# A comeback for composites in U.K. aerospace

The U.K. has traditionally been a major center for both the aerospace industry and the composite materials community that supplies it. Many of the early materials, including carbon fiber, were originally developed in the U.K. and saw their first aerospace applications courtesy of the country's strong civil and military aerospace sectors.

The U.K. developed many major companies that have produced composites, with BP, ICI, and Courtaulds among the world's major players. The country's composite research community was probably second only to that of the U.S. in terms of size and influence for much of the early period of composite development, during the 1970s and 1980s.

The rise of interest in these materials in other countries, the scarcity of research funds in the U.K., and the changing nature of the British aerospace industry resulted in a gradual relative decline in that position in the 1990s. During this time the industrial landscape also changed in the U.K.; BP, Courtaulds, and ICI divested themselves of their advanced materials businesses. BAE Systems refocused mainly on military systems markets and merged what remained of its civil aviation business into the multinational Airbus project.

Over the past few years, however, the country has found itself with a buoyant industrial scene, driven by the need to adopt new technologies and materials across a range of industry sectors in order for U.K. companies to stay ahead of low-cost competition from overseas.

Factors influencing the resurgence of composites in the U.K. include the success of Airbus in recent years, the sudden boost in applications following Boeing's wholesale adoption of carbon fiber for the 787 Dreamliner, and the growth of new defense-based applications. Increasing nonaerospace uses, especially in marine, automotive, and construction applications, are also helping to fuel the drive toward lower cost composite solutions.

What has been noticeable over the past two or three years is the importance assigned to composite materials by the U.K. government and its agencies. This has resulted in both increased funding opportunities and a revitalized research infrastructure designed to support the entire composites supply chain.

## Industry overview

The worldwide market for composite aerostructures has recently been valued at up to $24 billion, with growth predicted at 11.2% annually over the next five years, compared to only 4.7% for aerostructures as a whole.

In the U.K., materials-related industries directly support more than 1.5 million employees and have an annual turnover of more than $380 billion. U.K. composite product revenue for all sectors in 2004 was $1.6 billion, ranked fourth in Europe behind Germany, France, and Italy, and was significantly smaller than North America's $15.7 billion. The most recent comprehensive U.K. industry survey was performed in 2001. It indicated that 19% of composite finished product was produced for the aerospace sector and that over 13% of composite companies in the U.K. were involved in the military and civil aerospace markets.

The global scale of the aerospace industry, attractive growth prospects in composite aerostructures, and strategic supply-chain consolidation have led companies to invest in other countries, either through direct investment, acquisition, or mergers.

In May 2002 the secretary of state for trade and industry set up the Aerospace Innovation and Growth Team (www.aeigt.co.uk) to map out a 20-year vision for the future of the industry in the country. By May 2003, the vision was published and put forward recommendations that aimed to put U.K. aerospace at the forefront of delivering tomorrow's global solutions.

One of the report's recommendations was that advanced structures and smart materials become key areas for aerospace materials technology. This helped generate research funding for composites-related research in the U.K.

Similarly, the Materials Innovation and Growth Team (IGT) was launched on January 26, 2005, and subsequently issued a report entitled *A Strategy for Materials*. That report led to the establishment of Materials U.K. (www.matuk.co.uk), a partnership of industry, academia, policy stakeholders, and employee organizations. Its aim is to work with the materials community to optimize the U.K.'s R&D asset base and make it more accessible. It will also work with the Materials Knowledge Transfer Network (KTN) to facilitate and increase knowledge transfer into industry.

Another outcome of the Materials IGT report was the observation that "transport is already a major market for composite materials, with their potential to reduce the weight of aircraft, motor vehicles and trains." To support the composites community within the U.K., the National Composites Network (www.ncn-uk.co.uk) was created. The NCN operates within the Materials KTN to encourage innovation on composite technologies and to facilitate the transfer of that knowledge into the industrial base.

## Support for R&D

The U.K. government supports the composites community through a range of products aimed at different sectors of the supply chain.

The Engineering Physical Sciences



*Widespread use of composites in the development of the Boeing 787, as well as their use in military aircraft such as the Eurofighter, have led to increased interest in such materials in the U.K. and elsewhere.*

Research Council is currently sponsoring university-based research in 28 composite processing research projects worth £7.3 million. It is also spending over £11 million on composites-related aerospace and defense projects. In addition, there are numerous links between industry and academia. One example is the Rolls-Royce University Technology Centre for Composites, which will be located at Bristol University.

The Dept. of Trade and Industry (DTI), under its new Technology Programme, is contributing between £5 million and £10 million annually to collaborative R&D projects in Advanced Composite Materials and Structures. Previous projects included AMCAPS (affordable manufacture of aircraft primary structures), which developed the manufacturing expertise necessary for full-scale civil composite wing demonstrator components, and CASCADE (civil aircraft structures, composites application, development, and exploitation). These efforts laid the foundation for significant advances in the use of composites in aircraft structures.

U.K. companies also have access to the European Union's Framework programs for funding of collaborative R&D. Projects such as the recently completed TANGO (technology application to the near-term business goals and objectives of the aerospace industry) and current ALCAS (advanced low-cost aircraft structures) have looked at various cost-effective uses of carbon fiber composites in wing and fuselage applications for civil aircraft.

Under the new European Framework 7 Programme, which is due to start in 2007, significant funding has been allocated to materials research, with €3.5 billion to nanosciences, nanotechnologies, materials, and new production technologies, and €4.18 billion to transport. In addition, there is €1.3 billion for research to help small companies and €1.8 billion for research infrastructure.

## Drivers

In the aerospace industry, the main driver for progress in composite technology has always been performance. Composite performance can be tailored very specifically to meet requirements such as survivability (important not just in military, but also, increasingly, in civil systems) and weight or noise reduction for cost and environmental purposes.

Traditionally, the stiffness and high specific strength of composite materials and their relatively low through-life maintenance costs meant that composites could be cost-effective compared with other materials such as metals, despite often having relatively high manufacturing costs. However, recent years have seen rising energy costs and growing competition from countries that can provide low-cost manufacturing. These factors have led to an increased emphasis in the U.K. on technological changes in design and manufacturing processes to produce cost-effective composite structures.

Technologies that are being used or investigated to reduce costs include producing complex one-part structures to reduce the number of parts, out-of-autoclave processing, automated processing, lean manufacture (including concepts such as just-in-time delivery, and digital design and manufacture management).

### U.K. ORGANIZATIONS INVOLVED IN AEROSPACE COMPOSITES

| OEMs | Tier 1 | Material Suppliers | RTOs | Universities |
|---|---|---|---|---|
| *Airbus UK* | GKN | *Hexcel* | QinetiQ | Cranfield |
| *Bombardier* | Smiths Aerospace | *Cytec* | TWI | Bristol |
| BAE Systems | St. Bernard Composites | *ACG (owned by UMECO)* | NPL | Sheffield |
| *Astrium* | Marshall Aerospace | *Saint-Gobain Technical Fabrics* | | Manchester |
| *Boeing* | Rolls-Royce | *Gurit* | | Imperial |
| *Westland* | Cobham | Carr Reinforcements | | Nottingham |
| | CTG | *Aerovac (Owned by UMECO)* | | Oxford |
| | *Goodrich* | *Tygavac* | | Ulster |
| | *Hispano Suiza* | *Sigmatex* | | |
| | *BE Aerospace* | *PPG* | | |

This is an overview (not an exhaustive list) of companies/organizations that have a presence in the U.K. and are involved in composites for the aerospace industry. Companies that are fully or partly foreign owned are in italics.

Given current composite technologies, the goals of improved performance and reduced costs are usually mutually exclusive. Thus the composites community faces interesting challenges. An added complication is that the increased use of carbon fiber composites by aerospace OEMs means that demand for aerospace-grade carbon fiber has outstripped the current supply. This is driving a U.K. interest in alternative-grade or hybrid reinforcements and recycling technologies.

## Outputs

In response to these industrial drivers, the U.K.'s materials research community has become active in a number of critical areas in the field of composite materials.

There is significant, world-class work in predictive modeling research. This work is looking at a range of issues, including material properties, manufacturing optimization and design, and also modeling of the properties of future materials such as 3D technical textiles (at Nottingham University, for example) and nanomaterials.

There is also a burgeoning group of research institutions studying performance-driven concepts, among them:

- The application of nanoscale reinforcements (Cambridge University, Imperial College, London, Queen Mary, University of London).
- Novel composite architectures (University of Ulster).
- Smart structures (QinetiQ) and self-healing materials (Bristol University).
- Hybrid, tough structures (Queen Mary, University of London).

Others universities are focusing on low-cost processing-related themes (Cranfield, Sheffield, Plymouth, and Manchester universities).

New academia/industry consortia are focusing on modeling to enable better design and improved process control, including modeling infusion, predicting tooling and part interactions, springback, and distortion. The industrial drivers are often common between aerospace and other industrial sectors. Moreover, the advent of the NCN and the DTI's Technology Programme has created an environment where there is considerable impetus for cross-sectoral research teams to address common themes.

Waste reduction, recycling, and reuse of advanced composites is just one area where the U.K. may now be in a leading position, at a time when the recycling of these materials is becoming a real industrial consideration, especially as composite-containing aircraft and automobiles near the end of their lives. For example, WINGNet (led by Faraday Advance) is an initiative to study waste reduction in aircraft-related groups. Sheffield University and Nottingham University are developing recycling technologies, and Milled Carbon is the world's largest processor of recycled carbon fiber.

### *Regional centers of excellence*

*The National Composites Network has helped initiate an increasing number of regional centers of excellence that focus on different aspects of composites technology, funded jointly by industry, the central government, and regional development agencies.*

- *The Composite Structures Development Centre, situated at Airbus UK, Filton, focuses on the manufacture of advanced composite materials, particularly large, out-of-autoclave carbon structures. Around this facility, a partnership called CORAL REEF (Composites Research Alliance Regional Engineering Facilities) has been built up to bring together the key stakeholders in composites in the South West region of the U.K.*
- *The Low-Cost Composites Manufacturing Centre, based at GKN on the Isle of Wight, is developing low-cost manufacturing techniques for composites via materials specification and automated production of subassemblies. The objective is to reduce the cost of carbon fiber composite structures by 30%.*
- *The Composites NDT Validation Centre, based at TWI, Port Talbot, offers an independent NDT (nondestructive testing) validation service to industry and undertakes development work to meet the needs of specific NDT applications for composites.*
- *The North West Composite Centre is a collaborative venture by the universities of Manchester, Liverpool, Lancaster, and Bolton. The center focuses on 3D fiber structures and high-speed composite cure (such as Quickstep).*
- *Boeing and the Yorkshire Regional Development agency are supporting the University of Sheffield's Composites and Advanced Materials and Technology Centre. The Boeing-led center will be located on the Advanced Manufacturing Park in Rotherham and will focus on researching, designing, manufacturing, and technology transfer of civil and aerospace composite components.*

*There are two other "nodes" under the umbrella of the Materials KTN active in composite-related technologies: Faraday Advance, which focuses on new materials for transport applications, and Smart.-mat, which focuses on smart materials, surfaces, and structures. Along with the NCN, all the nodes work together to promote materials technology in the U.K.*

## Future plans

The U.K. is already leading in many aspects of aerospace composite technology. The composite wing spars on the A400M military transport aircraft, manufactured by GKN Aerospace (Cowes, Isle of Wight, U.K.) represent the global state of the art, at least until the Boeing 787 becomes a physical reality. The new and revised A350 XWB program will be another major effort where the U.K.'s composite wing technology will be deployed and strengthened by further investment. BAE Systems also has extensive experience in producing composite parts to extremely high tolerances for incorporation into multimaterial structures for programs including Typhoon and the Joint Strike Fighter.

This is an exciting time for the aerospace composites industry in the U.K., with renewed support providing significant revitalization. This revitalization will enable the U.K. to reestablish its status at the forefront of technological advance in the aerospace composites sector.

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