Composite Materials
A UK Overview

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Composites - definition

A composite material is one which is composed of at least two elements working together to produce material properties that are different to the properties of those elements on their own.

Filament winding, extrusion, pultrusion, VARI, RTM, SCRIMP, RFI, spray up, hand lay up.

Hand lay up, autoclave, roll wrapping, ATL, AFP, thermoforming, double diaphragm forming.

Compression moulding, blow moulding, injection moulding.
Composites - definition

Reinforcement

Glass fibre  Carbon fibre  Kevlar fibre  Natural fibre  Ceramic fibre  Particulates /nano

Resin

Polymer  Metal  Ceramic

Processing Method

Fibre & resin

Filament winding, extrusion, pultrusion, VARI, RTM, SCRIMP, RFI, spray up, hand lay up.

Prepreg / tape

Hand lay up, autoclave, roll wrapping, ATL, AFP, thermoforming, double diaphragm forming.

Moulding compound / SMC, DMC

Compression moulding, blow moulding, injection moulding.

GLARE

PMC
Strengths
- Properties.
  - High strength to weight ratio.
  - Fatigue resistance.
  - Corrosion resistant – reduced life cost.
- Tailor properties within a part.
- Complex shapes possible.
- Lower pressure tooling.
- Reduced part and fastener count.
- Reduced materials waste.

Opportunities
- Innovative manufacturing (automation, ALM, OOA).
- New recycling technologies.
- Legislation.
- Smart/functional materials (self healing, heating, morphing, SHM).

Weaknesses
- High cost.
- Damage tolerance.
- NDT requirements.
- Lack of design data and tools (improving).
- Uncertainties in failure prediction (improving).
- Need specialised repair techniques.

Threats
- Titanium – FFC process.
- Innovation in metals (high speed machining/ ALM/ super plastic forming).
- Recycling Issues.
- High profile failures.
- Material shortages.
- Legislation (REACH).
- Cost of oil.
Composites in Aircraft

Aircraft Composite Content (% of structural weight)

*Military Aircraft in Purple

Source: Teal Group, Boeing, Airbus, Composite Market Reports
UK composite industry

- Many composite materials were originally developed in the UK (e.g. carbon fibre and epoxy resin).
- 1940’s Gordon Aerolite Spitfire (UD flax & phenolic).
- In 70s & 80s UK's composite research was second only to the USA.
- In 90s there was a gradual decline, in all areas apart from motorsport, due to:
  - Rise in interest in composites in other countries.
  - Scarcity of research funds in the UK.
  - Changing nature of the British aerospace industry.
UK composite industry

- Recent resurgence in composites in the UK due to:
  - Development of technologies and materials to stay ahead of low cost competition from overseas.
  - The use of carbon fibre composites in ‘supercars’.
  - Boost in composites applications from Airbus and Boeing.
  - New defence based applications, (Eurofigher Typhoon, JSF, and A400M).
  - Growing use of composites in UK’s marine and defence industries.

- This is an exciting time for the aerospace composites industry in the UK, with renewed support providing significant revitalisation.
Composites Summary

- Current £53 billion composites world market is predicted to grow to £74 billion by 2013.
- Two sectors initially driving growth will be aerospace and wind energy, (15% and 13% each year respectively).
- UK composites market is currently worth £1 billion annually with approximately 40,000 employees.
- UK is a world leader in composites for the manufacture of civil and military aircraft.
- In high-performance cars, the UK’s composite expertise contributes to the fact that it is the headquarters of eight Formula 1 teams.
- The predicted growth in the UK’s wind market is driving composite blade development (Vestas) and manufacture (Clipper) in the UK.
- 40 UK universities working in this area. Several are regarded as centres of composites expertise, including:
  - Bristol,
  - Manchester,
  - Nottingham,
  - Sheffield,
  - Southampton,
  - Warwick,
  - Cranfield
  - Loughborough,
  - Imperial College.
- EPSRC funds over £50 million of composites related research at 28 institutions.
- Academic composites research forms only one part of the extensive research network active within the UK. Companies such as Airbus, GKN, Rolls-Royce, BAE Systems, McLaren, Bentley, ACG and the Formula 1 teams have significant composite R&D programmes in the UK.
UK strengths in aerospace composites

- UK is strong in certain markets:
  - Military products (missile/aircraft weapons).
  - Airbus and Bombardier wings.
  - Commercial aircraft secondary structures.

- UK is good at:
  - Large complex loaded structure design.
  - Composite tooling.
  - Systems integration (defence).
  - Low readiness level innovation.
  - Materials innovation.
  - Early investment in technology development.

- UK is pragmatic and adaptable.

- Increased use of composites, especially in critical areas e.g. primary structure.

- Funding programmes.

Examples:
- A400M wing spar, GKN
- BAe, Typhoon and JSF
- A380 composite wing
UK strengths in automotive composites

- The Motorsport Valley business community remains a world leader in advanced use of carbon technology.
- Strong in the use of composites in niche areas of the automotive industry (e.g. Bentley and Aston Martin).
- UK SMEs have a flexible approach (DTI’s Foresight report).
- Pragmatic and adaptable polices.
- Strong in innovation and R&D.
- Knowledge transfer to and from other industry sectors.

Examples:
- 60% of F1, most World Rally cars and other motorsport series designed and produced in UK.
- 8 of 12 F1 teams based in UK.
- Mercedes-Benz SLR McLaren –first occasion when Mercedes Benz allowed a car to be produced outside a fully owned MB factory.
Examples of Research Strengths

Predictive modelling
- Material properties (Imperial, Bristol, Surrey).
- Manufacturing optimisation and design (Nottingham, Manchester, Surrey).
- Properties of future materials such as 3D technical textiles (eg Nottingham) and nano materials (Bradford, Queen’s).
- Predicting tooling and part interactions, springback and distortion (ACG).

Performance driven concepts
- Application of nanoscale reinforcements (eg Cambridge, Imperial, UCL, Manchester).
- Novel composite architectures (eg Ulster, Manchester).
- Smart structures (eg QinetiQ, Aston, Manchester) self healing materials (eg Bristol, Nottingham).
- Hybrid, tough structures (eg Manchester).

Low-cost processing
- Out of autoclave processes, such as RTM, vacuum infusion, film infusion.
- Automated processes such as tape laying and fibre placement
  All being studied by universities such as Cranfield, Sheffield, Plymouth, Bristol, Manchester and organisations such as QinetiQ, GKN, Airbus, NW Composites Centre and CAMTeC.

Recycling, reuse and waste reduction of composites
- WINGNet is an initiative to study waste reduction in aircraft-related groups.
- DRIVENet is the Network for the design for dismantling, reuse and recycling in road vehicles. (www.drivenet.org.uk)
- Examples of universities developing recycling technologies are Sheffield, Nottingham, Birmingham and Exeter University
- Recycled Carbon Fibre Ltd is the world’s first commercial scale continuous recycled carbon fibre operation. (www.recycledcarbonfibre.com)
Composites Innovation

**Aerospace**

- **BAE Systems Samlesbury** - The composites facility is one of the most up-to-date anywhere in the world with continuous development for business including Eurofighter and JSF II production.

- **GKN Aerospace IoW and Filton** - £14.8m new facility on IoW will be at the heart of research to produce a new all-composite engine fan blade that will improve aircraft engine performance and reduce emissions. GKN took over Filton wing component and assemblies manufacturing unit and Filton-West is their new production plant making wing spars and trailing edge for A350.

**Wind Turbines**

- **Clipper Windpower** - In February, 2010 construction work began for the new Clipper Windpower facility in Newcastle. This will build 72m turbine blades – the world’s largest – for Clipper’s 10MW ‘Britannia’ wind turbine.

- **Vestas** - Vestas is investing more than £50m in R&D in the UK including a R&D Centre on the Isle of Wight to work on design and development of a next generation, multi mega watt offshore wind turbine.

**Automotive**

- **Mercedes SLR McLaren** - Much of the world-leading composites production technology was developed at the McLaren Technology Centre in Woking. 37 patents were created for revolutionary use of carbon fibre composites (never before used in 'mass' production).
UK Composites Strategy

- Launched November 2009 (under previous Govt).

- £22m investment.
  - £16m into a National Composites Centre.
  - £6m into ‘Grand Challenge’ to develop new manufacturing techniques.
UK Composites Strategy Summary

Strengthening Capability – Leadership, Skills and Awareness.
- Leadership Forum.
  Includes a Minister and industry stakeholders.
- Skills development.
  Build on Govt support and ensure skills councils work together.
- Raise Awareness.
  BIS, UKTI & RDAs map, grow and market supply chain.
  RDA funded composites supply chain initiative to support supply chain.
  National Composites Centre will strengthen the network of Centres of Excellence.

Increasing Sustainability and Recycling.
Consortium to drive and prioritise work.
e.g. Look at improving recycling processes, applications for recyclate, and the broader issue of sustainability of composite materials.

Building Capacity – Rapid Manufacturing
- National Composites Centre.
  Rapidly produce cost effective structures. £16m funding.
- TSB Grand Challenge.
  £6m for collaborative R&D for rapid manufacture of composite structures.

http://interactive.bis.gov.uk/advancedmanufacturing/composite-strategy-documents/
- Independent open-access National Centre delivering world-class innovation in the design & rapid manufacture of composites to enable industrial exploitation.
- An internationally leading hub linking activities across all sectors of the UK in research, education and training, technology transfer.
- £12M from Central Govt, £4M from SWRDA, additional £9M from ERDF.
- Purpose built 8000m² facility on SPark in Bristol with workshop, offices, meeting rooms, teaching facilities.

- Equipped to focus on optimised-design, analysis, rapid manufacture and testing.
- Two tier subscription membership.
- Founding tier 1 members currently include; Vestas, Rolls-Royce, GKN, Airbus, Agusta Westland, GE, Caterpillar.
- Coordinate Regional Composites Centres.

www.nationalcompositescentre.co.uk
UK Composites Strategy

Chaired by Minister. Industry led.

- National Composites Centre
- Regional Centres

Composites Leadership Forum

Working Groups
- Skills
- Supply Chain
- Sustainability

Sector Skills Councils SEMTA and Cogent have signed a partnership agreement. Composites Employers Skills Group being established. Workstreams and timescales identified.

Being taken forward by BIS and UKTI.

UK Government will establish a consortium of organisations that will work with a leading university (Nottingham) to address sustainability challenges.
i-Composites is a unique £10M Technology Strategy Board research programme led by GKN Aerospace and 22 cross-sector partners.

The 1 year programme will develop innovative composite manufacturing techniques, processes and materials for high-performance, high-value products.

Within technology themes, research partners from multiple industries are working together to strengthen UK capability in Advanced Materials.

Launched as a TSB ‘Grand Challenge’ in April this year, the programme addresses affordable composite challenges across design and manufacturing sectors in the UK.

Leading UK industry in time, cost and energy reduction, i-Composites will enhance the performance of composite materials through sustainable design and manufacturing technology. To learn more visit www.i-composites.org
Composites is a technology that is applied across, and developed within, a multitude of different industry sectors.

It is imperative therefore that the composites strategy, and those taking it forward, are aware of, and work with industry sectors/communities taking forward their own strategies.

This will facilitate technology transfer and prevent duplication of effort.

In the case of aerospace this linkage is easy..... There is a well defined strategy, which contains significant composite work....
The National Aerospace Technology Strategy (NATS) addresses the critical aerospace technologies required to ensure UK competitiveness in the global aerospace markets, and helps industry to meet the ambitious environmental performance targets of aviation.

NATS brings UK stakeholders together to shape and deliver the nation’s aerospace technology agenda.

The Aerospace & Defence KTN is the custodian of NATS.

This vision is captured in a comprehensive set of technology roadmaps, authored collaboratively by the aerospace industry.

The Strategy is delivered via collaborative research and development programmes, with joint investment from industry and Government.

The Roadmaps show:

- Top down review of global market drivers and service entry dates
- How, where and when UK products will fit into global market
- Technology and Innovation Programmes (TRL 1-4) and Validation and Demonstration Programme (TRL 4-6) needed to develop to ensure UK can make the most of the market opportunities.

https://ktn.innovateuk.org/web/national-aerospace-technology-strategy-nats
Top level Roadmap aggregated from individual Roadmaps

Airframes and Structures

Autonomous Systems

Equipment

Powerplants

Rotorcraft

Air Traffic Management
Airframes and Structures Roadmap

Within the Airframe and structures roadmap, composite technology development plays a major role in many programmes, e.g.:

- ALCAS
- Integrated Wing
- Next Generation Composite Wing
- Clean Skies

(More details on some of these in following slides)
Integrated Project under the EU Framework Programme.

59 partners from 18 countries (12 from UK including Airbus (lead), GKN, ACG Messier Dowty, Bombardier).

Total cost €101,277,380, funding €53,460,000, 2 years.

Objective: to develop more affordable composite solutions for primary structure through high component integration.

**Airliner Platform:**
- Objective - 20% weight saving, zero increase in recurring cost against metal
- Wing – build on Tango. Challenges include the inner wing structure, including engine and landing gear attachment
- Fuselage - Complex fuselage design features, enhanced damage capability and system integration requirements. Reduced maintenance costs.

**Business Jet Platform:**
- Objective - 20-30% reduction in recurring costs, with a 10% weight saving against metallic structures
- Wing - focus on high-structural integration. Validation will be through design, manufacture and test of a full-scale wing of partial length
- Fuselage – design, manufacture and test full-scale rear fuselage
Integrated Wing

- Integrated Wing ATVP is one of the UK national, collaborative, Aerospace Technology Validation Programmes proposed by the Aerospace Innovation and Growth Team (AeIGT), part of the National Aerospace Technology Strategy.
- 21 UK organisations (including Airbus, Bombardier, GE, BAE, QinetiQ, TWI, Messier Dowty, Queens University Belfast)
- Total cost £38 million. 50% from industrial partners. Remainder 2/3 by TSB, 1/3 by RDAs/DAs in South West and South East England, Wales and Northern Ireland. Yorkshire and the East Midlands also support partner facilities.
- The UK has established itself as a centre of excellence for wing design and manufacture. Integrated Wing brings the opportunity to develop and validate ‘high-risk / high-potential’ technologies and innovations for new wing designs from 2020 by:
  - ‘Pulling-through' technologies from UK research community.
  - Validating specific wing related technologies for exploitation in the short to medium term.
  - Optimising integration of advanced technologies to drive ‘step-change’ improvements.
  - Full lifecycle technology impact assessment (cost and environment are key).
Funded by Technology Strategy Board - 2007 call in design engineering and advanced manufacture.

Total project £103 million, including £25m from TSB, £26m from RDAs and DAs and £52 from partners over 3 years.


Aims to keep the UK at the cutting edge of innovation in aircraft wing development by ensuring the UK is competent and well-equipped to maximise the use of weight-saving composite materials in future wing design and development.

The generic challenges faced for future composite wings are similar to those faced on other composite parts of the aircraft, however:

- specific solutions required due to the unique combination of factors that need to be integrated to achieve an optimum wing solution
- optimised wing solutions also pose specific manufacturing challenges
Regional Support

As well as national support through the Composites Strategy, the Composites community has benefitted from support regionally.
Composite Centres

- International Centres of Excellence
- UK ‘champion’ for specific technology theme
- Resource for national tech transfer programme
- Regional requirements
  - R&D collaboration hub
  - Economic impacts via:
    - Technology transfer
    - Direct business growth

Absorbed within new NCC, to become ‘hub’ to spokes.

http://www.ncn-uk.co.uk/DesktopDefault.aspx?tabindex=3&tabid=271
SOUTH WEST
Independent open-access National Centre delivering world-class innovation in the design & rapid manufacture of composites to enable industrial exploitation.

An internationally leading hub linking activities across all sectors of the UK in research, education and training, technology transfer.

£12M from Central Govt, £4M from SWRDA, additional £9M from ERDF.

Purpose built 8000m² facility on SPark in Bristol with workshop, offices, meeting rooms, teaching facilities.

Equipped to focus on optimised-design, analysis, rapid manufacture and testing.

Two tier subscription membership.

Founding tier 1 members currently include; Vestas, Rolls-Royce, GKN, Airbus, Agusta Westland, GE, Caterpillar.

Coordinate Regional Composites Centres.

www.nationalcompositescentre.co.uk
South West Composites Initiatives

- **CORAL-REEF SW** - CComposites Research ALLiance REgional Engineering Facilities South West. State of the art facilities to support research on manufacturing and development of composite structures.
- **CSDC at Airbus Filton**
- **Rolls-Royce Composites UTC at Bristol University**
- **The Systems division of GE Aviation UTSP** - SMARTCOMP, a University Technology Strategic Partnership, with the Bristol and Oxford Universities. £1.25m funded by EPSRC and GE.
- **Bristol-Bath Collaboration on Composites** - £14m funding from the Great Western Research Alliance (5 years). Promotes regional collaboration. 11 postgrad studentships in composites, in collaboration with Exeter Uni, Airbus, Westland and Rolls-Royce.
- **ACCIS** – Advanced Composites Centre for Innovation and Science at Bristol University. £18m lab facilities. Opened Apr 2007.
- **Composites Doctoral Training Centre** - £6.4m from EPSRC to support more than 50 PhD students in composites at ACCIS.
- **Integrated Wing** – £34 m (RDA £2.7m)
- **Next Generation Composite Wing** – £105m (RDA £8m)
SOUTH EAST
A £5.5M Development
A 60,000 sq ft Advanced Technology Manufacturing Centre
A 15,000 sq ft Research Facility

Key technology development focus is on automated manufacture of complex subassemblies

- Torres Tape layer
- Double Diaphragm machine
- Autoclave
- 5-axis machine
- NDT inspection equipment
- Spray bake booths
South East Composite Capabilities

- In addition to the GKN Research Centre, GKN and Rolls Royce have a £30m JV to develop composite fan-blades with TSB and SEEDA support (£7.4m over 4 years) under the Environmental Lightweight Fan (ELF) programme. This will create a state of the art pre-production facility for a range of blade variants on the Isle of Wight.

- Established with SEEDA support in 2008, the SE Composite Alliance is developing a blueprint for future collaboration in respect of composite skills.

- Vestas is building a £90m global R&D Centre into advanced technology for next generation off-shore wind turbines on the Isle of Wight. The company received funding from the Environmental Technology Fund from DECC, which SEEDA will be match funding by £5m.

- VT Group, based in Southampton, is a high technology company engaged in the design and manufacture of naval and specialised vessels. The company operates the VT Composites Technology centre which has extensive capabilities.

- The leading composite universities are Southampton, Oxford, Cranfield and London’s Imperial College, all of whom are involved in the composites skills project.
NORTH WEST
The Northwest Composites Centre

- Established 2006

- Funding from mix of Regional / National government with industrial support

- Consortium of Manchester, Liverpool, Lancaster, Bolton and Glyndwr Universities, based at Manchester

- Identified as single focus for all science based activities in composites in the Northwest of England by NWDA, NWAA.

- One of the National Composites Networks five regional centres and identified by NCN as the national home for Certification and Evaluation activities (qualification).

www.futurecomposites.org.uk
NWCC Highlights

- European Centre for Quickstep research (advanced out of autoclave processing)

- Host to UK’s Composites Certification and Evaluation Facility (twinned with NIAR in the USA)

- Largest and best equipped composites textile research unit in Europe (with manufacturing capabilities)

- Most comprehensive suite of damage evaluation facilities (including £2.8 million X-ray CT)

- Draws on 50 academics from the partner universities and across faculties and schools at Manchester
National Composites Certification and Evaluation Facility

Launched 2010.

Hosted by the

Northwest Composites Centre

At the

School of Materials
University of Manchester

www.manchester.ac.uk/nccef
What is the role of NCCEF?

- Assist companies with certification
- Assist companies in understanding composites behaviour
- Reduce certification costs
- Explore ways of certifying new materials/structures
- Develop multi-user databases
  - (link with NIAR, follow AGATE model)
- Facilitate innovation
NWAA Aerospace Composites Strategy

- North West has key strengths in aerospace sector.
- North West Aerospace Alliance has identified the supply chain and ‘commodity groups’ in which the regions has key strengths – composites is one.
- Commodities group activities:
  - Set regional strategy
  - Share best practice
  - Improve efficiency (shared services, collaborative enterprise)
  - Assess technology shift and impact of programmes
  - Agree R&D priorities
  - Initiate skills & skills development demand to the skills academy
  - Benchmark the regional competitiveness
ASCE2 Commodity Groups Timeline – Programme Start

Commodity Groups:
1. Composites
2. Hard Metal Machining
3. Autonomous Systems
4. Process Treatments
5. Robotics & Tooling
6. Advanced Metal Forming
7. Digital Assembly

- **C**: Complete future capability assessment & GAP analysis to extend future capability
- **SS**: Set initial shared service requirement
- **S**: Generate Skills Demand Signal
- **+**: Establish global benchmark & set learning curve
- **◊**: Commodity Group Strategy Complete
- **☐**: Set innovation agenda & provide demand against detailed requirements
- **☐**: Set RAD plan incorporating TRL levels of extended enterprise & TSB or other funded programmes

Timeline:
- 2009
- 2010
- 2011

Northwest Aerospace Alliance
Shaping and Supporting our Industry
YORKSHIRE
AMRC Composites Centre

- A division of AMRC, a global research centre devoted to the research and development of new means, methodologies, tools and techniques to advance manufacturing technology

- A collaboration between AMRC and its 50+ industrial partners to develop composite manufacturing technologies appropriate for fabricating and assembling typical aerospace structures

- National Composites Network node for machining, drilling and joining

- Focus on reducing manufacturing costs of hybrid components (titanium and carbon fibre composites), increasing fibre application rate (AFP/ATL), and performance materials (MMCs)
Current Resources Available

• ADC automated fibre placement machine 2.75 x 1.4m heads: 1/4” thermoplastic, 3” thermoset tape and 1/8” tow placement
• LBBC 3 x 5m autoclave 210°C 10 Bar
• LLBC 1 x 2m high temperature autoclave 400°C 20 Bar
• Caltherm 3 x 3 x 3m oven 230°C
• ISPJET RTM injection system
• Clean room 15 x 7m
• CMS 5 Axis machining centre 4.8 x 1.8 x 1.2m
• Gerber N/C ply cutter 3.6 x 1.8m
• CAD: CATIA V5, ProE, UGS, Solid Works
• FEA: Nastran/Patran, StressCheck, Mechanica

• Knowledge base of tools, testing expertise to help partner companies and local industry select and optimise manufacturing methods
Areas of Focus

• Short term: automated thermoplastic processing, machining/drilling of hybrid components and carbon fiber composites, assembly of composite structures, tooling, RTM

• Medium term: automated processes with current tow/tape, off-axis thermoplastic processing for large structures, MMC development

• Long term: automated processes machine and materials development, exploitation of technical textiles

• 3 working groups planning development activities: automated manufacturing, hybrid structures, non-destructive inspection (automated detection)
NORTHERN IRELAND
Northern Ireland

Working to understand and develop regional expertise and transfer this technology and optimise exploitation and use of this technology within the region.

**Bombardier Aerospace**

- World’s 3rd largest aircraft manufacturer
- Global leader in regional and business aircraft markets
- Northern Ireland facility most diversified in aerospace division
- 12 of 15 Bombardier aircraft programmes supplied from Belfast
- Products Line: Aircraft Structures
  - Nacelles
  - Composites
University Capabilities

Queen’s University Belfast, Integrated Aircraft Technologies
• Integration of the design and manufacture of fuselage structure, nacelle structures and systems
• Control components
• Advanced composites
• Metal bonding
• Computer aided design and manufacture

University of Ulster, Engineering Composites Research Centre
• 3D Design of composite reinforced textiles
• Thermal and mechanical assessment of resin & composite materials
• Manufacture of components by Autoclave and Resin Transfer Moulding (RTM)
• Modelling of mechanical properties
EAST MIDLANDS
East Midlands Composite Capability

- Capability initially developed for F1. Larger organisations (e.g. Rolls-Royce) have developed this composite design and manufacturing competence to support their requirements. Companies such as the Advanced Composites Group were formed to serve this need.
- The region now has a cluster of companies undertaking the majority of activities involved with the composite product lifecycle from ‘Prepregging’ through to moulding.
- Strong links with the region’s Universities e.g. Collaboration between Ford and Aston Martin and the University of Nottingham.
Cluster

Companies include:
- ACG
- Amber composites
- Brightwake
- Carbon Concepts
- Cobham
- EPM Technology
- EPL Composites Solns
- Imhotep
- NetComposites
- Scott Bader

Universities include:
- University of Nottingham
  Polymer Composites Group focuses on the processing and performance of polymer matrix composites.
  http://www.nottingham.ac.uk/~eazwww/composite/
  UNIMAT is a world-class centre for excellence in multi-disciplinary materials research.
  www.nottingham.ac.uk/unimat
- Loughborough University
  Institute of Polymer Technology & Materials Engineering.
  www.lboro.ac.uk/departments/iptme
- Nottingham Trent
  School of Science &. A key research area is nanocomposites.
  www.ntu.ac.uk/science_technology/
West Midlands Composite Cluster

- **Companies include:**
  - Rojac
  - Nord Composites
  - Meggit Braking Systems
  - Meggit Thermal Systems
  - Tufnol Composites
  - Delcam
  - Unimerco
  - Recycled Carbon Fibre
  - Spinning-Composites
  - Assystem UK
  - Intermet Alloys
  - Eccles Tooling Systems
  - Kennametal UK

- **R&D Organisations**
  - **CERAM.** Expertise in MMC and CMC and processing of PMC.
  - **Smithers Rapra Technology.** Plastics consultancy with significant expertise in composites.
  - **Materials Solutions.** Strong in coatings and near net shape forming.
  - **Birmingham University.** Particular strengths in CMC.
  - **University of Warwick/Warwick Manufacturing Group.** Very strong in PMC, especially for automotive applications.
  - **Aston University.** Strong in Photonics (for SHM)
    www.ee.aston.ac.uk/research/prg
ADCOMP

- Started Dec 2008, due to run for 2 years.
- Vision:
  “To create a ‘Cluster of Excellence’ in the West Midlands to develop and sell world class thermoplastic composite parts”
- Project Partners:
  - NCN(TWI)
  - JCB
  - Airbus
  - Delcam
  - Victrex
  - Ten Cate
  - MNB Mould Services
  - WMG
  - Birmingham University
EAST OF ENGLAND
Commercial entities

Companies that manufacture with polymer composites in the East of England are mainly associated with the marine, aerospace, construction (incl wind energy) and automotive sectors, e.g.:

Lola Group, Hexcel Composites, Lockheed Martin, Broadwater Mouldings, Landamores, Broom Boats, Mussett Engineering, AIM Composites, Dark Matter Composites etc.
Research

- **Cambridge University**
  - Composite Design, including ceramic/metal laminates, compression, localisation and prediction of failure..

- **Cranfield University**
  - Range of expertise including cure monitoring, processing, nano, through thickness, testing, and demonstrator production. Range from blue-sky to industry focused.

- **University of Hertfordshire**
  - Studies in processing/microstructure/property relationships, fatigue, crack growth, crush analysis modelling, FEA, wear and processing of MMCs and intermetallics.

- **Hexcel Corporation**
  - Researching fibre and matrix chemistries in order to improve laminate properties.
Institutes

- **TWI**
  Technical support at all stages of manufacture. Expertise extends to:
  - polymer science, surface modification, curing techniques
  - mechanical & environmental testing, NDT
  - joining & lifetime assessments
  - structural integrity, failure analysis

- **MERL**
  Reputation for developing methods for the life prediction of composite materials for engineering applications. Materials research facilities are available for composites conditioning, exposure, mechanical testing, chemical analysis, modelling and failure analysis.
SCOTLAND
Scottish Composite Activity

- Almost 50 companies are presently active in the composite materials supply chain across the energy, aerospace, marine, automotive and construction sectors.
- Scotland is home to a number of global companies developing composite solutions to address market demand. These include such as Rolls Royce, BAE Systems and Vestas, who are in the vanguard of new composite technology development in their areas of business.
- Composite activity for the Aerospace industry in Scotland includes:
  - Manufacture of carbon fibres.
  - Conversion of technical textiles and polymers.
  - Design engineering.
  - Integration of manufactured composite products.
  - Resin transfer moulding, Autoclave, Pultrusion & Filament Winding
Aerospace composite industry players in Scotland range from micro-businesses to global corporations:

- Significant capability in carbon and polypropylene fibres and an emerging capacity in textile preforms and cores.
- Scottish companies, particularly those in technical textiles, have the potential to address currently unmet market needs on a global basis. Technical textiles market is growing at 5 per cent per annum.
- Expertise in R&D and repair and manufacture of composite products embedded in companies such as Goodrich, Spirit AeroSystems, Slingsby and technical textile companies such as SGL Technic, Culzean Fabrics and Dun & Low.
- R&D and training activity takes place at Scottish universities.
- Slingsby Advanced Composites (http://www.slingsby.co.uk) and Assystem (http://www.assystem.com) already have facilities on site to support this going forward.
Final Comments

- It is an exciting time for the composites industry – it has many great opportunities, but also has challenges to face in order to take advantage of these.

- The UK recognises the importance of composites across a wide range of industry sectors of strategic importance to us as a nation.

- We are working strategically, and collaboratively, to ensure we stay at the forefront of composite technology development.
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