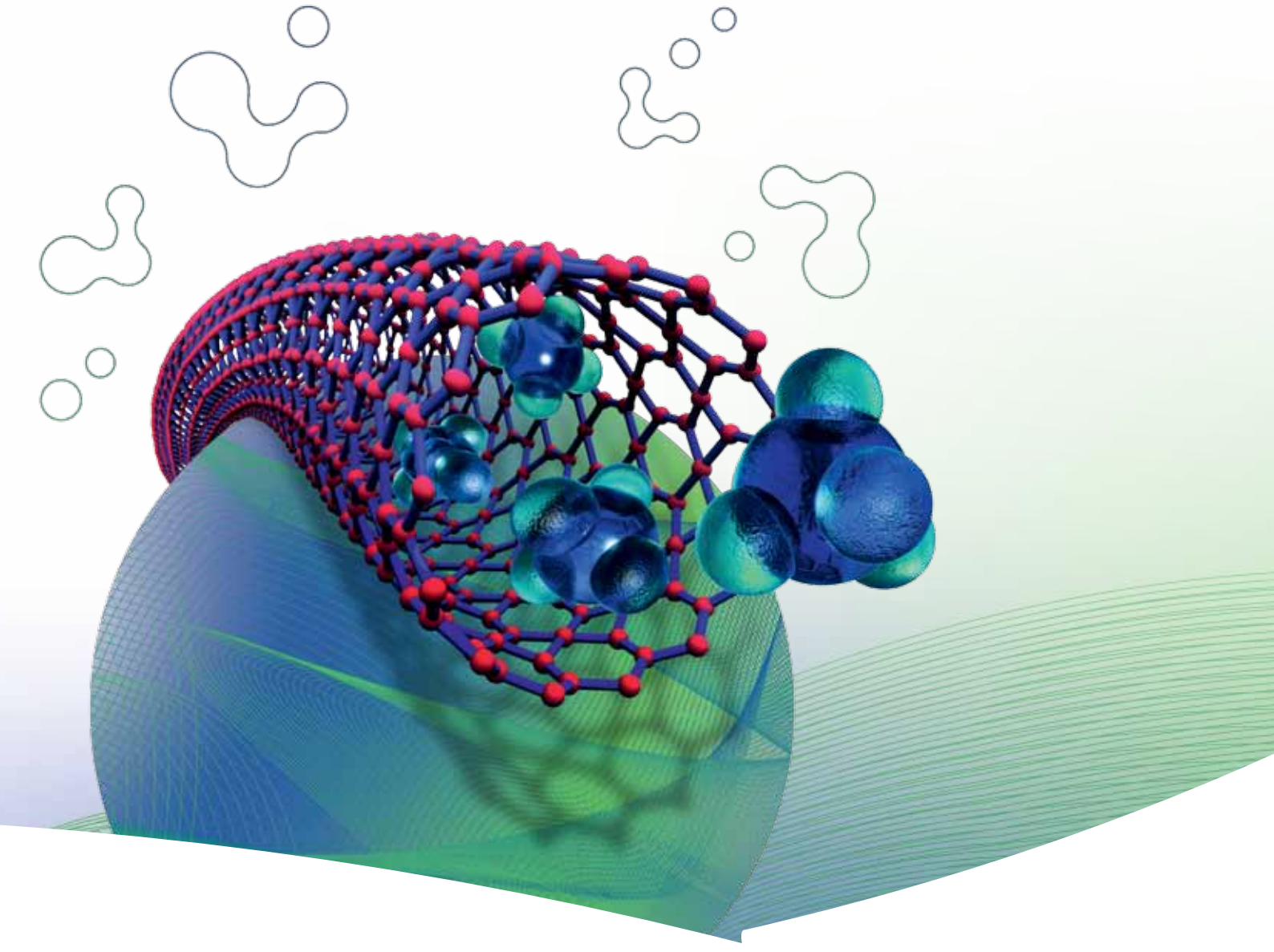
OPPORTUNITIES IN
ADVANCED MATERIALS

Scottish Enterprise

insight

Materialising a brighter future



TAG TECHNOLOGY & ADVANCED ENGINEERING GROUP

Scottish Enterprise

Supporting a globally competitive Scotland

FOREWORD

Scotland's Enabling Technologies

The coming years will offer huge opportunities for the Scottish economy but Scotland must exploit its technological prowess better in order to deliver fast sustainable economic growth and enable the low carbon economy of the future.

The Technology and Advanced Engineering Group (TAG) is a partnership between business, academia and government with the task of transferring Scotland's strong research and development base into a major driver of the economy. The Group has formulated the Enabling Technologies Strategy, which outlines what needs to be done in order to generate a thriving, innovative Scottish economy based on the development of key enabling technologies – a sector where Scotland already has particular strengths.

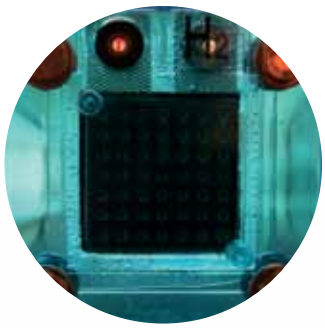
Scotland is home to over 900 enabling technology companies and organisations, including a number of world leaders in many key sectors. The Strategy outlines how these world-leading companies can retain and increase competitive advantage through targeted investment in their technologies and applications, based on opportunities for maximum economic return, represented by industry demand. This will then be supported through increased use of collaborative support at a national, UK and international level.

Scotland's company base will be strengthened through collaborative projects and programmes aimed at increasing the adoption and exploitation of enabling technologies, both by technology-dependant industries and across the wider business base.

Within enabling technologies, there are five focus areas:

- Information and Communications Technologies
- Electronic, Photonic and Electrical Systems
- High Value Manufacturing and Advanced Engineering
- Biosciences
- Advanced Materials

Inside, we will highlight the most attractive opportunities we have identified for Scotland within the area of Advanced Materials.



Three steps to success

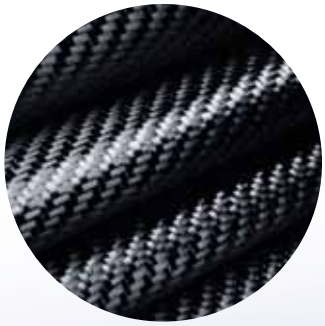
The Enabling Technologies Strategy highlights three steps needed to enhance national productivity through greater use of Enabling Technologies. These steps are:

- Plant: Identifying the key areas for investment and strengthening those creative networks between industry, universities and government to stimulate economic growth across Scotland.
- Nurture: Growing the opportunities by implementing a co-ordinated programme of strategic investments in projects designed to enhance and sustain the way Scotland innovates.
- Harvest: Reaping the rewards by systematically exploiting the commercial benefits of the most promising innovations in global growth markets.

This report aims to sow the seeds in the most fertile opportunity areas for the advanced materials industry for Scotland.

Advancing the market for materials

Industry has an insatiable appetite for more advanced materials, from strong, lightweight composites to high-efficiency insulators. Increasingly, innovative materials which can also advance the low carbon economy are desired. The prime market opportunities include materials and their associated process technologies with the potential to be exploited in high value products.



THE ADVANCED MATERIALS MARKET

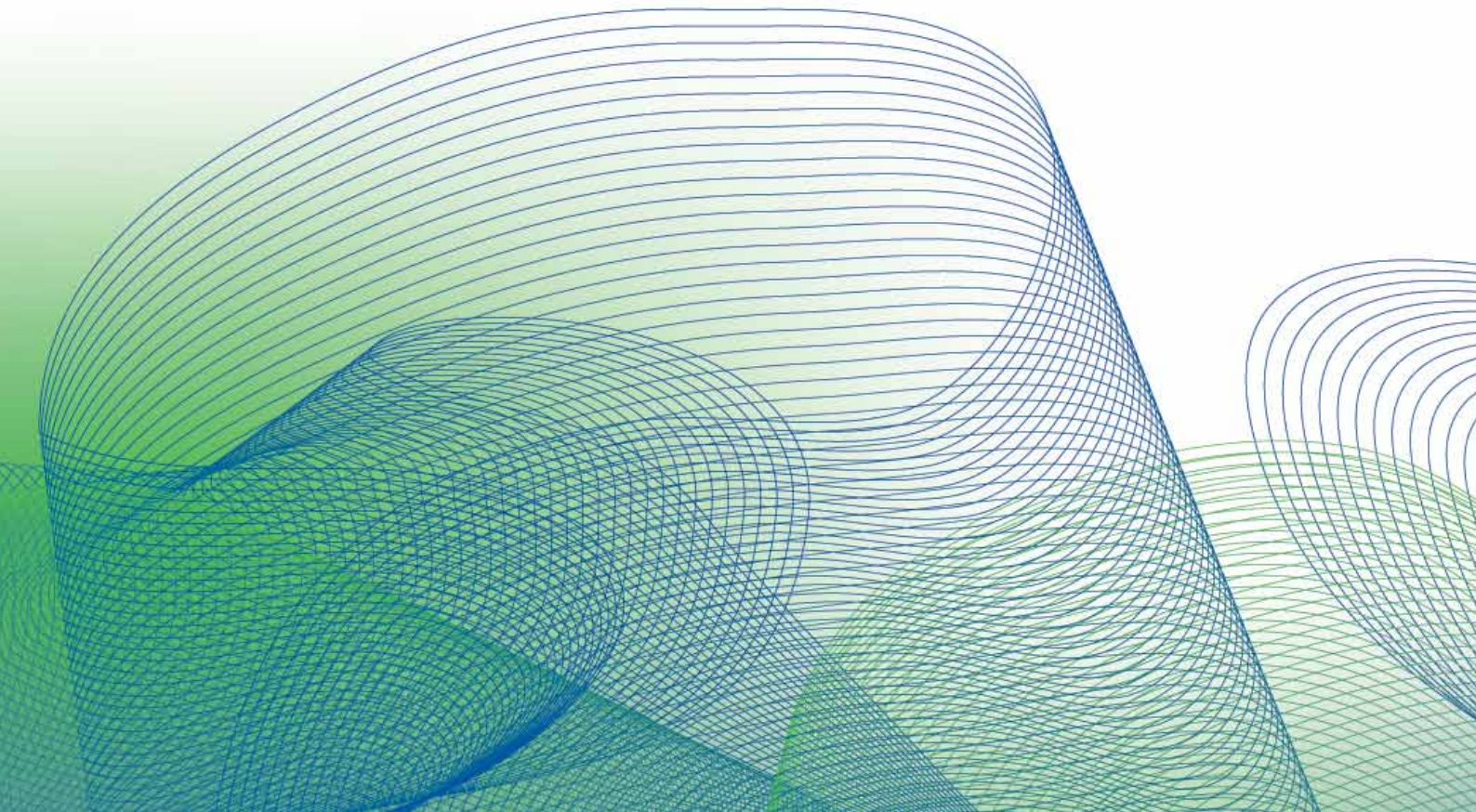
The materials market is huge, accounting for over £10 billion turnover in Scotland alone. While traditional materials such as steel and concrete account for much of this, advanced materials offer greater opportunities for growth and differentiation. There are over 120 companies in Scotland developing and manufacturing advanced materials both for the domestic market and for export.

These advanced materials are adding value to the end products of many sectors including aerospace, chemicals, construction, defence, energy, food & drink, ICT, life sciences, marine and transport.

Looking ahead, the most fruitful areas for Scottish companies in advanced materials are likely to be:

- Smart packaging (films, inks and chemical markers for product integrity)
- Composites
- Electronic functional materials (with emphasis on low-carbon applications)
- Biomaterials, textiles and hybrids for sustainable construction
- Coatings and surface treatments
- Materials for batteries and fuel cells (titanium metal oxides and alloys, zinc-air, lithium sulphur and lithium-air electrochemistries, platinum replacements and polymer membranes)
- Metals and alloys

Each of these opportunities is investigated in detail later.



INDUSTRY GROWTH

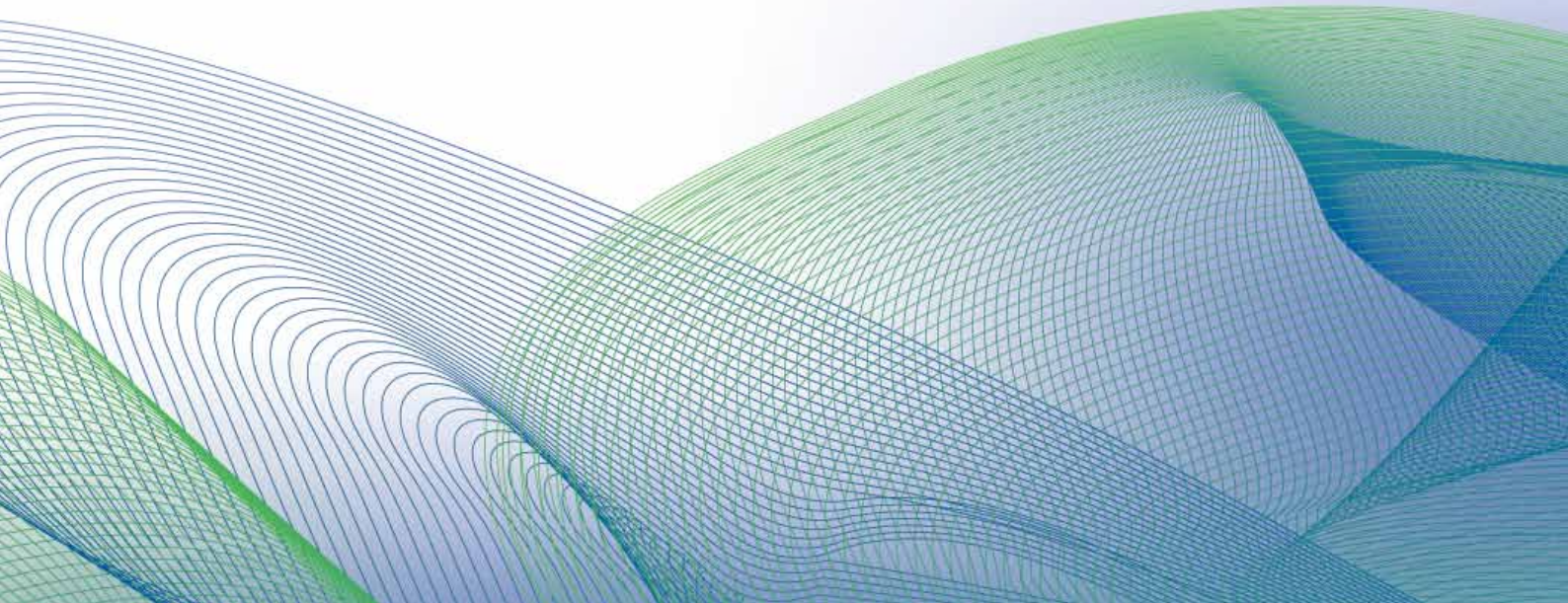
This document focuses on seven advanced materials themes where Scotland already has relevant capabilities, there is a strong pull for innovative technologies and an attractive global market.

There are opportunities for growth not just in the development and production of the materials themselves but also in their application and deployment.

For example, new joining technologies, tools and modelling software are often required to enable a new material to be used effectively.

In fact, innovative materials often disrupt whole supply chains, opening up new opportunities for companies from chemicals manufacturers to system integrators across multiple industries.

Advanced materials theme	Market size estimate	Growth rate estimate
Smart packaging	$29.6 billion in 2010 (Global)	CAGR 6.7% to 2015
Composites	$17.7 billion in 2010 (Global)	CAGR 7.8% to 2016
Electronic functional materials (low carbon applications)	$2.5billion in 2010 (Global)	CAGR 15 to 40% to 2015
Biomaterials, textiles and hybrids for sustainable construction	$160 billion in 2010 (Global)	CAGR 21% to 2015
Coatings and surface treatments	£10.8 billion by 2015 (UK)	CAGR 6.24% to 2015
Materials for batteries and fuel cells	$10.9 billion in 2010 (Global)	CAGR 18 to 25% to 2020
Metals and alloys	$1,661.2 billion in 2009 (Global)	CAGR 7.1% 2005 to 2009



SCOTLAND'S POTENTIAL FOR SUCCESS

Scotland's universities provide a strong platform for success by delivering a stream of talented graduates and a portfolio of world-class research in advanced materials.

Our healthy company base provides a place where these skills and ideas can flourish, leading to high quality advanced materials products and services.

Equally importantly, there is strong customer pull. Scotland's oil and gas, renewables, aerospace, food and drink, construction and electronics industries are examples of globally competitive sectors which are demanding ever more sophisticated materials solutions from their supply chains.

Academic strengths

Through their strong links with industry, Scotland's 15 universities and four higher education institutions ensure Scotland remains one of the world's leading engineering powerhouses.

The many programmes, projects and initiatives being undertaken to progress advanced material research in Scotland's universities include the following examples:

- Aberdeen is a hot-spot for composite research, with the mechanical behaviour of complex composites studied at **The University of Aberdeen**, while **Robert Gordon University's** Advanced Materials and Biomaterials Research Centre has been looking at how surfaces and interfaces determine the properties of composites and biomaterials.
- **The University of Dundee** has established an international reputation in concrete technology while architectural researchers at **The University of Edinburgh** are studying fabric formwork for concrete structures.
- **Edinburgh Napier University's** Forest Products Research Institute studies a range of wood-based materials including biocomposites.

- With over £20 million of investment, the James Watt Nanofabrication Centre within **The University of Glasgow** undertakes R&D including small production runs for applications such as nanoelectronics and biotechnology.
- **Glasgow Caledonian University** has considerable expertise in surface engineering, including metallic coatings, in its Products and Materials Technologies Group.
- **Heriot-Watt University** is active in 3D textile composites and has collaborated with industry in smart and secure labelling technologies.
- Solid oxide fuel cells and novel battery technologies are the focus for research teams at **The University of St Andrews**.
- **The University of Strathclyde** has expertise across the materials landscape and has recently opened its Advanced Materials Research Laboratory to provide first-class characterisation and testing facilities.
- The Thin Film Centre at **The University of the West of Scotland** has earned plaudits in the development and characterisation of thin-film products and processes for industry.

Company strengths

Today, Scotland is home to over 120 companies with innovative advanced materials at the core of their business. Some are multinationals attracted by Scotland's welcoming business environment, such as **Du Pont Teijin Films**, **Spirit Aerosystems** and **WL Gore** while the majority are SMEs of Scottish origin.

A few examples will illustrate the breadth of materials innovation across Scotland's SME base:

- **Cellucomp:** this young company has developed Curran®, a material created from the extraction of nano cellulose fibres of root vegetables
- **Exxelis:** leading innovators of optical materials and illumination systems, particularly for use in LCD displays in laptops, mobile handsets and flat panel TVs
- **J&D Wilkie:** responsible for developing a range of advanced technical textiles including 3D woven composites
- **Kraft Architecture:** specialises in low energy and Passivhaus buildings and develops sustainable insulation materials
- **Worldmark:** the company's strong materials R&D team develops innovative brand protection and authentication solutions for leading consumer electronics companies

SMART PACKAGING

Materials innovation is enabling a new generation of packaging which can guarantee the provenance, freshness or integrity of its contents.

The market for smart materials for packaging was estimated at $29.5 billion in 2011 and is set to grow to $40.1 billion by 2015 *(BCC 2008, Freedonia 2008, CosmeticsDesign.com 2006)*.

While smart packaging materials can be used across a range of sectors, food and drink, healthcare and cosmetics together comprise 90% of the current market.

Market drivers

- Combating counterfeiting
- Consumer desire for guaranteed fresh packaged food
- The need to ensure medication is taken correctly
- Requirements for improved security and anti-theft features
- Waste reduction targets

Opportunities

With an established and internationally-competitive industry focused on manufacturing security papers and labels as well as printing security features, Scotland already has a head-start in the competitive smart packaging sector.

Scottish universities are also seizing the opportunity, with researchers at Strathclyde University developing freshness indicators while other universities are working on covert security/product identification chemical makers, holographic devices and chip-less smart labels.

The key opportunities fall into two categories:

- Smart labels or chemical marking to detect counterfeiting and preserve product integrity in high value goods, documents and pharmaceuticals.
- Packaging materials integrating novel materials technologies to monitor food freshness.

Technology

Smart packaging in the food and drink industry can take the form of:

- Freshness indicators, such as solvent based inks or magnetic coated fibres
- Oxygen scavenging, using metallic and enzyme compounds
- Temperature control packaging using phase-change materials
- Tamper evidence features and intelligent films, including silicon nanoparticulate films and triboluminescent materials which glow when ripped apart

Applications in healthcare, cosmetics and other high-integrity applications include supply chain tracking and assurance of product provenance and integrity. Material-based technologies include:

- Digitally embedded watermarks
- Microlens arrays
- Next generation 2D data matrix barcodes using novel printing inks and printed electronic materials, which could include covert security features
- Holographic labels
- Infrared inks
- Digital serial number identification chromatography
- Sensors to indicate ultraviolet exposure, moisture conditions and skin types

COMPOSITES

Composites are created by embedding fibrous materials in a polymer matrix to produce a strong but light material. Carbon-fibre composites are well established in high-performance applications while natural fibre composites are growing in appeal.

The global composites industry is significant and growing. In 2010, it was valued at an estimated $17.7 billion and is predicted to grow by an impressive 10.3% year on year *(Lucintel 2011)*.

Aerospace is the largest end user of advanced composites and the market is set to increase by a massive 15.6% each year in this sector. The booming wind energy industry is also set to increase its demand for composite materials and this market is set to grow by 13.3% annually. Given Scotland's head start in the sector, the domestic market could be set to enjoy further growth.

Market drivers

- Weight reduction in transport for fuel efficiency
- Need for stronger but lighter blades in large wind turbines
- Sustainability through recycling and use of biomaterials within composites
- Development of larger scale, higher volume manufacturing processes
- Reduction in servicing costs through smart composites

Opportunities

In the near-term, there are a number of opportunities to extend the reach of Scotland's existing composites capability into new fields:

- Offshore wind, including blades, nose cone components and nacelle housings
- Fast marine vessels and marine energy structures, including wave and tidal
- Carbon composite-reinforced umbilicals and pipes for deep-water oil and gas applications
- Maintenance, repair and overhaul of composites in offshore renewable energy applications.

In addition, there are further opportunities for Scottish industry to develop its expertise in:

- Natural fibre reinforced polymer composites for lightweight structural applications, exploiting Scottish capability in nano-cellulose composites
- Smart composites capable of monitoring structural integrity or self-repairing for use in demanding applications including offshore wind, marine energy and aerospace

Technology

Composite technology is advancing in terms of the materials themselves, manufacturing processes and modelling of engineering performance.

Carbon Fibre Composites: Innovations in the orientation of fibres within the matrix and in weave patterns are leading to the development of new carbon fibre composites, while progress is being made in out-of-autoclave manufacturing processes, particularly for large components.

Biocomposites: Many natural fibres, such as cellulose, have outstanding mechanical properties which can be exploited in novel composites, which also leads to greater sustainability.

Smart composites: Optical fibre can be embedded into composite structures to enable stresses and strains to be measured and mechanical faults to be identified.

Self-repairing composites: For example, monomers can be stored in microcapsules dispersed in the polymer matrix. When ruptured by a progressing crack, the monomer is drawn along the crack and contacts dispersed particulate catalysts which initiates polymerisation to heal the damage.

Nanocomposites: Carbon nanofibres can be used to improve thermal and electrical conduction.

ELECTRONIC FUNCTIONAL MATERIALS

The Scottish Government is committed to reducing carbon emissions by 42% by 2020 and 80% by 2050. To reach these targets, Scotland is determined to create and foster a low carbon economy where cutting-edge technology is employed to slash emissions across all industrial sectors. Electronic functional materials will be key in delivering this.

The economic impact of developing low carbon energy electronic materials could be significant: the Organic Photovoltaics market is forecast to reach €1.3 billion by 2018 *(OE-A, EPOSS and Opera 2009)*; OLED lighting will achieve a market of €4.5bn by 2015 *(Nanomarkets 2010)* while GaN power devices will reach $350M by 2018 *(Yole Developments 2011)*.

Market drivers

- Energy efficiency
- Reducing emissions
- Reducing costs
- Longer lifespan
- Higher power outputs

Opportunities

Research and development in photonics is a well established strength in Scotland and there are a wide range of companies developing and using photonic materials in Scotland today. Meanwhile, Scottish universities are active in III-V semiconductors and organic electronics.

There are three high-growth market segments which are likely to exploit this technology:

- Organic photovoltaics which can be embedded into a wide range of products from roof tiles to clothing. This market is at an early stage in development.
- Organic LEDs for energy efficient lighting and displays. This is a high-growth market already.
- High power electronics – driven by demand for renewable energy generation and electric vehicles. This market is expected to take off over the next 5 years.

Scotland's renewable energy, defence, construction and transportation sectors could all potentially benefit from these novel materials.

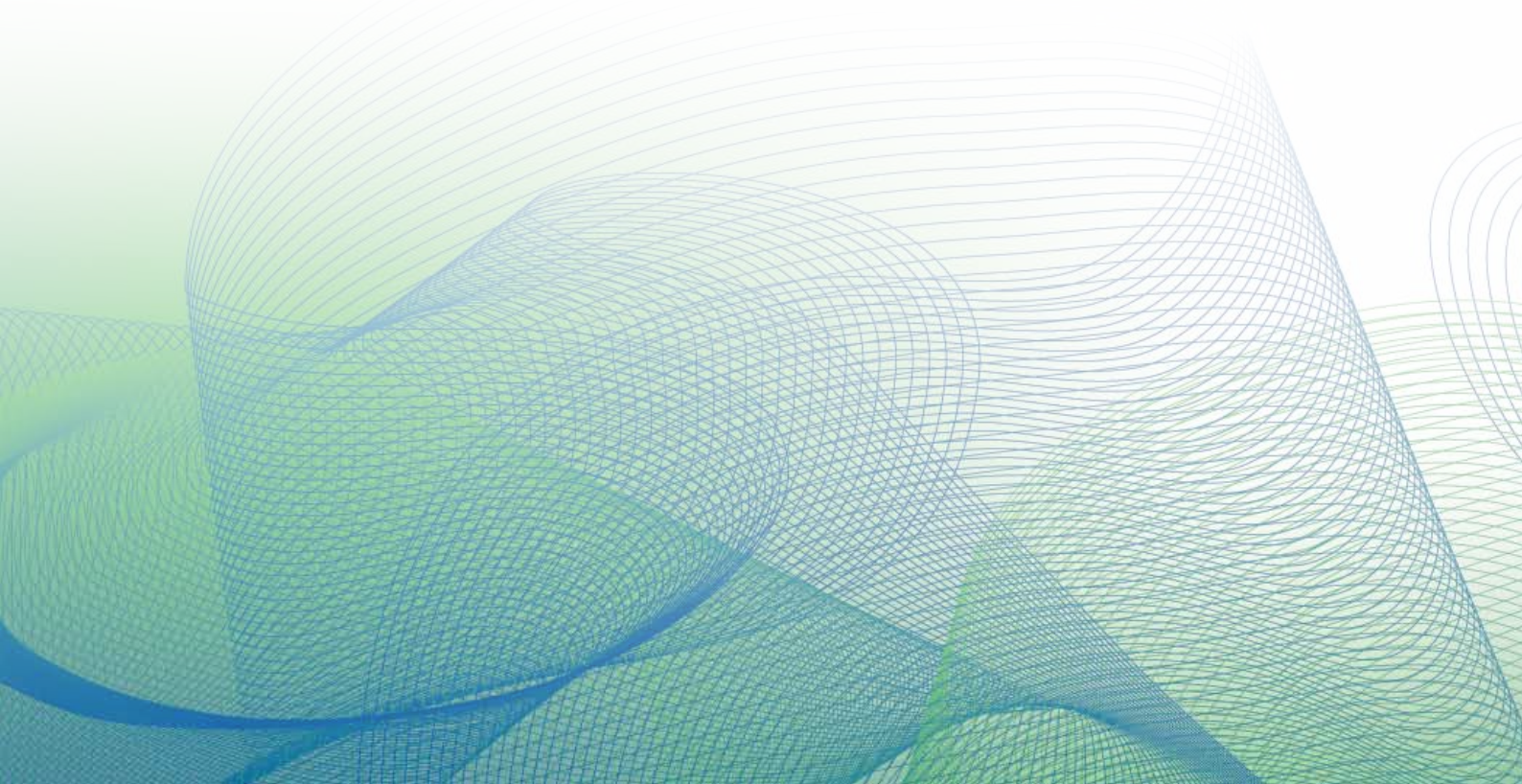
Technology

Organic Photovoltaics are starting to achieve useful efficiencies but further work is required to optimise transport and absorption properties. Low cost flexible substrate materials will broaden the application scope. Manufacturing efficiencies are likely to be achieved by improved deposition techniques and roll-to-roll processing.

Organic light emitting diodes (OLEDs) are very power-efficient and will be used in next generation lighting, where they can be embedded into the structure of buildings or vehicles. The R&D focus is on high efficiency emitter materials, materials suitable for high temperature processing, improved electrode materials, enhanced encapsulation materials and high volume processing technologies.

OLEDs are also being deployed into active-matrix displays for consumer electronics where the challenge is to achieve larger, cost-effective displays with long-lasting colour integrity.

Gallium Nitride is expected to become one of the main materials for high power electronics as it has been shown to perform effectively at the voltages and conditions required.



BIOMATERIALS, TEXTILES AND HYBRIDS FOR SUSTAINABLE CONSTRUCTION

Creating and maintaining buildings requires a vast amount of materials. Concrete, timber, metals, polymers and glass all go into the construction of buildings and the make-up of these materials will have a big impact on the energy consumption of any structure.

Sustainable construction is becoming more and more important, particularly in countries like Scotland which have set challenging carbon and energy reduction targets.

This market is only going to increase as more and more governments seek to reduce their energy bills. The global market for sustainable construction materials was estimated at $160 billion in 2010 and is forecast to grow at 21% a year up to 2015 *(SBI Energy 2010)*.

Market drivers

- Energy efficiency
- Lifetime carbon emission reduction
- Cost reduction to compete with established materials
- Minimisation of waste
- Increased regulation and compliance requirements
- Drive to use recycled materials

Opportunities

The sustainable construction materials industry in Scotland is focusing on innovation in thermal insulation, technical textiles and timber-based construction. A number of Scottish architects are also designing to stringent Passivhaus standards. To complement this, Scotland's universities also have significant strengths in advanced composite and nanotechnology-based materials for construction. As a result, there are opportunities for Scotland in:

- Use of biomaterials to replace established building materials with high carbon footprints
- Application of technical textiles to support climate control in highly insulated buildings
- Use of technical textiles to replace current inflexible and wasteful wooden moulds
- Development of hybrid materials to create multifunctional modular building components with a low carbon footprint
- Super-thin and efficient insulation materials for existing buildings

Technology

Biomaterials: The most commonly used natural materials are cellulose, hemp and wood fibre. Such materials offer good insulation properties and can be used in polymer composites or cement composites for structural applications.

Technical textiles for membranes: The weave should be weather-tight yet breathable for membranes in air-tight buildings.

3D textile mould: Enables lightweight precast concrete and architectural products. The textiles must be strong to contain the concrete. Sophisticated design software will be required to create the 3D moulds to match the architect's vision.

Aerogels: These high-tech insulators offer outstanding performance for their thickness, making them ideal for retrofitting old buildings with minimal impact on internal dimensions.

Sustainable insulators: Materials including wool, recycled textiles and cellulose offer good performance with minimal environmental impact compared to current glass-fibre insulation.

Prefabricated hybrids: Used to allow the rapid construction or refitting of high-quality buildings, prefabricated components increasingly feature sophisticated hybrid construction techniques using layers of carefully selected materials to achieve a combination of strength, insulation and damp-proofing.

COATINGS AND SURFACE TREATMENTS

Coatings and surface treatments can make materials more durable, prevent corrosion or enhance other properties.

Some of the most demanding requirements come from the aerospace sector and subsea applications for the oil and gas industry, where pipes are subject to highly abrasive wear.

The fast-growing offshore renewables sector also requires high performance coatings, as rain and insects can hit wind turbine blades at very high speeds. A number of other industries can also benefit from innovation in surface treatments.

The global surface engineering market is a huge one. In the UK alone, the coatings market was estimated at £10.8bn in 2010 and was part of the supply chain for products worth over £140bn. This market is expected to grow by over 6% year on year through to 2015 *(Surface Engineering Association 2010)*.

Market drivers

- Tightening regulations mandating cleaner, greener, less toxic products
- Durability of coatings to avoid the need for reapplication
- Performance in harsh environments – particularly for sectors such as oil & gas, aerospace and renewable energy

Opportunities

Four Scottish university research groups are involved in coatings and surface treatment research and several others are investigating nanoscale materials and nanosurfaces which could have a positive impact on the surface engineering and coatings industry. A broad range of SMEs could adopt these new technologies, many of whom serve the energy sector.

The most attractive emerging opportunities are:

Offshore renewables: Capitalising on existing expertise honed in the oil & gas industry, the potential exists to develop new materials for offshore wind surface engineering, potentially utilising nanotechnology.

Sustainable coatings and coating processes: Pressure from industry and regulatory bodies is leading to the development of new materials and processes which remove the need for harmful and toxic substances such as chrome, while maintaining surface hardness.

Technology

Passive films and coatings, which includes anodising and thermal spraying processes, provide a protective barrier which may provide scratch resistance and antimicrobial effects, can repel dirt, improve thermal insulation and UV resistance and promote anti-fouling. New materials under investigation include advanced nitride based coatings and ultra durable multi-component polyester urethanes.

Active nano-enabled coatings are sensitive to environmental stimuli such as pH, temperature, light oxidation/reduction and certain chemicals. These have potential to be used in sensors, responsive drug delivery, environmentally responsive actuators and photocatalytically induced cleaning.

Transforming active nanostructures change irreversibly during some stage of use or life. These include self healing coatings which repair damage caused by corrosion or mechanical abrasion in response to specific triggers.

Other examples of nanotechnology based coatings for industrial applications include:

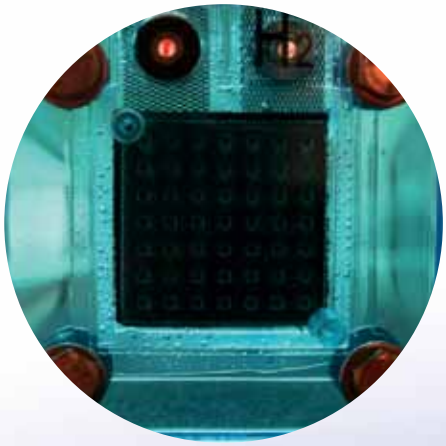
- Graphene or diamondoid coatings to control corrosion, reduce friction and resist abrasion
- Super hydrophobic surfaces that repel water, ice and dirt
- Nanostructured metal-ceramic composite coatings for ultra-hard durable coatings
- Nanocrystalline metal coatings for weight reduction

ELECTRODE AND MEMBRANE MATERIALS

From electric cars to grid-power back-up, the need to store electrical energy is growing all the time.

Innovative electrode and membrane materials are key to the success of future battery and fuel cell technologies.

The global market for each of these technologies is expected to explode over the next 10-20 years driving the Li-ion battery market to $28 billion in 2020 *(Nanomarkets 2010)* and fuel cell trade to $9.2 billion in 2020 *(Freedonia 2011)*.



Market drivers

- Need to store renewable generated electricity on a large scale in the grid
- Requirement for substantial back-up power in data centres
- Trend towards electric vehicles requiring longer range
- Need to reduce cost to access high-volume markets
- Enhanced battery lifetime (recharge cycles)
- Use of more readily available materials for security of supply

Opportunities

There are a number of high-end battery manufacturers in Scotland, including Axeon, Europe's largest independent designer and manufacturer of lithium-ion battery systems. Scottish companies are also involved in the design and manufacture of niche electric and hybrid vehicles – a vital route to market for new battery technology developments.

Novel battery materials and electrochemistries currently being researched in Scottish universities include titanium metal oxides and alloys, zinc-air, lithium sulphur and lithium-air systems. There is real potential to exploit these innovations industrially.

Looking further ahead, the EU aims to support the development of a fuel cell industry in Europe. Scotland's universities, in particular, are at the forefront of research into materials for fuel cell applications, with several recognised as world leaders.

Scotland has the opportunity to position itself as a centre of excellence for the development of new and improved materials which offer more efficient, robust and less expensive fuel cells. This matches perfectly the Scottish Government's ambition to create a low-carbon economy.

Technology

Batteries: The challenge is to scale up Li-ion batteries for electric vehicle and grid storage applications. This is leading to the development of polymer based solid state electrolytes, titanium metal oxides and alloys, zinc-air, lithium sulphur and lithium-air systems. In addition, nanoscale materials including graphene, tin, silicon and germanium offer potential to boost the energy capacity and charging speed of batteries.

Fuel cells: Hydrogen and direct methanol fuel cells must reduce costs and increase durability to become mainstream. In order to achieve the required cost reduction, there is research into nanoparticulate platinum and platinum-free electrode materials, such as carbon, iron or cobalt, activated carbon cloths and carbon nanontubes. There is also innovation in developing proton-exchange membranes which are suitable for mass production.

METALS AND ALLOYS

Metals manufacturing is far from a relic of Scotland's industrial past. Today, production of metals accounts for 12.5% of all Scottish manufacturing, demonstrating its continuing importance to the economy. Globally, the metals & mining market had total revenues of $1,661.2 billion in 2009 *(Datamonitor 2011)*.

Market drivers

Developments in metals and alloys manufacture will be driven by:

- Lowering costs through more efficient processes
- Greater resilience and reliability in the most demanding applications
- Enhanced strength to weight for transport applications

Opportunities

Scotland has a long-standing capability in the forming and forging of metals and alloys, developed over many decades. Companies such as Rolls-Royce, Wyman Gordon and Corus are industry leaders in this field, while The University of Strathclyde and its industrial partners are undertaking pioneering work at the Advanced Forming Research Centre, part of the UK-wide High Value Manufacturing Catapult.

The primary consumers for high performance metals and alloys in Scotland are in the following sectors:

- Oil and gas
- Offshore renewables
- Aerospace and defence

Technology

Forming and Forging: Material is shaped through mechanical forces delivered by a tool or die. The challenges are in accuracy, repeatability and sustainability.

Near-net shape: Bulk and sheet processes which minimise waste of materials and energy. These processes are increasingly computer-controlled.

Modelling: Sophisticated software can support the design and manufacture of metallic dies and workpieces to give "right first time" part production.

EMERGING MATERIALS

Advanced materials technology continues to evolve at pace and a number of new materials are emerging which will offer opportunities for Scottish firms, including:

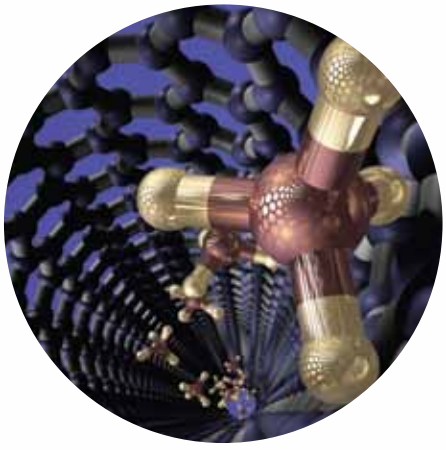
- Nanocarbon
- Hydrogen storage materials
- Sustainable plastics

Nanocarbon

Novel carbon materials such as carbon nanotubes and graphene can make a huge impact across a range of applications.

Carbon nanotubes promise to dramatically increase the capacity of electrical capacitors and Li-ion batteries, and have potential as a hydrogen storage medium. Dundee University's Nanomaterials Research Laboratory is active in this field.

Graphene is expected to revolutionise microelectronics and may be used in chemical sensing instruments, biosensors, ultra-capacitance devices, flexible displays and fast DNA sequencing.



Hydrogen storage materials

Fuel cells convert hydrogen into electricity. To enable the hydrogen economy to flourish, advanced materials must be developed to facilitate high density hydrogen storage.

Materials under consideration include metal organic frameworks, interstitial metal hydrides, complex metal hydrides, nanocarbon structures, glass microspheres and chemical hydrogen storage materials.

A number of universities, including Glasgow, St Andrews, Heriot-Watt, Strathclyde and Edinburgh Napier are undertaking innovative research into hydrogen storage materials.

Sustainable Plastics

The market for both recycled plastics and bioplastics is expected to boom in the coming years.

Increasingly sophisticated technology is being developed to recover and recycle plastics which can be used by the textile and construction industries, for example. Bioplastics are fabricated from renewable biomass sources instead of petrochemicals. Sometimes, it will be effective to combine bioplastics with recycled material in new formulations.

SUPPORT AND FUNDING

Scotland has long enjoyed a reputation for innovation, underpinned by a world-leading academic base and cutting-edge research and development activity.

With Scotland's 15 universities and four higher education institutions, Scotland has a strong engineering tradition, ensuring potential employers have a steady supply of people with appropriate qualifications and skills. If you are interested in seeking particular research expertise or specialist facilities within Scotland's universities contact Interface, a free service which matches businesses with academics.
www.interface-online.org.uk

A number of agencies can provide assistance to businesses in Scotland's advanced materials industries through innovation, investment and business productivity:

Business Gateway focuses on the needs of new and small enterprises:
www.business.scotland.gov.uk.

Scottish Enterprise offers grants, loans and equity investment to ambitious businesses looking to grow, develop and export.
www.scottish-enterprise.com

Highlands and Islands Enterprise is the Scottish Government's economic and community development agency for the north and west of Scotland.
www.hie.co.uk

Scottish Development International can assist Scottish companies in reaching overseas markets. SDI can also provide advice and support to international companies interested in locating in Scotland.
www.sdi.co.uk

For more information on the advanced materials industry in Scotland or initiatives to support the industry, please contact:

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Thanks are due to the many people in Scottish companies and universities who have provided input during the course of this work.

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