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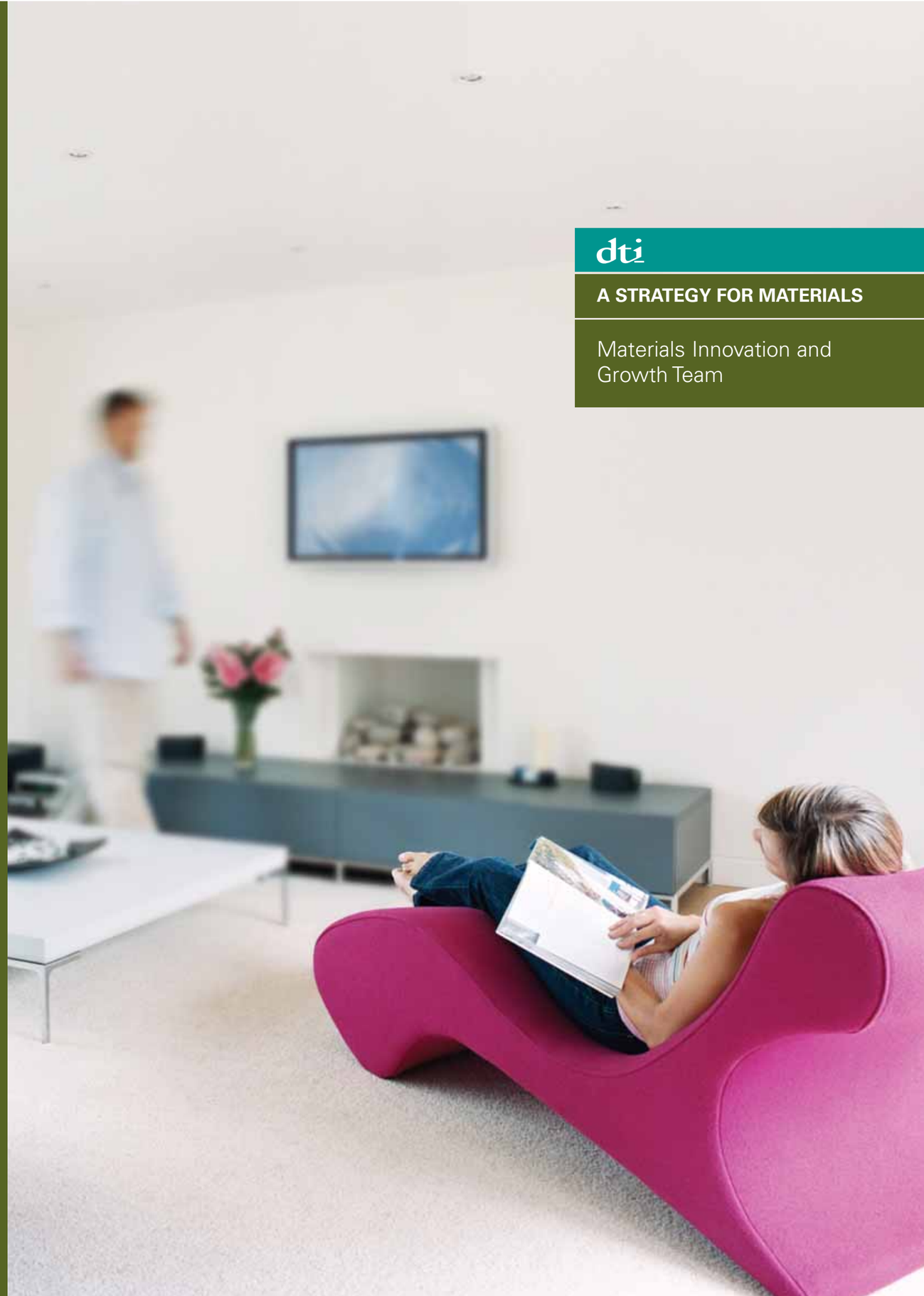

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A STRATEGY FOR MATERIALS

Materials Innovation and Growth Team

Contents

Supporting this report of the Materials IGT's findings, we have reproduced on the attached CD the record of various workshops held to inform the work and a series of working papers written by the Task Groups covering:

- Science & Technology.
- Policy & Impact.
- Assets & Infrastructure.
- Best Practice.
- People & Skills.
- Economic Analysis.
- International comparisons.

Forewords

Foreword by the Prime Minister

I must congratulate the materials industry for coming together to form this Innovation and Growth Team and providing this excellent report.

I am delighted the whole materials community, industry, academia customers and other stakeholders, are determined to continue to drive forward together to deliver a strategy that will enable Britain to continue to benefit from being one of the foremost advanced technological societies in which world class materials expertise underpins sustainable growth.

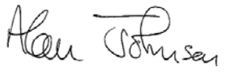
I wish them and the body they are forming, Materials UK, every success as they strive to deliver the challenging but very necessary agenda they are proposing.

The Rt. Hon. Tony Blair Prime Minister

Foreword by the Secretary of State

Materials are important to everyday life. It seems eminently sensible that Britain seeks to ensure it optimises the wealth creation opportunities materials production, processing, use, recycling and re-use provide. However, tough challenges lie ahead, the global economy is highly competitive. While we still retain some excellence in traditional materials, it is essential we continue to evolve this and develop our expertise in the newer emerging materials such as composites and smart materials utilising our acknowledged world class academic expertise in materials and other technology such as nano and bio-technology. The strategy produced by Wyn and his team should help us do this. I wish them well as they move into the implementation phase and hope that Materials UK does indeed become the driving force for continuing success in Materials.

The Rt. Hon. Alan Johnson MP



Chairmans introduction
by Wyn Jones, OBE, Chairman Materials IGT

The UK has a long established reputation for excellence in materials science, research and development. Companies in the UK excel in the development and use of materials in engineering and constructional steels, float glass, aerospace and automotive. They also excel in bio-pharmaceutical manufacturing.

The consumption of materials, directly or in manufactured products, is growing in the UK as it is globally. In emerging economies people aspire to the fundamentals of modern life including good health and nutrition. In advanced countries people show little sign of abating their desire for improved life styles and this is politically difficult to change. New technologies, such as communications, create new demands for materials and developments in materials. This growth in the use of materials - and acceptance of the challenges posed by health, climate change, energy supply and the quest for sustainability - place pressures to use materials differently and more wisely. Innovation has to bridge the conflict between satisfying the global demands of societies and what is sustainable.

Sophisticated societies employ regulation to bridge any gaps between the desirable and undesired effect of human endeavour. Not all countries have the same regulatory framework, for example on environment and energy matters. Regulatory interfaces tend to be larger for materials than for other industries and can be more complex. It is therefore important that regulation is intelligent and focused on the intended outcomes rather than prescriptive on the methods of achieving them. The materials community believes the focus on sustainability is rightly growing but the recycling infrastructure in the UK and its regulatory regime needs to change to promote the avoidance of, collection, segregation, and reuse, of waste.

The "Materials Industry" has largely been defined intuitively. Metrics are not readily available and the community, although containing significant skills, is fragmented and disparate. Because of this my team deployed a wide focus on supply chain issues rather than selecting a group of materials. By looking at the supply chains and infrastructure, we have identified ways in which the UK can continue to prosper from materials manufacturing by improving knowledge transfer and innovation. There is significant scope for sharing information and addressing common barriers.

Decisions on manufacturing, design and engineering are often taken outside the UK. By improving the UK infrastructure and networks, in the widest sense, sound decision making will be accelerated making the UK a better choice for multinationals to continue to invest. Also, public procurement will benefit from improved coordination in promoting and delivering sustainable supply chains.

From the viewpoint of skills, "materials" has an undeservedly dull image in the UK that pays little regard to the highly innovative worlds of nanotechnology and miniaturisation, or

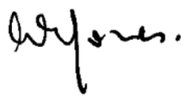
to the huge progress in "traditional" materials. The absence of a good image hinders recruitment and this in turn leads to insufficient skills at both the technical and research levels.

Many issues, such as better regulation and the need to improve sustainability, affect all materials. Skills and education are also common issues, as is image. Many of the challenges facing society will rely on multi-material solutions. There is a need for a clear interface between the major forces driving industry and the supply chains affecting materials.

By working in an industry-led cooperation across supply chains the materials community can address the common themes uncovered in our year long investigation. We are forming Materials UK, an industry-led body with a clear purpose and well defined measures of success. The new body will build on what has gone before. In broad terms it will improve the efficiency of communication, accelerate innovation and the transfer of knowledge, and help to reduce regulatory and financial risk. Its aim is to resolve the multinational dilemma by making the UK the best place in which to do business involving materials.

We have welcomed the involvement of customers and specifiers in our task groups, as well as representation from manufacturers, academics and representative organisations. We are also grateful for the significant interest from Government Departments.

I thank my colleagues from industry, academia and many government bodies for their support of this IGT. It has been a major enterprise and the enthusiasm and tremendous commitment shown convinces me that the materials industry in the UK has found a way to address itself to a challenging world. I also pay tribute to the foundations of institutions and analysis on which we have built and thank those who took part in creating them. They will all be important players in the new body.



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Scott MacDonald, Corus
David Farrar, Smith & Nephew
Ian Rodgers, EEF
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Gordon McColvin, Siemens
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Executive summary

Society cannot exist without materials. They underpin everything we do and affect most areas of economic activity. Manufacturing and construction are entirely dependent on materials in many different forms.

Material businesses in the UK, companies that produce and process materials, have an annual turnover of around £200 billion. They make a major direct contribution to the economy at 15% of the country's GDP, while also underpinning all areas of economic activity. The diversity of the materials community has previously made it difficult to achieve a collective vision and to respond with a coherent strategy to the major challenges of the day, globalisation, sustainability and the environment. To address these issues, the Materials Innovation and Growth Team (Materials IGT) has looked forward to define the challenges facing those who develop, make and use materials.

The vision of the Materials IGT is that the UK will continue to be one of the foremost advanced technological societies in which world-class materials expertise underpins sustainable growth.

We have identified the key issues to realise this vision as:

- **Resources** - uncertainties in the availability of energy and raw materials due to the depletion of, and growing competition for, global reserves, limitation of supplies and availability of strategic materials.
- **Globalisation** - threat from low-cost manufacturing in emerging countries and opportunities in emerging markets
- **Sustainability** - energy efficiency, the low-carbon economy, recycling reuse and 'ecodesign'.
- **Innovation** - making best use of the R&D base, bringing more value added products to the market, faster than the competition, enhancing existing materials through design.

To meet these challenges, we propose specific actions under five broad headings:

- **Knowledge transfer** - through, for example, signposting services, access to materials education and databases of job vacancies, best practice tools, technology roadmaps and the techniques of life-cycle analysis.
- **Raise awareness** - alert young people and the public to the importance of materials through promotion in schools, work experience and collaboration with Regional Development Agencies.
- **Accelerate innovation** - better use of assets, implementation of R&D priorities and effective support mechanisms throughout the innovation cycle, and through better interaction of materials with design.
- **Improve skills and knowledge** - promote best practice, the development of specialist courses and international partnerships.
- **Build a better business environment** - improve materials innovation in the UK through better regulation, enhanced supply chains and public procurement.

To take forward these actions, and to unite the materials community under a common vision, we are establishing Materials UK, a body that will act as an umbrella for the existing organisations within the broader materials sector. Building on the success of Materials Knowledge Transfer Network (KTN), Materials UK would provide the leadership required to meet the challenges.

Action matrix

What the UK should do to build on the strengths of the materials community to ensure continuing prosperity from it

	The First Steps	The Goal	The Reason
Knowledge Transfer	Use the Materials KTN. Signpost services. Support for SMEs. Codify and share best practice. Life Cycle Analysis Database. Sector Technology Roadmaps.	Greater efficiency of total materials industry. Greater awareness of materials selection - for manufacture, use and recycle.	Effective use of physical and intellectual assets will enable the UK to extract the maximum value from what has been a fragmented and poorly coordinated industry.
Raising Awareness	Input to schools curricula. Publicise career opportunities. Organise work experience. Bursaries for schools and Universities. Drive message of sustainable materials.	Supply of properly trained materials scientists to design, manufacturing and application industries. Greater awareness of the importance of materials in everyday life in society.	The requirements for innovation in design, materials selection, processing and re-use/recycling requires a highly skilled workforce and greater awareness within society.
Accelerating Innovation	Register of assets. Coordinated approach by Government. Agree and implement research priorities. Phased funding. Design innovation. Raw materials.	One set of shared and well used research assets. More companies growing through the cycle. Greater continuity between Government and private funding. Integration across intellectual supply chain. Much greater re-use/recycling. A sustainable UK materials Industry.	The UK's materials industry needs to increase its overall efficiency and effectiveness if it is to compete globally. It needs new companies and high growth rates. Above all it needs to manage its access to raw materials and ensure that it is sustainable as well as its products!
Improving Skills and Knowledge	Share and promote best practice. Develop and provide short skills courses. Strategic international Alliances.	Greater efficiency of total materials industry. Larger and better trained pool of materials scientists. Collaboration with those with complementary skills. Develop coherence in the skills and training needs of the broader materials community. Benchmarking of the rapidly evolving skills needs in response to global developments.	It is people that drive the UK based materials industry - greater skills and awareness will raise performance and attract further investment from multinationals. Common skills and training needs are not effectively managed in the current disparate materials community.
Better Business Environment	Better awareness of, and influence over, regulation. Analysis of supply chains and planning for their future. Use public procurement to drive sustainability and innovation.	Use regulation for commercial advantage. Collaboration throughout supply chain for maximum productivity and profitability. Government sets standards for intelligent procurement.	Regulation needs to be seen as an opportunity, by anticipating and identifying opportunities it raises. Government is one of the largest customers for the materials industry.

The way forward

Key recommendations

Promote the important role that materials play in enhancing the quality of life and in protecting the environment in the UK, by:

- facilitating communications within the materials community
- raising the profile and image of materials science and technology
- promoting awareness of the principles of sustainable production and consumption, and defining what it means for materials
- promoting to young people the importance of materials to society and highlighting the variety of career opportunities the industry can offer.

Accelerate innovation and diffusion of new technologies in materials, by:

- optimising the UK's research base and the utilisation of its R&D assets
- facilitating access to support for R&D
- ensuring that 'routes to international markets' are optimised so that materials from the UK are designed into new products
- improving design innovation
- making energy a focus for innovative development of materials.

Ensure that the appropriate people, skills and knowledge are available and used effectively, by:

- promoting the development of people and skills
- facilitating the sharing of best practice.

Work with Government to make the UK the best place in which to do business in materials, by:

- providing a voice to Government on the implications of regulatory policies on the wider materials community
- facilitating access to validated data on materials property
- international benchmarking of what other countries are doing
- making Government aware of strategic issues surrounding the materials supply-chain that could affect the UK.

Materials UK (MatUK)[1]

Many of our recommendations require close and continued collaboration between the research community, professional institutions, businesses and Government. This will not happen without strong and sustained leadership. Such is the nature of the materials community that no single body can presently provide this leadership and bring together all of the interested parties.

A representative body, Materials UK (MatUK), is being established to take forward this strategy and to build on the momentum created by the Materials IGT.

The intention is not that this body will displace existing bodies that represent the numerous sections of the materials community, many of which were involved in the Materials IGT, but that the new body will bring them together in a structure that will enable them all to continue to function as they wish in their own key areas. MatUK will build on the best practice or expertise of each organisation and will add value to their activities by working with them to address major issues of common concern. MatUK will have a strong focus on supply chain issues and be seeking to identify clear wins for the UK.

Creating an umbrella organisation for the wider community of materials bodies will make it easier for the community to engage at an early stage in policy development through responding to formal consultations. Collectively, the community should also find it easier to gather intelligence on, and respond to, international initiatives such as the OECD's work on sustainable materials management or how to optimise the opportunities for UK firms in delivery of the Olympics in 2012.

MatUK will seek out opportunities where the materials community working together can seize global advantage for the benefit of companies operating in the UK by ensuring the recommendations of the Materials IGT are taken forward.

A detailed structure for MatUK is set out in Annex 1.

Vision

The vision of the Materials IGT, and for the future of MatUK, is that the UK will continue to be one of the foremost advanced technological societies in which world-class materials expertise underpins sustainable growth.

Mission

The mission of MatUK is to enable the UK to pursue and benefit from opportunities for materials in the global economy, through:

- Leadership
- Strategic guidance and direction
- Engaging stakeholders
- Working with Government to make UK the best place in which to do business
- Recognising the importance of materials to society's needs.

Aims and objectives

MatUK will enlist broad representation from the materials community, working with such bodies as trade associations, learned societies (e.g. IoM3[2]), the Foresight Materials Panel, Defence and Aerospace National Advisory Committees, for example.

Working with that broader community, MatUK will continue the work of the Materials IGT to deliver strategies for essential activities such as the optimisation of the UK's R&D base, provision of a validated database of materials property for designers, producers and users, and knowledge transfer to support the development of materials, manufacturing and new applications.

With the support of the new body, the UK's materials community will be in a position to respond to new opportunities and challenges and to mobilise high-powered teams quickly to review key issues and identify opportunities for global leads for the UK.

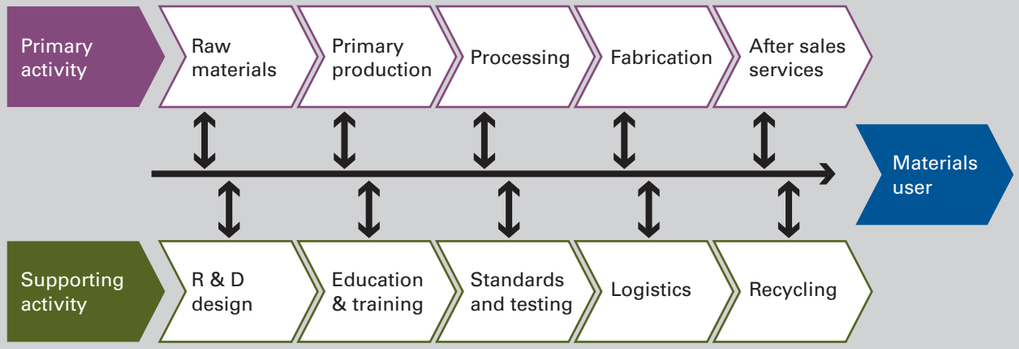
MatUK will allow the materials community to provide a coherent view on common policy, regulation and funding strategies to government. In this way the umbrella body will add strength and persuasiveness to the activities of the organisations that now represent individual sectors.

The new body will seek to influence the regional materials strategies of the RDAs, devolved administrations and major funding bodies such as Research Councils, Ministry of Defence, Health and Safety Executive, Department of Health, Department for Transport and others so that UK resources for innovations in materials are optimised.

MatUK will seek to create a climate in which the UK is considered to be a good place to carry out materials related business, including world leading design, R&D and education and training.

As delivery mechanisms MatUK should take ownership of the Materials Knowledge Transfer Network (KTN) and promote and sustain the new Materials Assets Connect and Materials Property Validation facilities. It will deliver its mandate following the key performance indicators that we have developed in consultation with the community (see Annex 2).

Activities defining the materials community



The IGT's definition of the Materials Community includes the full cycle of value-adding activities:
- Research, design and development.
- Raw materials, primary production.
- Processing and fabrication.
- Standards, testing and end of life management.

[1] Information of how to engage with MatUK is available on www.MatUK.co.uk
[2] IoM3 is the Institute of Materials, Minerals and Mining

The Innovation and Growth Team

Recognising the importance of materials against a background of climate change, energy pressures, resource needs and increasing global competitiveness – and the need to assess the implications of these factors for the UK materials sectors – the Secretary of State for Trade and Industry approved the creation of the Materials Innovation and Growth Team (Materials IGT) in October 2004.

The Materials IGT began its formal work in January 2005. The purpose was to propose a strategy to optimise the benefits that materials technology can bring to the UK. In particular, the terms of reference were:

- Look ahead at 5, 10 and 20-year horizons and define what the key materials requirements will be and how these compare with current materials.
- Look at likely future Government policy approaches – for example, to environmental challenges – and how the industry can respond.
- Consider what constitutes best practice in all aspects of the business process, including R&D, knowledge transfer, design, efficient use of resources, waste minimisation and recovery/recycling, and investigate how it could be promulgated in the UK.
- Consider the policy implications for Government, and address the effects that current and future national and European legislation – on emissions, recycling, sustainable production, for example – might have on the materials sector.

The Materials IGT's methodology[3] involved establishing Task Groups to engage all interested stakeholders through a series of workshops, meetings and interaction electronically through a website[4]. In addition, there was specific activity on materials in energy, construction, sustainable production and consumption, the contribution of minerals and the academic community as well as some formal stakeholder surveys. In all, some 650 companies, organisations[5] or individuals contributed to the work of the Materials IGT and its Task Groups.

[3] Methodology used by the Materials IGT outlined in Annex 3
[4] www.amf.uk.com
[5] see CD and website for complete list

Materials and their importance

Materials underpin everything we do. Manufacturing and construction are entirely dependent on materials in some form. Materials technology affects most economic activities. The quickening revolution in information and communications technologies would not be possible without a wealth of novel functional materials.

As the report of the Economic Analysis Task Group[6] shows, the materials sector is a major contributor to the UK's economy (Figure 1) and has a higher productivity than the national average (Figure 2).

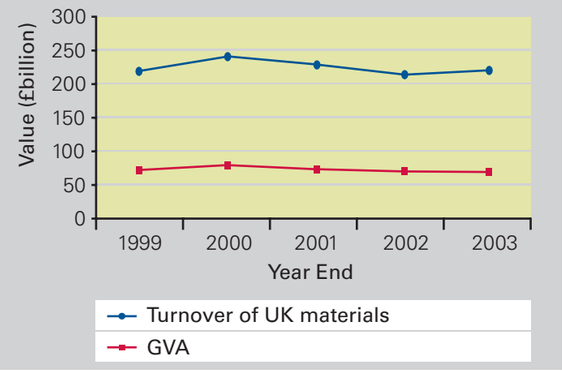
The nature of the materials sector is such that it is difficult to analyse the economic activities of particular areas in any detail, however, we do know that with activities that range from processing raw materials through to recycling, the sector has a turnover of around £200 billion, contributing at least 15% of the GDP of the UK. It employs some 1.5 million people and supports around 4 million more jobs.

The economic goal

The UK will always be a major user of materials, so it is essential that we optimise the wealth creation opportunities from materials production, processing, fabrication, use and recycling. Increased activity in processing and fabrication should more than match any decline in primary production. In this way, the UK can create increasing value for the economy, including significant export opportunities.

Figure 1

Turnover & GVA of UK materials



[6] Report of the Economic Analysis Task Group can be found in attached CD

Figure 2

Labour productivity: Gross Value-added (GVA) per employee in UK Materials

Dimension of diameter is nominal 20mm.

CASE STUDY

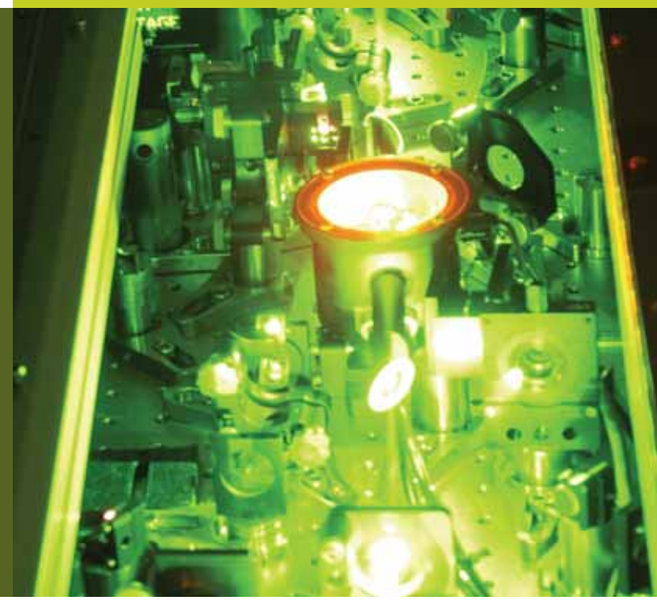
Minimizing greenhouse gases with monolithic activated carbons

Based on its advanced monolithic activated Carbons, 'MAST' has developed a unique environmental solvent vapour recovery system from polymer-derived Carbons.

With less than 0.1% of the environmental emissions of conventional thermal oxidation systems, MAST's system minimizes solvent vapours that are a major contributor to greenhouse gases arising from biomedical, catalytic and energy storage applications.

MAST Carbon http://www.mastcarbon.com/

How the UK measures up



Any analysis of the challenges facing the materials sector in the UK has to build on an understanding of the strengths and weaknesses of the materials community.

The contribution that the materials sector makes to the economy is one obvious strength Figure 3 shows turnover by value chain, Figure 4 a typical export profile. For 2003 total exports were £50bn.

The UK is the home of a number of world class manufacturing companies whose success depends on their development and use of advanced materials. The country also has an active world-class research community. The business environment is such that the UK is a favoured nation for inward investment, and is ahead of some countries in providing venture capital and other forms of investment.

While we have already highlighted the fact the materials sector in the UK has higher productivity than some other areas of manufacturing, no industry can ever call a halt to attempts to improve its productivity. The materials community certainly needs to continue to improve on this front, particularly in the fabrication area, if it wants to match the best performance of its competitors and maintain or increase its contribution to GDP.

Figure 3

Breakdown of turnover by value chain activity for UK materials

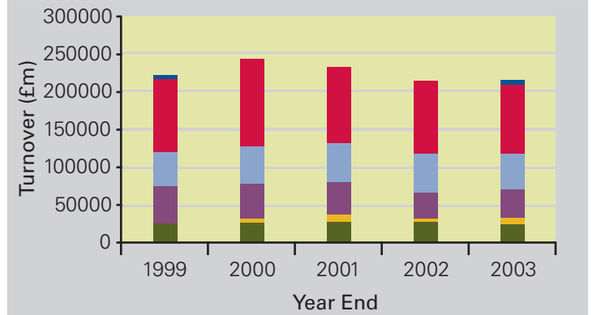
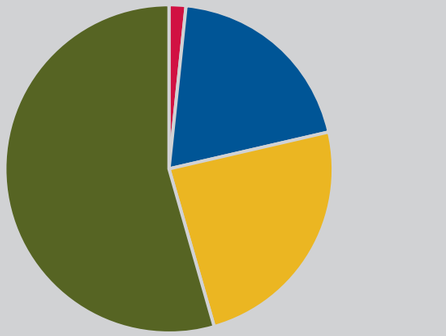


Figure 4

Exports by UK Material in 2003



The Materials IGT and its Task Groups have analysed those strengths and weaknesses (Figure 5). We address the most important issues that arise from this analysis in the following sections, including Drivers of Change and Challenges for the Future.

Materials community

A possible weakness of the materials community, in perception at least, is that it covers the whole landscape, unlike many other sectors of manufacturing, which supply a specific market or inhabit a particular technological niche.

While manufacturers of electronic chips can drive the development of electronic materials, and makers of aircraft engines can push forward the frontiers for materials for gas turbines, in many areas of materials technology the connection between the material manufacturer and the end user is less clear.

Traditionally, the materials community has organised itself along material groupings, for example, minerals, steel, non-ferrous metals, polymers, plastics, ceramics, glass, wood, concrete and so on. Yet these sectors share many issues. For example, they are all influenced by globalisation, climate change, trade liberalisation, and the challenge of an ever developing world.

This breadth of the materials community has implications both for the way in which it comes together to discuss common issues and for the way in which it communicates with other groups.

The diffuse nature of materials requires action to bring together the various players. It is for this reason that we believe that the UK should create an umbrella organisation that can act as a voice for materials.

CASE STUDY

Cutting carbon dioxide emissions

Low emissivity glass looks just the same as ordinary glass but a transparent coating on its surface "reflects" heat back into a room while allowing heat from the external environment into the room.

About half of our total Carbon dioxide emissions in the UK are attributable to buildings, more than twice that from cars. However we are progressively replacing glazing with low emissivity double glazing: Pilkington 'K'. That will save over 9 million tonnes of CO2 emissions annually, which is enough energy to heat six cities the size of Birmingham.

Figure 5

SWOT analysis of UK materials

UK Strengths	Weaknesses
UK has a stable economy with low inflation	Disparate Community
Long established academic reputation	Decision making is often taken outside UK for manufacturing, design and engineering
World class engineering/construction steels, float glass, aerospace, automotive and biopharmaceutical manufacturing	Investment levels not high
World class and well respected designers	Recycling infrastructure is far behind established collection segregation and re-use schemes in EU
Excellence in low volume, niche production	Productivity and capacity issues
Attractive location for inward investment	Status (image) of materials and manufacturing
Financial centre facilitating raising of capital	Uncoordinated public procurement
Opportunities	**Threats**
Make greater use of bilateral International joint co-operation agreements	Low-cost economies getting smarter
Decisive energy policy: for materials, the re-growth of nuclear power is also an opportunity	Access to raw materials
UK to become an international hub for research and design in materials	Transport infrastructure
Build upon low volume, high niche manufacturing	Strong national strategies for materials research and exploitation by rival countries
Develop or import the right skills	Lack of engineering and technician skills
Enhance/address the image of Manufacturing	Decision making/influences outside UK
	Lack of adequate recycling infrastructure is becoming a burden to business
	Strong national facilities, e.g. Japan, Singapore, Germany

Drivers of change

Climate change, demands for sustainable economic growth, uncertain energy supplies and an ever changing technological landscape are constant challenges for materials businesses. On its own, each of these drivers of change is a challenge, together they add up to a dramatic shift in the way in which materials businesses operate.

The economic strength of the materials community in the UK, the robust performance of the country's economy, a world leading materials research community and the generally healthy business environment mean that materials companies and the businesses that depend on their outputs are well placed to forge a successful future. However, this will not happen without a coordinated and sustained effort.

Investment in materials - from research through to development and innovation - will lead to new wealth creation, supporting existing high-tech industries and creating new spin offs. Materials also underpin many of the technologies that will help society to respond to such challenges as climate change, and the growing demand for business models based on sustainable development that meets the needs of today's society without compromising the ability of future generations to meet their own needs. As well as these major drivers of change there is also the distinct possibility that energy resources and supplies of other raw materials will become scarce and increasingly expensive.

Globalisation and the developing world

Like all of manufacturing in the UK, the materials sector faces growing pressure from globalisation and the rise of economies such as China and India.

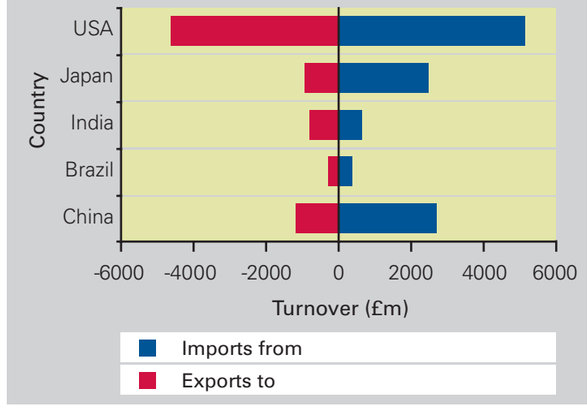
Multinationals are investing in China and India as these countries become major consumer markets. In 2003, China, Japan and Korea together produced 40% of the world's crude steel. At the end of 2005, China alone was responsible for one third of world production. The UK has significant trading links with these countries (Figure 6). China is rapidly evolving from 'Factory China,' a place for manufacturing commodities, to making its own high-quality products for internal consumption and export. In less than a decade, the country may become the world's largest market, placing further pressure on the demand for energy and raw materials.

The Indian economy is also growing rapidly. Its huge industrial capacity and growing affluence have made India one of the world's fastest-growing economies. On the back of a sharp rise in industrial exports and buoyant domestic demand, India's economy grew by 8.1% in the three months to June 2005, well ahead of the 7% rise seen in the previous quarter.

The effects of globalisation go beyond the obvious economic factors. As companies move operations offshore, decision making on key aspects such as R&D, product design and procurement may also migrate. This means that specification of materials that go into many industrial products - such as cars, aeroplanes, electrical and electronic goods, for example - may also move abroad. Not only does this remove the influence of British designers on the materials used, it can also have knock on effects on providers of materials R&D services, possibly leading to a serious loss of intellectual capital from the UK.

Figure 6

UK Materials import and export trade with selected countries



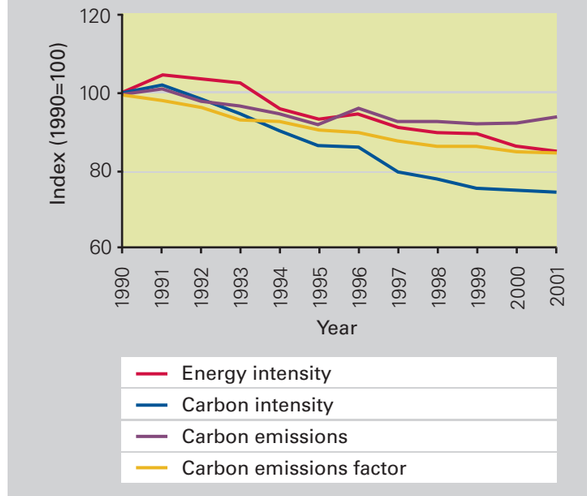
Climate change

Emissions of carbon dioxide from energy generation, with their role in climate change, represent perhaps the biggest environmental challenge facing the world today and materials play a significant part both in their production and mitigation. Materials that are commonly used globally such as concrete, steel and aluminium are some of the most energy intensive to produce. However, materials also play an important role in addressing the effects of climate change by their development and use in advanced technologies such as carbon sequestration, where the carbon dioxide is captured before it reaches the environment.

Industry has responded well to the environmental challenge, and must continue to do so, in helping the UK to lead the way among developed nations in meeting its commitments. The UK Government's own domestic target to reduce carbon dioxide emissions to 20 per cent below 1990 levels by 2010. By 2001, carbon dioxide emissions were

Figure 7

UK performance in reducing its carbon



estimated to be 6 per cent below 1990 levels (Figure 7). This places significant challenges on the materials sector in terms of energy production, conservation and usage.

Energy

The world has experienced fuel crises in the past, along with forecasts of declining production, only to see these disappear. However, rising consumption and the rapid increase in demand in industrialising nations, combined with political instability in certain parts of the world, add to the concern over the future availability and security of energy supply.

To tackle this, the UK will require a balanced energy portfolio to minimise both the environmental impact and the risks to security of supply. As such, materials technology will play a key role in the development of advanced generation technologies, which will likely comprise a mix of fossil, nuclear and renewable energy sources.

Equally, materials have an important part to play in the more efficient use of energy. Improved insulating materials and lightweight alloys and composites can lead to big reductions in the energy that is used by the buildings, products and services that we all need to sustain our way of life.

Raw materials

Energy is but one of many 'raw materials' that we depend on for continued economic growth. Indeed, the sources of that energy, such as oil, are also sources of feedstock for many materials e.g. plastics or many chemicals. In parallel with uncertainties about energy supplies, there are also uncertainties in the supply of some strategic metals for example titanium, tantalum, hafnium especially as they are found in only a few countries. Closer to home, while the UK has large reserves of minerals, in reality, those readily accessible are limited or declining due to environmental and land use policies. These need to be placed in the strategic context of materials availability.

Sustainable development

Sustainable consumption and production forms a key part of the UK's and EU's drive to sustainable development. It is also increasingly being taken up by the emerging economies - notably China. It is about doing more with less and about breaking the link between economic growth and environmental degradation and the unsustainable use of resources. The aim is to reduce both the amount of materials input and waste outputs and to make fullest use of materials in the economy

This is increasingly being reflected with the introduction of mutually reinforcing policy instruments designed to transform markets and behaviours. Such producer responsibility legislation (e.g. End of Life Vehicles, Waste Electrical and Electronic Equipment) taxation (e.g. Climate Change Levy, Aggregates and Landfill taxes) fiscal incentives (e.g. Enhanced Capital Allowances for energy and water saving equipment), permit trading, public procurement, negotiated and voluntary agreements, and business support programmes, all form part of the drive towards greater resource efficiency.

The regulation and taxation has increased public awareness of these issues. Younger generations are certainly aligned towards sustainable development. However, consumption of products is increasing as is the demand for new applications. There are opportunities for the materials community through innovation and use of materials. Also sophisticated applications of materials technology such as composites bring heir own technological demands for end of life deconstruction and recycling or reuse. This presents further opportunities for innovation and growth.

Challenges for the future

Materials technologies will play a central part in addressing many of the challenges of the 21st century.

Materials are central to all areas of technology and economic activity. For example, it will be difficult, if not impossible, to improve energy efficiency or to create new energy technologies, without materials technology. Thus materials R&D will be essential in any efforts to reduce emissions of carbon dioxide and to achieve sustainability. To meet those challenges, the UK's materials community needs to address a number of important issues. The Materials IGT Task Group on science and technology has conducted a detailed assessment of materials R&D in the UK[7]. This analysis, along with recommendations for specific areas, appear in a separate report. In the following section, we look at the contributions that materials technologies can make to a number of essential sectors.

Energy

Energy is an area where materials technology will play a particularly important role in meeting the needs of the future.

The global energy industry is more than £600 billion. Energy generation is highest in North America followed by Far East and Oceania, and then Western Europe.

The growing importance of environmental issues is such that energy generation, conservation, storage and security of supply will continue to be major drivers for materials technology. We need sustainable energy production and use while at the same time meeting socio economic and environmental targets.

Energy production through to conservation encompass a broad range of technologies and materials (see table in Figure 9).

The high priority of energy makes it important to sustain research, development and modelling of materials for energy applications.

Skills are also an issue of continuing concern. Changes in the energy markets in the UK over the past 30 years, particularly the lack of investment in cleaner coal and new

[7] The Science & Technology Task Group report is on the enclosed CD. This report will be published along with the reports from the Task Group's subgroups in June 2006

nuclear plant, mean that the country has lost much of its technical expertise in materials relevant to important areas of energy technology.

The UK should set out to recover, capture and develop the knowledge-base of high integrity structural materials for future power generation.

The UK needs design skills and manufacturing capability to enable it to be an intelligent customer for future procurement of energy technologies. For example, the UK needs to quantify the contribution that materials technologies can make to nuclear decommissioning and possible new civil nuclear generation. In addition, the development of nuclear fusion technologies, in particular, will not be possible without a complete strategy for associated materials. Figure 8 shows how materials companies supply the UK energy generation industry at present.

The UK should examine transferable material solutions and methods across the complete energy portfolio to attain maximum competitive advantage.

It is equally important to investigate the materials needs of other sources of energy generation, such as fossil fuel, fuel cells, renewables, and energy conservation and storage.

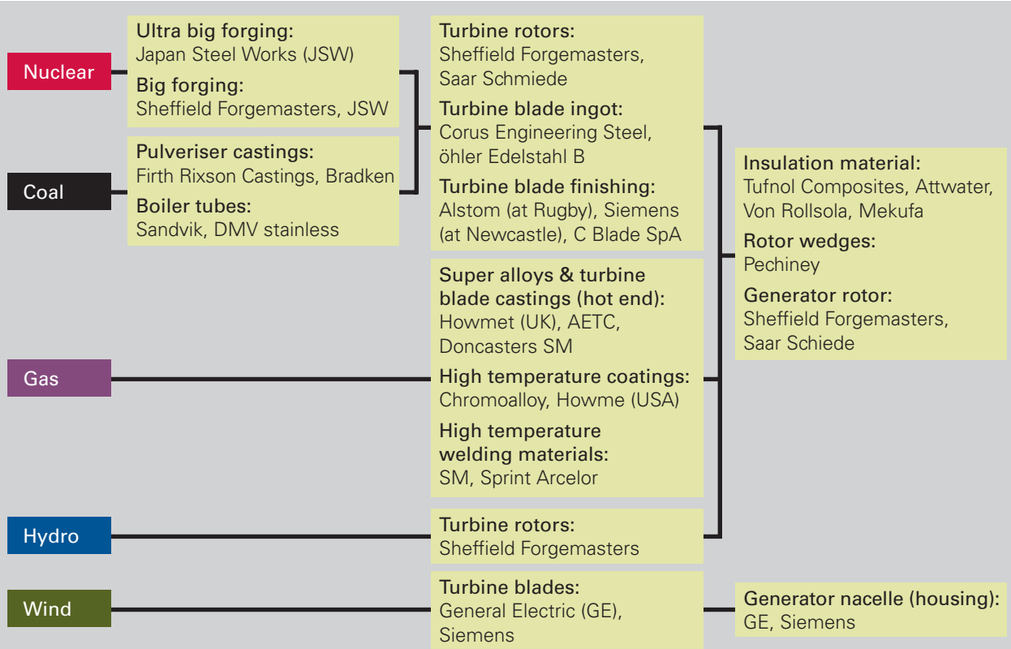
The global focus on energy is an opportunity to develop world-class knowledge and capability in the UK in materials for energy generation, low energy processing and energy conservation, and to attract investment (including inward investment).

Raw materials

Production and consumption of materials continues to increase worldwide. While there is no immediate threat to the global supply of the raw materials required to make

Figure 8

Overview of the material supply market



Note: List of companies is not exhaustive. It covers the main names provided during interviews with generators, contractors and OEMs.

Figure 9

Table of materials required for energy generation, transmission, storage, conservation etc.

Energy	Plant/ components	Structural materials	Functional materials	Multifunctional materials	Biomaterials
Generation *Conventional and advanced fossil*	e.g. Steam turbines Boilers Gas turbines Gasifiers Fuel cells Hydrogen from coal Coal liquefaction	Steels Alloy steels Superalloys Ceramics Composites Coatings	Activated carbons Filters Interconnectors Membranes Sorbents Chemical looping materials	Structural health monitoring systems Diagnostic Smart materials Catalytic filter materials	Anti-corrosion biofilms
Generation *Nuclear*	e.g. Boilers & turbines Decommissioning / storage Reactor vessels Fission/fusion materials	Steels Alloy steels Superalloys Ceramics Composites Coatings	Filters, Active carbons	Structural health monitoring Materials for remote robots Self-repair materials SMART materials	
Generation *Renewable*	e.g. Wind turbines Tidal power Hydro turbines Biomass plant Heat exchangers Fuel cells	Composites Polymers Steels Superalloys Ceramics Coatings	Photovoltaic Thermal materials (Geo and Solar) Fuel-cells materials Anti-fouling coatings	Photovoltaic materials Piezoelectrics Fuel-cell materials Catalytic Filters Conducting membranes Solid Electrolytes Thermoelectrics Power harvesting Structural health monitoring SMART actuation materials	Biofuels Biomimetic structures Biohybrid materials Anti-corrosion biofilms
Transmission	e.g. High conductivity applications Insulators High Strength	Ceramics Polymers Composites	Piezoelectric materials Superconductors		
Storage *Electrical*	e.g. Batteries	Ceramics Non-ferrous alloys	Electrode materials	Electrolytes Materials for integrated power systems	
Storage *Hydrogen*	e.g. Pipelines Compressors Pressure Vessels	Steels Alloy steels	Carbon Nanostructures Activated carbon membranes	High capacity/integrity	
Conservation	e.g. Lightweight structures Thermal insulation	Composites Ceramics	Photochromics Electrochromics Thermochromics	Smart packaging Insulation Energy harvesting	Biodegradation

This table maps the requirements for future applications of materials against key energy areas.

primary materials, reserves are not limitless. Thus the principles of sustainable production and consumption are essential for continuing future development.

Materials supply depends on 'raw materials' other than those needed for primary manufacturing. For example, there is a growing demand for composite materials. These too can suffer from supply problems. For example, in the UK there are relatively limited supplies of materials such as carbon fibre.

The demand for composites in the aerospace market could grow by more than 10% in the next five years with the introduction of several new aircraft containing high percentages of composites. Airbus has increased the composite content of its airliners from less than 5% in the A300-600 20 years ago, to 15% in the A320 in the 1990s. Its next generation aircraft, the A380, will have nearer 25% composite material. Boeing too has used composites since the 1960s. Its 787 'Dreamliner' is due to be the first commercial jet aircraft in which composite materials will make up most of the primary structure.

While market forces appear to have addressed immediate problems - a new carbon fibre plant is being built in Spain for example - supply issues are likely to continue to occur. To deal with the possibility of future threats, the Materials IGT identified several options, such as a major re-use initiative, and an audit of where the UK now depends on relatively scarce materials, to enable targeted recycling.

To ensure the best use of raw materials, the UK should compile an inventory of the materials that are already in use. It should also define a recycling policy for strategic materials. This should covering collection, segregation and processing.

The UK should embark upon a major recycling initiative and work harder to optimise its use of materials resources including a major re-use initiative.

With its high dependence on imported raw materials, the UK should monitor the implications for the materials community of its dependence on finite raw materials and investment in R&D should focus on the search for alternative raw materials and sources or process technologies.

Sustainable development

Materials are crucial to sustainability and the quest for manufacturing processes that reduce our impact on the environment. Innovative technologies that set out to meet these environmental objectives can bring new business opportunities, open up developing markets and enhance competitiveness.

Discussions of sustainability focused on three key areas:

- energy efficiency, production, use and low-carbon emission
- minimising waste generation, and maximising recycling and re-use
- product design for sustainability (Eco-design).

Business that can meet growing expectations of higher environmental and ethical standards that develop 'material light' goods and services will be best placed to enhance their competitiveness. Corporate responsibility, including product stewardship, must extend throughout supply chains, from tackling the issues arising in the extraction of raw materials, to engagement with consumers about the products and services they buy and eventually discard.

There is a need for better understanding of the impact of materials and products throughout their life cycle through dialogue to enable joined up thinking between materials producers and users. The materials design and user community should make greater use of life-cycle and design-for-life concepts, supported by access to data for materials within a sustainable production and consumption agenda. This should be backed up with specific training where it is needed.

Computer modelling is increasingly important in the development of materials and processes, in predicting the properties of new materials, for example. While the UK has significant strengths in materials modelling, there is a need for a more holistic approach to the mathematical modelling of materials, both in terms of scale and lifecycle. Modelling the continuum, from the atomic level up to bulk materials, can bring enormous benefits, for example in improving our understanding of adhesion and welding.

Whole lifetime predictive modelling, cradle to grave, is important for the development of new materials as well as to sustainability, recycling and re-use.

The generation of generic models in this area would be particularly valuable.

Innovative solutions, including developments in technology, to reduce the materials component of manufactured goods would not only support the quest for sustainability but would also minimise the risks of loss of supply to manufacturing in the UK.

Health

Medicine and healthcare have a growing need for biomaterials, materials that can reside in close contact with the body. Biomaterials have seen exceptional growth and development over the past decade, creating a worldwide market of over $36 billion. This is projected to grow by up to 10% per annum, for some clinical applications.

Biomaterials are important in the delivery of radical surgical interventions. They often provide the only viable option for repairing major tissue and organ structures. Though originally developed for life-threatening and serious debilitating conditions, biomaterials are now increasingly used to correct minor structural and functional defects.

Current generations of biomaterials are inadequate for the management of serious clinical conditions, particularly over the longer term. There are major opportunities to develop new biomaterials, but if the risk of failure of clinical devices is to be avoided, then research on biomaterials in a fully multidisciplinary context, encompassing material/physical and biological sciences will be required.

Surgical procedures already make use of bio-resorbable polymeric materials that, for example, dissolve in the body and release drugs. Fundamental materials design and concepts are already in place, so in the next five years new materials with controlled interfacial

CASE STUDY

Future challenges for Biomaterials

Integration of biomaterials with inorganic functional materials for diagnostic capability and sensors. Also self-diagnostic systems and self-healing materials.

Website www.iom3.org/foresight/Biomaterials

properties and predictable degradation are likely to enter the market. This will initially be for conventional surgical use, but subsequently as scaffolds to provide structural integrity for the body's own regeneration processes to replace lost tissue. As part of this development, new biodegradable systems will enable controlled release of bioactive components to enhance tissue repair and regeneration. While such materials do exist they are not available in the desired purity and form. Commercialisation will depend upon refined manufacturing and production techniques.

Novel manufacturing will further extend the functional, structural and multifunctional repertoire of existing, clinically acceptable biomaterials, with adaptation of processing technologies from other materials sectors. New biomaterials products will emerge within five years, many incorporating bioactive components, with retained stability because of more biologically compatibles process development.

Continued support for Biomaterials is essential particularly for the development and refinement of bio-resorbable and bioactive materials.

There is also scope for materials to improve the quality of life for an aging population. For example, lifestyle aids that provide mobility and facilitate self care.

Security and defence

National and personal security will continue to be a concern. Technology can play a significant part here. For example, materials offer new ways of preventing counterfeiting of products. There could also be applications of materials in 'bio-tags' and biometric products.

There are opportunities to develop materials for sensors and systems that rapidly scan luggage and travellers and for sensors in clothing and baggage that facilitate detection of dangerous substances.

There will also be a continuing need for materials to support defence. Indeed, defence applications have long been a driving force for new civil technology in the UK. But for this to happen, there has to be greater awareness of the opportunities. It is also important for businesses to realise the potential for 'dual use' of defence-related products for commercial applications. Like its civil counterparts, the defence sector also needs to call on deep scientific and technology understanding, particularly in materials characterisation and modelling. Designers and users need a fully validated capability to predict the performance, safety and reliability of materials and systems throughout their life.

Effective modelling spans the materials continuum from atomic, micro, meso and macro scales right through to engineering models. Additionally, for defence applications there is an even greater need to understand how materials behave under extreme conditions of temperature, pressure, high strain rate and shock.

Multifunctional materials are a priority in future applications for defence and aerospace, particularly where they enable the design of smart structures. There is also a move towards lighter and smaller systems for certain applications. Here advanced materials, including composites, can offer potential robust, weight efficient solutions.

A priority must be research, development and modelling of materials and technologies for sensing and diagnostic applications. This has been highlighted as a key theme for all aspects of our lives, with applications in security, both personal and 'homeland,' energy, transportation, healthcare, the built environment and communications and IT.

Construction and the built environment

Construction uses large amounts of structural materials, an area in which the UK has considerable expertise. Building materials are also used in large volume so a small reduction in cost or improvement in properties has a large economic effect.

There is a range of activities going on with the construction sector in the UK many of which relate to materials and which could derive useful lessons for materials applications in other areas. MatUK is proposing to establish a working group for materials in construction to build on the very successful events the Materials IGT ran with the Construction Products Association (CPA). The latter will lead this group for MatUK.

Major drivers for the future in construction include affordable housing, renewal of infrastructure, and buildings that can be easily adapted for change of use or style of living or working or deconstructed optimising re-use and recycling of the constituent materials. The impact of surroundings on worker productivity is now an acknowledged fact. Modular off site construction is growing and needs to be exploited by UK firms.

Construction materials will also be important in any attempts to improve sustainability and to make better use of energy. Buildings are a major user of energy - cutting heat loss from buildings can make a large contribution to reducing climate change.

Transport

Transport is a also major user of energy and materials. Pressure to reduce congestion and the demand for cheaper and better public transport all present challenges for materials technology.

The UK has large automotive and aerospace industries which other IGTs have already reviewed. These reviews highlighted the need for lighter, safer road and rail vehicles, with a smaller environmental footprint. Transport will be a large and growing market for composite materials, with their potential to reduce the weight of aircraft, motor vehicles and trains.

With its success in the aerospace sector, for example, the UK has done much to advance materials technologies. As the Aerospace IGT has already pointed out, light alloys and high-temperature nickel-based materials and coatings are important for the continuing competitiveness of the UK's aerospace sector.

Building on the recommendations of the previous IGTs, specific materials requirements in these sectors are:

- *Transport is already a major market for composite materials, with their potential to reduce the weight of aircraft, motor vehicles and trains.*
- *Light alloys and high-temperature nickel-based materials and coatings are important for the continuing competitiveness of the UK's aerospace sector.*
- *At the same time, there is a continuing need for continued improvements in more 'traditional' materials (steel, aluminium, glass, plastics etc.) and processing techniques (casting, forging, powder metallurgy etc.). Continuing development in these areas must remain a priority.*

Information and communication

The rapid rise of information and communications services over the past half century raises particular issues for materials. The many technologies of the past 50 years, broad band revolution - optical fibre, lasers, electronic devices, mobiles, displays and so on - all depended on the continued development of novel functional materials. The R&D community in the UK has been at the forefront in the science behind many of these materials technologies.

The global market for electronic materials is estimated as being between five and ten percent of semiconductor sales (www.sia-online.org). Forecasts to 2010 shows a significant increase, with consequent opportunities for materials (Figure 10).

Photonic materials and such concepts as plasmonics, the merger of photonics and electronics at nanoscale dimensions, are critical to the future of Information and Communication Technologies (ICT) from the continuing increases in density and speed of electronic circuits to the future development of display and solid state laser technology and the integration of photonics and electronics.

As a related technological development in a separate market, there is a rapidly growing global industry in solid-state lighting, such as semiconductor light emitting devices and laser-based lighting. This will have a significant impact on energy efficiency, consuming much less energy for lighting. There are opportunities as this technology affects the general lighting field.

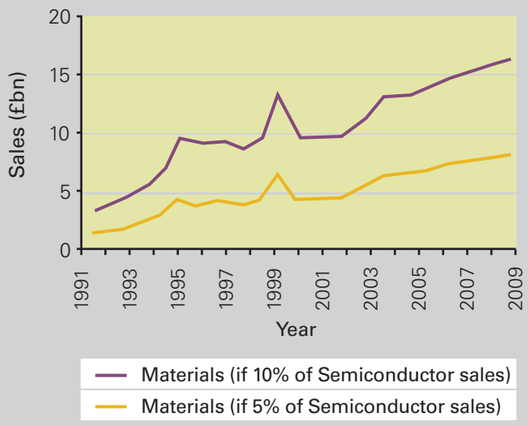
The semiconductor industry is capital and technology intensive and faces intense competition and bouts of over-capacity. Historically, new input materials and production processes have resulted in both sustaining and disruptive innovation. Consequently, entrenched firms and new entrants with innovative technologies have both been successful.

Magnetic materials are also important in electronics, in data storage for example. Through the commercialisation of such ideas as spintronics, they will also contribute to future sensor technologies and quantum computing.

The challenges for electronics materials arise both at the production end, with the demand for ever more sophisticated functional materials, and at the end of life of equipment. The proliferation of electronic devices creates a growing demand for recycling and/or re-use.

Figure 10

Global market for electronic materials



Source: www.sia-online.org (using $1.50 to £1 as nominal exchange rate)

Sensors and diagnostics

Many of the opportunities that we have described in this section will need sensors that can monitor and diagnose systems, artificial and natural. For example, research, development and modelling of materials and technologies for sensing and diagnostic applications are important in the development of applications in security, both personal and 'homeland,' energy, transportation, healthcare, the built environment and communications and IT.

Materials are the essential ingredient of sensing and diagnostics (Figure 11). This area is ripe for invention, innovation and exploitation. Interdisciplinary work will be essential to model and develop materials and technologies for sensors.

Those sensor applications that have the greatest promise should be prioritised for further research funding.

Further opportunities

So far we have highlighted areas of industry and materials technology where there are major challenges and opportunities. There are many other areas where materials technology will play a major role, and where there are significant opportunities for research to influence the direction of particular applications.

Materials technologies will also play a part in many other aspects of manufacturing. For example, materials for packaging must also respond to the major challenges of energy and sustainability. They must also address such issues as the growth of internet trading, the need to recycle, the presence of in-built sensors that monitor and indicate integrity of content.

Packaging raises a number of materials issues. For example, we should seek ways to minimise packaging to support 'material light' goods whilst enhancing product presentation. The quest for sustainable development is also a spur to consider reusability and recyclability of packaging materials and the use of alternative materials with lower environmental impacts across the life cycle. The use of regulation in this area is widespread and will benefit from a co-ordinated industry perspective across materials.

In addition to construction applications, structural materials also represent an area where the UK can achieve significant benefits through continuing 'incremental' developments of materials, where the country has considerable expertise in advanced steels and light alloys. Composites are increasingly important in applications such as aerospace and transport.

Figure 11

Materials for sensors

Sector	Structural materials	Functional materials	Multifunctional materials	Biomaterials
Healthcare	Implant wear / prosthetics	Telemedicine/ robot surgery Body signs	Health monitoring 'wearables' Remote sensing Biocompatible materials Compatibility	Assays Drug delivery systems Intelligent Implants
Energy	Fuel cells	Fuel cells	Fuel cells	Waste management
Construction	Lifetime measurement	Concrete ageing	Structural health monitoring/ diagnostics	Microbial hazards
Transport	Composite monitoring	Heat, pressure, wear Asset management Proximity alarms	Integrated sensors/ actuators Self-diagnostics	Driver alertness Environment quality
Retail		Produce lifetime Stock management	Smart packaging Sports equipment Product Tagging Printable power	Antifouling Biosensing
Communications	Asset management - proactive fault reporting	Magnetic Optical Network security		Biomimetic networks
Security	Structural/building management - earthquake sensors	Smoke detection Gas detection Identification	Anti-counterfeiting Offender tagging Biometrics	Biometrics Biohazard detection

The environment for research and innovation

To support the technology opportunities that we have described, the UK needs to create and sustain the right environment for academic and business research in the UK.

Many of the recommendations that we make elsewhere in the report will also influence the environment for R&D, on skills and training for example. Indeed, most of our recommendations will also bring benefits by helping to focus the UK's materials R&D programmes and support mechanisms. For example, 'road mapping,' which we discuss in the section on Knowledge Transfer, will be important in optimising the research base.

We have described many of the specific needs of research and innovation in the report of the Materials IGT Task Group on Science and Technology. This also describes the opportunities for particular materials in some detail. Here we present the key cross cutting recommendations from that study.

Better use of R&D assets

Universities, Government laboratories, independent technology organisations and businesses individually maintain extensive laboratory equipment. This hardware would be better used if the various players had better knowledge of the location and capabilities of these assets.

The UK should establish mechanisms to facilitate access to that equipment, and promote its use, maintaining it where appropriate. Such a network will avoid duplication and, where necessary, enhance the justification for new equipment in the UK's capability. (A business plan for this activity, Materials Assets Connect[8], will be prepared for consideration by the DTI, EPSRC and appropriate RDAs[9] by the end of September 2006.)

To enhance the use of the country's R&D assets, the UK should establish a database and network of equipment available in industry, government and academic laboratories for materials R&D.

[8] Annex 1 shows where this fits within MatUK

[9] RDAs are the Regional Development Agencies

Optimising the research base

We believe that there should be stronger links between the UK's research funding bodies - the DTI, Research Councils, MOD and others - to ensure support for basic and applied research aligns with the materials technology roadmaps validated by MatUK. This activity will include advising the Government's Technology Strategy Board on the research and technology requirements for materials success in the UK.

Funding for R&D

Materials-related research and application driven exploitation is often high risk. While materials technology is recognised as a key underpinning technology by the Technology Strategy Board and funded as such, consideration should be given to "phased" funding which would give a fixed level of funding during the initial development phases of a project, continuing on a tapering basis as the project gains industry support and innovations come to market. This would facilitate the transfer of research and development from academia into industry.

Aligned with this, there should also be mechanisms to fund materials technology demonstrators. Together with better predictive modelling, support for demonstrators would reduce overall risks of bringing products to market. Other support models should be researched to see if lessons can be learned e.g. programme funded by the US Department of Defense such as the Defense Advanced Research Projects Agency (DARPA) and the Small Business Innovation Research (SBIR). The SBIR[10] is the largest source of early stage technology financing in the US.

Funding for materials R&D as a key underpinning technology should continue but in addition consideration should be given to more support for the development phase (and/or demonstrators) which is often still high risk.

The UK should seek to influence the direction of EC funding to enhance materials R&D across the EU and maximise the opportunities for researchers and industry in the UK.

The UK should ensure that routes to international markets are optimized so that new products incorporate materials from the UK.

CASE STUDY

Lead-free metallic coated steel for fuel tanks - Neotec™

Neotec™ offers a cost-effective and light-weight alternative to plastic fuel tanks.

Lead-free Steel is easily recycled and emission-free from fuel impregnation, that affects plastics and raises their recycling costs, therefore future environmental legislation and end-of-life recycling targets can be met.

www.corusgroup.com

[10] http://www.acq.osd.mil/sadbu/sbir/overview/index.htm

Priorities for the UK

The strength of the materials community, and the importance of materials to every aspect of economic activity, is such that the UK is well placed to take swift and concentrated action to deal with some of the weaknesses, and to exploit the strengths, that are described earlier in this report. In particular, it is important to find ways for the various sometimes disparate materials communities to come together to develop a common vision and to make it happen.

As we have already stated, our own vision is that the UK will continue to be one of the foremost advanced technological societies in which world-class materials expertise underpins sustainable growth.

The strengths in research and the positive business environment are especially important, putting the UK in a good position to achieve our vision. By tapping into the opportunities that we have described in energy, resources and the environment, and by using these as areas around which to develop coherent, focussed and well managed research, we can tackle the threats of climate change, energy uncertainties and economic globalisation.

We have identified five key themes which the UK need to address to enhance the prospects of the materials community:

- Knowledge transfer
- Raising awareness
- Accelerating innovation
- Improving skills and knowledge
- Better business environment.

In the following section we describe the issues within each of these themes.

Knowledge transfer

No matter how good the UK's scientific knowledge, it will be of little value without effective transfer to the commercial sector.

While there are undeniable pockets of excellence in business practices in the UK, there is also room for improvement. Wider use of 'best practice' would enhance the competitiveness of the materials community, as would wider use of such tools as road mapping to improve R&D planning and product development.

Small and medium-sized enterprises face particular challenges in knowing where to gain access to information on the choice and use of materials.

The newly created Materials KTN should continue to be developed to facilitate communication with the materials community in the UK and interested stakeholders, particularly SMEs.

The National Composite Network exists to support the composites sector and links into the Materials KTN. Composite materials also provide the platform on which to develop a range of integrated functional, multifunctional and "smart" structures and system.

This and other network nodes for the Materials KTN should continue to be supported and new ones put in place provided the business case is strong.

Best practice

Best Practice concerns the behaviours, processes and procedures which together lead to the best achievable efficiency and effectiveness in industry.

The continued competitiveness of British industry depends on the application of best practice and continuous improvement. The Materials IGT's Task Group on Best Practice identified a number of issues, including a lack of a common understanding of just what constitutes best practice in all aspects of the business process, including shop floor practices, management, optimising innovation in the selection and use of materials, and the advantage of benchmarking. Although many large companies have significant strength and understanding, this is not so for SMEs.

The Best Practice Task Group found that the most common perceived

barriers to implementation of best practice in materials can be summarised as a general lack of knowledge of the possibilities and potential benefits. Without this knowledge, it is difficult for businesses to justify investment of resources and funding. Other common barriers include lack of sources of materials data and a lack of leadership or vision.

The materials community needs to be made aware of the advantages of using best-practice tools and encouraged to make use of the help available via the Manufacturing Advisory Service and various industry groups.

There is a need for intelligent signposting to sources of best-practice tools, covering all aspects of the business process, including on-line benchmarking of performance. The Materials KTN should undertake this role.

With the support of the Materials KTN, large companies should assist their suppliers in the adoption of best practice and in the introduction of new materials into the supply chain.

Benchmark

The UK should benchmark internationally its performance in all aspects of business delivery , performance and supply chain issues, and monitor what is happening in other countries so that the UK can react appropriately.

As well as monitoring key materials, we should also monitor changes in manufacturing processes and the supporting infrastructure.

Roadmaps

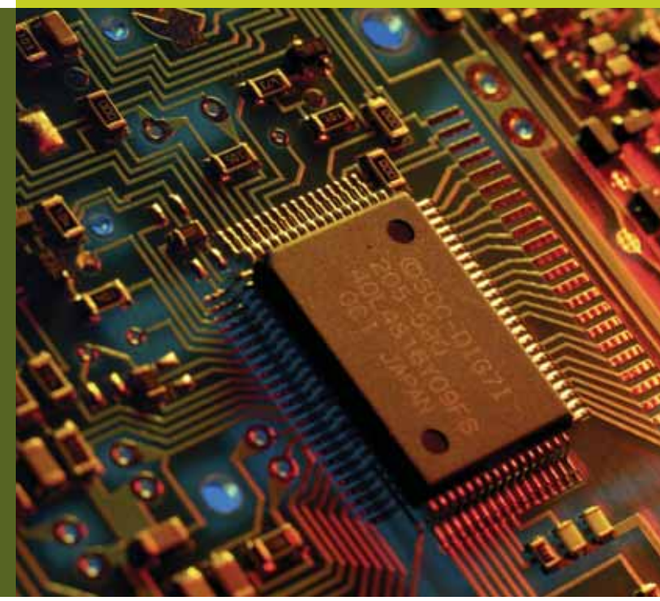
Technology roadmaps are an increasingly effective way of tapping into the collective thinking and expertise of a business community. Roadmaps offer a way of thinking about the future, and a framework for supporting collaboration, decision making. The Foresight Materials Panel has, under the auspices of the IoM3, acted as a focus for the creation of a number of roadmaps for materials technology.

The Materials KTN should maintain a database of industry approved and validated 'roadmaps' of technology futures for materials.

Materials services

There is a strong need to co-ordinate and signpost materials services, including R&D, materials properties and access to materials manufacturing databases. The Materials KTN should facilitate access to these resources. It should promote better use of existing facilities and of the existing infrastructure supported by the National Measurement System Programmes on materials measurement testing and standardisation. For innovative and competitive application of new and improved materials, designers need reliable property data. Such data must be obtained by using validated test and measurement methods. A Materials Property Validation Network should be brought into service as quickly as possible (see annex 1 for its position in Materials UK) building on the planned initiative by the London Development Agency to provide the hub of a national network. This would be well positioned to link in with the current metrology standardisation work at NPL.

The UK can enhance the attraction of the UK as a place to do business by establishing a centre (or network) to validate materials properties.

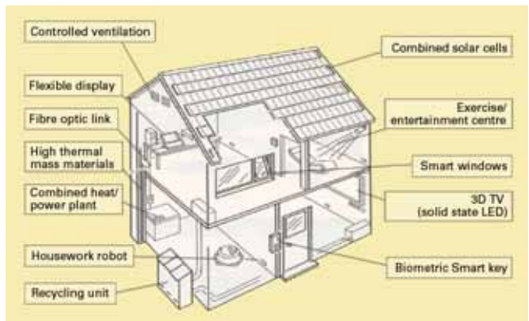


Raising awareness

Support for materials technology - and training and recruitment of skilled workers - depends on greater awareness of the importance of materials to society.

There is a lack of perception of "materials" among the wider community in its modern sense. This is a constraint to recruitment of qualified young people. Those with an interest in science tend to focus on the pure sciences and not their application to materials until late in the current curricula. We believe that there should initiatives to promote the importance of materials to quality of life and protection of the environment.

There is also a need to raise the profile and image of materials so that users optimise their choices of materials based on whole-life considerations. The materials community should also ensure that the 'materials message' come through in other 'Image' raising programmes, such as those intended to improve the image of manufacturing.



House of the future

In addition there should be specific materials activity to:

- *Enhance the appreciation of materials at school level by influencing curriculum changes to promote teaching of science as early as possible, using 'materials' to illustrate what science can do. Find ways to increase the number and quality of teachers who can develop and deliver materials related subjects in schools.*
- *In collaboration with the RDAs, to develop a Material s IGT Youth report as a basis for a better appreciation of the value of materials and to highlight the career opportunities in materials*

(publication planned for June 2006).

- *Foster work experience in the UK materials community, building on best practice from elsewhere, such as the Singapore model.*
- *Promote the use of bursaries, funded by industry to encourage materials students in school and beyond.*
- *Promoting awareness of the principles of sustainable production and consumption and defining what this means for materials.*

Design innovation

There are many issues where design is crucial to meet the challenges that we have addressed in the work of the Materials IGT. Sustainable development, for example, depends on the choice of the right materials. To improve the awareness of new materials, there should be greater interaction between materials scientists and engineers, including production engineering, and the design community to disseminate knowledge and information on the capabilities of materials. The Materials and Design Exchange programme (MaDE) run by IoM3 has begun this process.

The Materials KTN should facilitate the engagement between designers and materials technologists to encourage information exchange leading to new and innovative applications of materials.

Such an approach has already successfully promoted the use of steel in construction through the interaction between specifiers, designers and the steel industry in the UK. This has resulted in the UK taking a lead in innovative applications of steel in construction. Aluminium too has made huge inroads into construction applications.

The materials community working with the Design Council and other design practices, such as the Royal College of Art, should build on this work to bring the design and materials communities together to optimise the opportunities for the UK, particularly eco-design.

Harnessing the pull of design, together with the technology push of materials, is important for rapid innovation in materials and design in the UK.

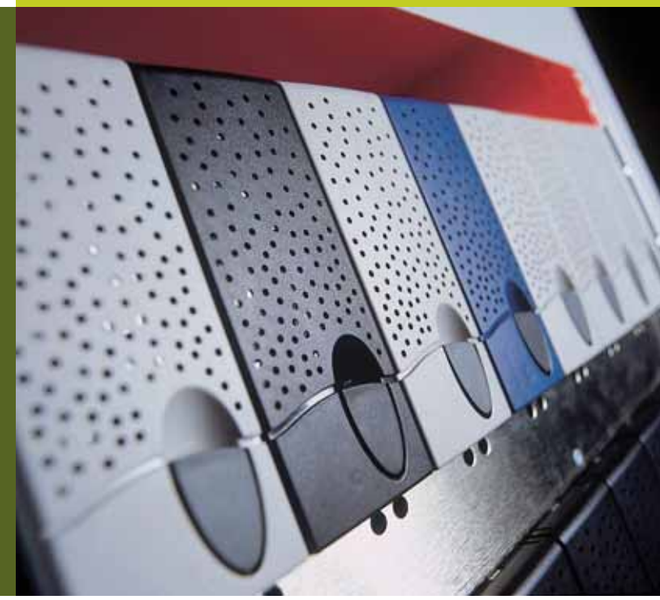
CASE STUDY

New opportunities for lightweight metal alloys

Production technology development for Elektron AJ62, a high strength, creep resistant magnesium alloy based on Noranda alloy patents, has placed Magnesium Elektron UK as a major supplier to the BMW six-cylinder engine programme.

Website www.magnesium-elektron.com

Photo Credit: Magnesium Elektron UK , a Luxfer Group Company, with kind permission of BMW Group



Accelerating innovation

The UK must build on its strengths in materials science and technology and accelerate the pace of innovation if it wants to remain competitive.

The UK has an undoubted position as a leader in materials science and technology. The country's materials community should make better use of that expertise by accelerating the rate at which it adopts new technologies. We have already described some of the opportunities available by bringing materials technology to particular sectors. All of the areas described in the section on technology opportunities will depend on effective exploitation of the science and technology. The separate report on opportunities for science and technology contains more detailed description of opportunities and recommendations. Here we describe just two areas where there are significant opportunities that could affect many different areas of materials technology.

Multifunctional materials

Multifunctional materials represent a diverse and strongly multidisciplinary area, with links to functional, structural and bio-materials topics.

There are strong market drivers to develop added-value products across numerous sectors, including aerospace, transportation, healthcare, packaging, energy, security, consumer products and defence. In addition, there are strong drivers, increasingly underpinned by legislation, related to the environment, energy and sustainability. Two examples of applications to illustrate this field are:

- Damage tolerant, self-diagnostic and self-healing materials, and
- Structural / power generating materials.

As the next big step in product development, multifunctional materials offer great opportunities for the UK to exploit the strengths of the country's science base.

Technically for multifunctional materials, interfacial and surface properties, often embodied within composite materials, will be important. More interdisciplinary work, including multifunctional modelling, is required.

As many natural materials succeed in fulfilling more than one function, there is naturally growing interest in materials research in drawing inspiration from biology known as biomimetics.

The area of biomimetics will require innovation as well as driving future exploitation of multifunctional materials.

Nanotechnology

Nanotechnology builds on a technological history of moving towards ever-finer dimensions. It has attracted considerable Government investment in the UK and abroad. It is, therefore, important to bring it to fruition and to promote industrial exploitation of the opportunities that arise from this massive R&D effort.

There is huge scope for innovation and development in nanotechnology, which pervades all areas of materials. There will be increasingly important innovative ideas arising in nanomaterials, nanomedicine and nanobiosciences. For example, there is growing activity in the use of nanomaterials in drug delivery.

If progress continues in the development of basic nanoscale materials - such as metal oxides, nanotubes and nanoparticles - then the market for nanomaterials in the USA alone could surpass $1 billion in 2007.

There should be a continuing programme of development and support for exploitation of nanotechnology to bring the industrial applications to maturity.

CASE STUDY

Photovoltaic foils for solar energy - KALZIP™

Corus KALZIP™ 'AluPlusSolar' range offers affordable solar power with greater design freedom for mounting amorphous photovoltaic films. Although slightly less efficient than rigid panels of crystalline semiconductor material, these aluminium frames are used to clamp photovoltaic panels, that collect solar energy from roofing.

www.corusgroup.com

Improving skills and knowledge

Materials science and technology will languish unless we can persuade young people to study the subject and seek employment in the sector.

The materials sector has to attract and retain a skilled and educated workforce. It is essential to ensure that the appropriate people, skills and knowledge are available and used effectively.

People and skills

It is as important to implement best practice in education and training as it is in business processes, manufacturing and research.

As well as recruiting young people and giving them the right skills, it is important to develop a continuous career path in materials.

The materials community should work with Manufacturing Skills Academy and the Sector Skills Councils to fill gaps in the provision of short, technology based training courses.

There is a need to coordinate new courses for undergraduate and masters degrees that meet the needs of businesses in the UK for materials knowledge. For example, there should be foundation degrees that allow specialisation to happen as late as possible. Graduates should also have access to 'conversion' courses to enable them to move into other careers where there are skills shortages.

Effective global marketing of UK based materials education courses is important to strengthen the present supply chain for people and skills and to enable strategic international alliances.

There should be a coordinated approach to providing up to date information for young people on the many careers in the materials sector. When reaching out to this audience, it is important to reinforce the connections between materials, the environment and sustainable development, issues that are of particular interest to young people.

There is also a case for developing mechanisms for a more effective 'skills market' for people seeking jobs or with vacancies to fill. This would facilitate recruitment from other EU countries and globally where work permits could be obtained. Such a marketplace

would have the added advantage of allowing school students considering university application to see that there is a demand for material technologists.

In general, the demands made on the technical community are changing in response to the need to be able to monitor, assess and improve environmental performance across the life cycle. Materials specialists need to have the skills needed to adopt best practice in materials selection, production, use and reuse, for example, through Environmental Management Systems, performance monitoring, product labelling and supply chain management.

The UK needs to provide knowledge of, and access to, education and training courses that are relevant to the skills required for the production, processing, safe use, re-use and recycling of material including the assessment of whole life cycle analysis.

The Materials KTN should be used to develop a register of vacancies for skilled personnel in the UK materials community.

CASE STUDY

High temperature superalloy prototype castings

Aerospace components produced from castings, introduced rapid prototyping technology from the US. That enhanced competitiveness, lowering long-term production costs.

Honeywell Hymatic http://www.hymatic.com/

Better business environment

A thriving materials community depends on creating the right business environment.

The materials community should work with Government to make the UK the best place in which to do business in materials. This will entail a number of positive moves. Key roles for Government are the continuing support for R&D, prudent regulation and not least in its own role in procurement. In all these areas there is, to varying degrees, an international dimension.

Regional administration

Regional Development Agencies and other more local organisations play an increasing role in delivering local services.

MatUK should act as a gatekeeper for the materials sector and should provide access to, and facilitate understanding of, the materials strategies of the various regional development agencies and devolved administrations, working with them to avoid duplication and to optimise the resources available to the materials community in the UK.

Regulation

The materials community should work with Government, and where appropriate the EU, on regulatory policy to ensure that the community is well informed and that the policy makers are fully aware of the implications of their ideas on the future wealth creation capability of the materials community for the UK.

In general where regulation is necessary industry favours a focus on "outcomes" rather than prescription on methodologies. For example, the development of "greener" transport is complicated by the plethora of technologies and funds proffered and regulated by various EU member states.

A particular aim should be to deliver regulation that balances the need to protect the environment and human health without compromising safety critical components. For example, it is important to avoid blanket bans on substances where there are no adequate substitutes. When materials that have been in use are to be

withdrawn (which should only be on the basis of a thorough risk assessment), it is important to give industry enough time to develop substitutes.

MatUK should bring together regulatory issues of common concern across sectors and along supply chains. It should work with the regulators to define common objectives to accelerate improvements in outcomes in the most efficient and effective way.

Public procurement

Public procurement is an important factor in the demand for materials in the UK. For example, healthcare, construction, defence and security are all significant markets for materials where Government is the procuring agency. The Government itself is also a major user of utility services which depend on materials.

Judicious use of materials can add value to procurement, particularly life-cycle considerations, tailoring design and manufacture to give the required performance. The materials community needs to continue the dialogue it has opened through the Materials IGT process with Office of Government Commerce (OGC) and contribute to current initiatives, such as Sustainable Procurement, and the construction sector led Rethinking Construction/Accelerating Change and OGC's own work with the construction sector "Achieving Excellence", to ensure that future UK procurement policy benefits from the optimum properties appropriate materials selection can offer.

Public procurement can facilitate better exploitation of the UK's science base. It can also provide economies of scale through more uniform standards. Standards set up by public procurement can drive innovation if this is supported by an adequate research and development infrastructure aimed at common public/private objectives for innovation.

International alliances

There are opportunities for the UK to work with materials users and producers in other countries. We should build on the UK's acknowledged strengths in materials R&D, design and finance to develop strategic alliances with other countries, for example Singapore or Fraunhofers in Germany. The Government should also ensure that routes to international markets are optimised so that UK materials are designed into new products.

Annex 1 Representative body: Materials UK

Structure

See figure 13 schematic of key constituent parts and how they connect together. Website address www.MatUK.co.uk Home page will signpost all the parts and directories.

(i) Ownership via a £1 shareholding to be offered to current members of the IGT Advisory Group plus other companies/organisations who want to be members. Members have the opportunity to stand for election for Management Director positions but also have an automatic place on the Advisory Council.

(ii) Management Board to consist of Chairman (2/3 year appointment), Company Secretariat plus six Directors elected by owners with two representing materials producers, two major materials users, and two representative bodies (e.g. EEF or CBI or Community). These Directors to serve for two years but can be re-elected for a further term. In addition permanent Directors, one each from the Materials KTN, i.e. Operations Board Director), Materials Assets Connect, and Materials Property Validation Centre. Non Executive Director positions held by DTI, EPSRC, MOD and DEFRA.

(iii) Executive Committee to be run by CEO comprising Chairs of all current working groups and Directors of the three main Networks/centres and reporting to the Management Board.

(iv) Working Groups - time limited groups established to address a clear remit endorsed by the Advisory Council and approved by the Management Board. Report through the Executive Committee.

(v) Advisory Council - owners all have places plus one each for all network groups involved in the Materials KTN and other key bodies embraced by the Representative Body as well as key users groups of materials e.g. organisations representing aerospace, automotive, construction, marine, packaging, general engineering to ensure major interest groups are receiving the materials support they need to do business in the UK.

(vi) Materials KTN - knowledge transfer network covering materials, cross cutting technologies and applications, that currently is sub contracting Five Faradays to fill nodes and also incorporates the National Composites Network, the Smart Materials Structures and Surfaces and shortly National Metals Technology Centre as well as other key knowledge providers including Trade Associations.

(vii) Materials Assets Connect - register of all UK R&D assets that will be used to facilitate access through a signposting and booking system, maintain unique capability for UK and fill technology gaps. (The service may be expanded to link in overseas kit which it would not be economic to establish in the UK).

(viii) Materials Property Validation - Centre which will deliver certified/validated data from existing sources where possible and fill gaps on materials properties covering whole life cycle data, recycling, re-use etc., and provide access to local sources of help through a network of regional centres if needed.

Resources

People

(i) In addition to the Board structure the Representative Body should appoint a CEO (possibly part time) to manage the process of set-up, ensuring the key links are in place between all the building blocks and that Materials UK delivers. The DTI will provide secretariat support to help the CEO with his work over the next two years. In addition the Materials KTN Director funded via the DTI Project will be expected to actively support the CEO to deliver the work of the whole Representative Body.

Finance

(ii) Modest funding should be available to help support the cost of the CEO and the youth report publicity programme over the first year and probably continuing for next two but at a reducing level. It is anticipated that top up maintenance funding for the Materials KTN will be able to be used in part to assist the other key networks the MatUK will rely on to do its work. RDA Funding and EPSRC is likely to be available for the Property Validation and Assets Connect networks respectively.

(iii) Corporate sponsorship should be sought as well as owners/members contributing annual fees to cover the running costs involved. Services could be sold. Networks using the KTN could be charged a premium for business delivered/won via the site. Nodes could be leased.

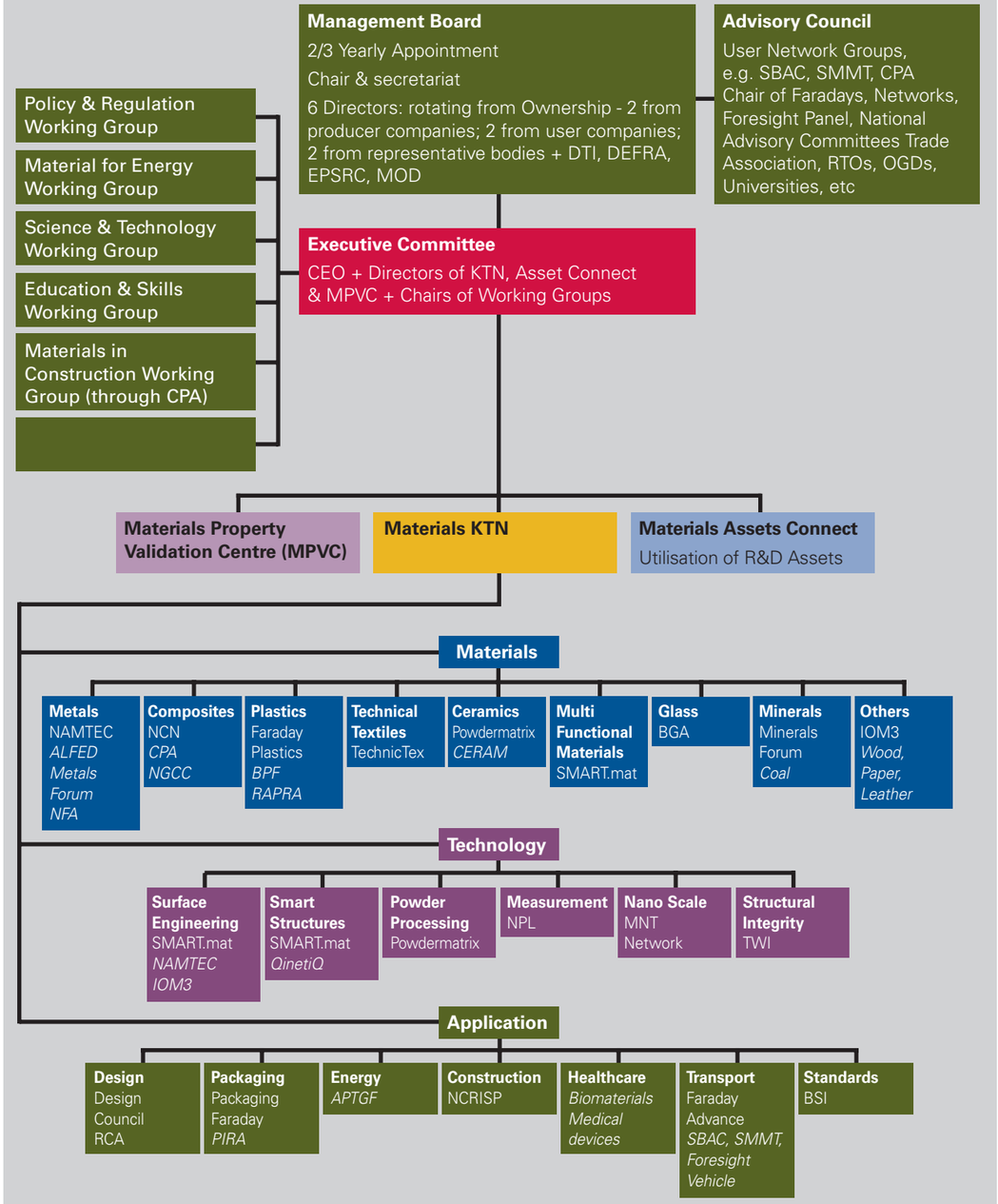
Articles of Association and Memorandum of Understanding

(iv) These should be based on tried and tested models used recently for setting up National Metal Technology Centre (NAMTEC) and National Composites Network (NCN) similar to those used for successful Research Technology Organisations (RTOs) such as TWI.

(v) The Management Board should take decisions based on advice from the Executive Committee and Advisory Council. It would be the exception for such advice to be overruled but ultimately the Management Board/Group/Committee is responsible for the company.

Figure 12

Materials Representative Body - Materials UK



First named organisation taking the lead for each node, the other names indicative of other organisations that could help deliver each node. Each list is not exhaustive.

Annex 2 Materials UK: Key Performance Indicators

Accelerating innovation and technology diffusion

(i) S&T Working Group to publish the reports produced by the Task Group and continue its work highlighting priority topics in underpinning materials technology for the Technology Strategy Board and Research Councils by October 2006 for the 2007 calls for proposals.

(ii) S&T Group to work with the Energy Group to construct a proposal for an Energy Materials Technology Platform by end of October 2006.

(iii) Research public funding mechanisms used outside EU to see what lessons can be learned for promoting change within EU rules.

(iv) Work with financial community through a series of workshops to facilitate investment opportunities for UK firms in materials related activity.

(v) Materials Assets Connect and Materials Properties Validation Centre formally launched by end of December 2006.

(vi) Establish intelligent signposting to sources of best practice tools covering all aspects of the business process (including on-line benchmarking of performance) and technology roadmaps via the Materials KTN by end of September 2006.

(vii) Run at least 6 best practice awareness workshops targeted at the materials community each year.

(viii) Annual survey of materials community indicates a 25% increase in use of best practice year on year as a result of the Representative Body's work.

(ix) Deliver a standard methodology for life cycle and design for life concepts and factual data for materials within a sustainable production and consumption agenda via the KTN nodes and Property Validation Centre by end of December 2006.

Knowledge transfer

Improving Knowledge Transfer Infrastructure

(i) Provide up to date information and intelligent signposting in your technology areas within UK and to enquirers from overseas that offer business opportunities for the UK - deal with at least 1,000 such requests in year 1, rising to 5,000 in year three.

(ii) Target number of organisations actively engaged with the network to rise to 20,000 by year three.

(iii) Review with other Faradays/KTNs within MatKTN how provision of technology translators can be optimised across the network and work with the MatKTN Operations Board to achieve this.

Improve UK assisted productivity and competitiveness

(iv) Number of start-up business's to be assisted or facilitated to be 50 per year.

(v) Using technology translators interact on a one-to-one basis with members to define what issues they have and help to solve them, giving guidance and support as appropriate. Business assists to increase new company business in total by £100m in year one, £200m in year 2 and £500m in year three.

(vi) Define skills development needs of the community and how to address these working with appropriate intermediaries and delivery organisations - first audit and plan to address needs to be completed by end of year one.

Improve Knowledge Exchange between assisted businesses and the science base

(vii) Achieve at least 200 new Industry/Science base collaborations by year three.

(viii) Achieve at least 100 new Business/Business collaborations by year three.

(ix) Produce 20-30 newsletters per year and monthly e-mail alerts to keep UK members alert on current developments.

(x) Work with MatKTN Director and Secretariat to run on line and off line events, including workshops - around 20 or more per year.

(xi) Ensure news items are fed through to MatKTN Secretariat in a timely manner - at least 30 per year.

(xii) Engage with the appropriate regional networks to ensure that regional clusters are informed of the network and how to participate through the MatKTN.

Increase innovation activity amongst assisted businesses

(xiii) Use the public areas with the MatKTN to encourage project proposal brokerage for the DTI's Technology Fund and other collaborative support initiatives.

(xiv) Lever in Funding from the RDAs or other public bodies to enhance the work of each network and where needed fill gaps in the UK's technology portfolio with regional centres or through enhancement of existing technology providers capability to ensure hands on access to state of the art technology is available for UK firms.

(xv) Generate 100 good R&D proposals with success rate of 1 in 4 per year.

Improve the ability of assisted business to exploit global knowledge

(xvi) Establish links with existing complimentary research and other communities, including Faradays outside the MatKTN through regular meetings and joint events - at least 10 per year.

(xvii) Produce or update existing foresight technology and research road maps that identify technology or research themes to support UK industry every two years.

(xviii) Produce as least one state of the art review per year on developments within each key technology area.

Linking design

(i) Work with the Design Council and other agencies such as RCA to develop a design for functionality node within the Materials KTN that will be fully operational by end March 2007.

(ii) Linking design and technology through this node generates new business opportunities and products for UK firms of the order of at least £10m per year by end of December 2007.

(iii) Communicate the UK excellence in Design to Specifiers and Accreditors, through international workshops in design to attract OEMs to the UK for design for functionality.

Energy

(i) Energy Working Group to be established and have had first meeting by end of March 2006.

(ii) Group to take account of all existing activity going on via research councils and elsewhere, then identify opportunities for materials in energy efficiency, generation, transmission, storage, conservation, and security of supply and produce an action plan to address them by end of June 2006 feeding in as appropriate to the energy review.

(iii) Identify opportunities for UK materials producers and processors that will generate significant new business within 5 years (increase of at least 5%).

(iv) Report progress on a quarterly basis to the Representative Body, over the initial two year life of this group.

People & skills

(i) People and Skills Working Group established and meets for first time in April 2006 to start defining a two year programme of work to address the IGT recommendations.

(ii) Work to ensure Manufacturing Skills Academy delivers appropriate vocational training to fill the gaps for the materials industry. Initial contact with SEMTA by end of June 2006.

(iii) Provide basis for a register of skilled vacancies in the UK materials community on KTN by end of September 2006 and have service fully operational by end of December 2006.

(iv) Initiate providing knowledge of and access to education and training courses relevant to the broad range of skills required for the production, processing, safe use, re-use and recycling of materials via KTN nodes by end of June and have service fully operational by end of December 2006.

(v) Develop mechanism by end of December 2006 for rapid transformation of graduates or final year students into specialised areas required to fill skills gaps - to facilitate this appropriate foundation degree courses may need to be designed.

(vi) Research and deliver longer term work experience projects for schools to stimulate and promote a greater understanding of the materials industry including the challenges and opportunities offered.

Image

(i) Develop key messages for youth report via five regional youth focus groups in April/May 2006.

(ii) Produce youth report by June 2006 and disseminate via series of regional workshops over following six month period.

(iii) Work with national curriculum review team to influence optimise use of materials to teach science at primary school level in the curriculum review to be completed by September 2006.

(iv) Provide access to and facilitate understanding of the various regional and devolved administration materials strategies to avoid duplication and optimise UK resources to enhance the image and an appreciation of the importance of materials to everyday life.

(v) Establish Best Practice framework for Sustainable Production and Consumption along with social responsibility and promote its adoption widely across the UK materials community.

Policy & regulation

(i) Policy & Regulations Group established and meets for first time in April 2006 to define how best it can build on all the available expertise in all the organisations linked to the KTN on policy issues so that the Representative Body can develop a sound coherent strategy for communicating with HMG (and the EU where appropriate) on issues of common concern adding measurable value to the lobbying efforts of individual materials groups.

International alliances

(i) Develop strategy for international alliances with other countries (e.g. Brazil, Korea, China, Russia, India) by building on:-

(a) initial links in Singapore to develop at least three ongoing partnerships that will lead to new business and collaborative R&D opportunities by the end of June 2006;

(b) initial dialogue with Fraunhofers to define scope for developing new collaborations including defining what the business gains could be for the UK materials community from these by end of October 2006.

Organisational

(i) Management Board for the Representative Body established by end of March 2006 with Chairman and Secretariat in place and first CEO by June.

(ii) Business Plan for Materials Property Validation Centre to be submitted for consideration by London Development Agency by end of June 2006.

(iii) Management Board to meet in June and October 2006 then bi-annually in March and October each year thereafter.

(iv) Business plan for creation of Materials Assets Connect (to optimise utilisations of R&D assets) to be submitted to DTI and EPSRC in July 2006.

(v) Representative Body established as a company limited by guarantee with articles of association and a memorandum of understanding agreed by end of September 2006.

(vi) Representative Body to take ownership of Materials Knowledge Transfer Network by end of October 2006.

(vii) Produce report of progress on taking forward IGT recommendations by end of March 2007.

Annex 3 IGT's methodology

The Advisory Group (see page 4) initially established 5 Task Groups to cover the issues of common concern identified in the pre- IGT work. Each task group had two co-chairs and a member of the Secretariat team to run it and was asked to look at 5, 10 and 20 year horizons, identify between 5 and 10 key issues that needed to be addressed by the materials community, and ideas how to do this.

Task Group	Co Chairs
Science & Technology	Graham Davies, Birmingham University. David Bott, Consultant
Policy & Impact	Duncan Pell, Corus Bernie Bulkin, Sustainable Development Commission
Assets & Infrastructure	David Pulling, GKN Jason Wiggins, RDAs
Best Practice	Ebby Shahidi, Advanced Composites Group Bob John, TWI
People & Skills	Bernie Rickinson, IoM3 Jack Brettle, Pilkington

The task groups were open to anyone who wanted to make a useful contribution. They sought to engage the broadest possible materials community in their work, by regularly placing discussion documents on the Advanced Materials Forum (www.AMF.UK.com) website and inviting registered users to contribute electronically to general discussion points and to feedback on the specific questions raised in the documents. A series of task group meetings and workshops also took place to discuss issues relevant to the IGT's terms of reference, to set direction and to review feedback.

Two additional Task Groups were later established - an International Group, chaired by Prof John Wood, Council for the Central Laboratory of the Research Councils (CCLRC) to look at this dimension and an Economic Analysis Task Group, chaired by Robert Quarshie, DTI/Corus.

As well as individual task group meetings, workshops were held to discuss government procurement and where it affected the materials sector; the relationship between materials and sustainability; the importance of minerals; materials requirement for the construction sector and the relationship between energy and materials.

The IGT also undertook a number of surveys of materials producers and users to underpin their work.

Individual reports from the Task Groups, proceedings of the workshops and outcomes from the surveys are available on the CD or the website: www.MatUK.co.uk

For further information on any aspect of this report or the content of the CD please visit **www.MatUK.co.uk** or **www.dti.gov.uk**

Photography
Unless otherwise stated elsewhere, images were supplied from DTI, NPL and IoM3. We should like to thank all companies who contributed their images.