't seen my blasting videos yet, remind me to show them the next time I visit your school or college!

The second was the annual conference of the Earth Science Teacher's Association, held this year at the National Oceanic Centre, part of the University of Southampton. A number of new members were signed up for the Schools Affiliate Scheme and quite a few school visits were booked between November and May! There were some excellent presentations, including one by Dr Iain Stewart (yes – him on the telly), in which we were treated to a world exclusive from his new TV show, probably on our screens in the new year. If you are a geology teacher and not a member of ESTA or have not attended the conference, I would thoroughly recommend it. It's informative and fun. Next year I believe it will be at Leicester University which has an excellent Geology department and does a lot of outreach work into schools.

Finally, if you would like me to visit your school or college this year, then please get in touch as soon as you can to ensure you get the date that suits you. Don't worry if the group is small, I'm still happy to visit. I look forward to seeing you later in the year.

Ecton Hill Field Studies Association

EHFSA has for many years run tutored one-day courses to support A-level science courses in Chemistry and Geology.

Both Chemistry and Geology courses focus on the application of these sciences to some or all of the following:

- the unusual copper mineralisation at Ecton, and the geological setting
- the mining of these ores
- the collection and identification of the minerals present
- the separation of the economic minerals
- the extraction of copper from these.

Courses can be tailored to the needs of different A level specifications on request, including fieldwork requirements for Geology. All A-level courses provide the opportunity for an underground visit into Salt's Level to see the mineralisation, and understand how the miners were able to make the mine such a profitable enterprise.

Ecton lies in Staffordshire, in the valley of the River Manifold.

For more information about visiting or to book on-line please visit www.ectonhillfsa.org.uk.

Where does Gallium come from?

Discovery

When Mendeleev was putting together his Periodic Table of the elements he predicted the existence of an element beneath aluminium and named it eka-aluminium. He accurately predicted most of the properties of this new material.

Gallium was actually discovered in 1875 by Lecoq de Boisbaudran, a French Scientist. He observed two previously unidentified violet spectral lines when he was analysing zinc blende from the Pyrenees and suggested these must be from an unknown element. He obtained the free metal later the same year by electrolysing a solution of potassium hydroxide containing gallium hydroxide. He named the element gallium after his home country as Gallia means France in Latin.

Gallite (grey) mixed with germanite (gold) and renierite (red)

Occurrence

Like most elements, gallium does not exist in its elemental form in nature. Gallium occurs at a concentration of about 16.9ppm in the Earth's crust, but the few gallium-rich minerals (such as gallite – $CuGaS_2$) are too rare to serve as a primary source. Gallium is however, found as a trace element in a number of other common ores. The main sources are bauxite and sphalerite though it is also found in other zinc and germanium ores.

The main suppliers of gallium are France, Australia, China, Germany, Kazakhstan, Japan and Russia

Bauxite mining in Australia

Extraction

The primary source of gallium is obtained as a by-product of bauxite processing. During the Bayer Process, which uses electrolysis to extract aluminium, an alkaline solution rich in gallium is produced (sodium gallate). The concentration of gallium in this solution is further increased by electrolysis using a mercury electrode. Liquid gallium is then produced by electrolysis of the sodium gallate using a stainless steel cathode.

The purity of the gallium metal produced by electrolysis can be increased by zone refining. In this process a long cylinder of gallium is put in a furnace with a moveable heating element. The heating element starts at one end of the bar and slowly moves to the other, thus creating a moving zone of molten metal. The leading edge of the molten zone consists of impure metal and any impurities are concentrated in this region. The trailing edge of the molten zone contains purified material. Once the process is complete, the end of the cylinder containing all the impurities can be removed.

GALLIUM

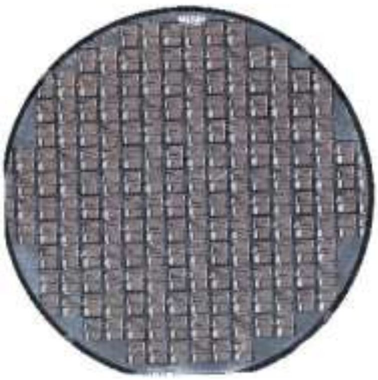
	Al	Si
Zn	Ga	Ge
Cd	In	Sn

- Gallium has atomic number 31 and atomic mass 69.72. In the periodic table it sits in the same group as aluminium and indium and between zinc and germanium.
- It is solid at room temperature, but will melt in the palm of your hand, having a melting point of just 29.76°C. Gallium is liquid over a wide temperature range and boils at 2204°C.
- Solid gallium has a density of 5.91gcm^{-3} near room temperature and is one of very few materials that expand on solidification, in this case by 3.1%. This means the metal cannot be stored in glass or metal containers due to the risk of rupture. Other materials with this unusual property are germanium, silicon, bismuth, and water.

- The large liquid range of gallium means that it can be used in metal-in-glass high temperature thermometers. However, despite being less toxic than mercury it is more difficult to handle as it wets glass and skin.
- Gallium can attack most other metals by diffusing into their crystal lattice where it can cause embrittlement. However it has been used an alloying element, particularly for creating alloys with a low melting point or to aid wetting in solders.

- The biggest use of gallium by far is in the semiconductor industry where it is used in the form of gallium arsenide (GaAs) and gallium nitride (GaN).
- Gallium arsenide is a semiconductor that is used in optoelectronic devices such as LEDs (light emitting diodes) and laser diodes. GaAs is relatively insensitive to heat and resistant to radiation damage, making it suitable for integrated circuits and other devices for space applications. It generates less noise than some other semiconductors thus making it suitable for weak signal amplification devices which operate at ultra high radio frequencies.

- Gallium nitride is used in LEDs as it produces blue light. Blue LEDs completed the range of primary colours and allowed the development of full colour LED displays, white LEDs and blue laser devices. GaN-based violet laser diodes are used in Blu-Ray technology, e.g. the Sony PS3. By mixing GaN with other materials the full colour spectrum of LEDs can be produced. One potential mass market application of GaN is in the form of a radio frequency transistor which can be used as the microwave source for domestic microwave ovens.



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