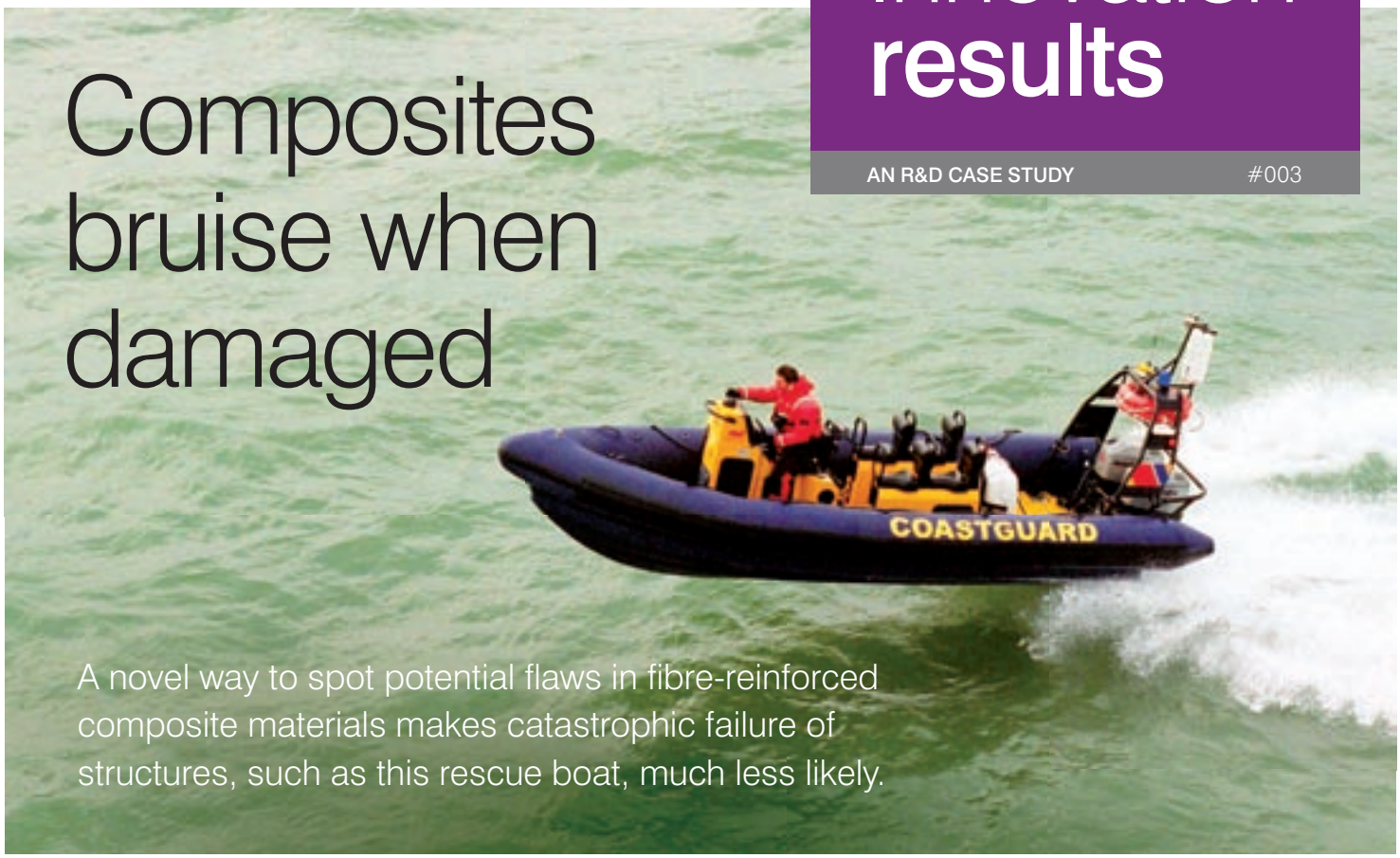
Technology Strategy Board
Driving Innovation

Innovation **results**

AN R&D CASE STUDY #003

Composites bruise when damaged



A novel way to spot potential flaws in fibre-reinforced composite materials makes catastrophic failure of structures, such as this rescue boat, much less likely.

The need

Polymer composites (fibres and resin bonded together) are the most adaptable engineering materials known to man. With their high strength and stiffness, composites are increasingly popular for use in bridges, wind turbines, surface and aerospace transport, and chemical plants. But invisible damage may go undetected for long periods, weakening the product to critical levels.

Thorough but expensive inspection systems, as used in aerospace composite structures, are simply unaffordable in many applications. Inspectors need an easy visual method to flag potential problems, pinpointing where to use tests that are more elaborate.

The results

In this Technology Strategy Board co-funded R&D project, EPL Composite Solutions led a consortium to discover a simple non-destructive method to inspect and evaluate polymer composite structures. Just as bruises on the human body vividly indicate physical injury, bruisable composite materials show where the structure may be 'injured'.

The idea, which arose from old-fashioned carbonless paper, was to apply existing technologies to make composites 'bruisable', in order to show not just that damage had occurred but also its extent. Reading the bruises, inspectors could order a more detailed inspection, monitoring, repair or replacement.

First, they developed the 'bruises' from tiny spheres that rupture to release telltale chemicals. In the simpler types, the ruptured spheres just spill their contents, while other types use a chemical reaction to create the bruised effect.

Then they worked out how to implant these spheres. Two ways emerged, depending on the surface treatment. Some structures have a gelcoat, which is a protective barrier that protects against corrosive fluids. Other structures use a veil – an extra sheet of material that enhances the appearance or capability of a structure.

Several spin-off applications are emerging. An aircraft maker thinks the system would help to detect damage suffered when components move along production lines. Manufacturers could apply the bruisable material in several forms including a 'stick-on plaster' and the idea could highlight 'injuries' to conventional materials, in the same way.

Expense is no longer an excuse for not knowing whether a structure is safe or not.

The market

To guard against its Achilles heel – unexpected failure – designers use generous factors of safety when working with composites. And alert operators have strict inspection systems. Therefore, simple and reliable methods of inspection, such as 'bruisable' composites, will shift the whole-life economics of polymer composite structures.

Safety-critical applications are the most likely to benefit from this innovation. The global market for polymer composite structures is worth more than £80bn. The use of composites in the exteriors of aircraft is forecast to grow at a rate of 12.3% from 11,250 tonnes in 2007 to 25,400 tonnes in 2014 (Frost & Sullivan 2008).

In aerospace alone EPL estimates that it could achieve potential added value of £7m annually.

Making it happen

Eight companies working in the polymer composites industry pooled their specialist resources to make this breakthrough:

- EPL developed the concept, investigated the microcapsule technology, studied the chemistry of the bruise and manufactured the microcapsules.
- Scott Bader investigated techniques to incorporate the microspheres into the resin.
- Smart Fibres supplied optical fibres for health monitoring.
- PERA undertook a structural impact and mechanical analysis programme.
- Exel and BVT Surface Fleet specified case study applications and tested the compounds in their process lines.
- BMT worked with EPL to generate a model for mapping the area and intensity of damage and likely impact on structural performance.
- Technical Fibre Products developed their tissue manufacturing technology to filter and embed the microcapsules.

'This simple system will build confidence in safety, make designs less conservative and so reduce weight and CO_2 emissions.'

EPL

Project 10435

Project partners
EPL Composite Solutions, BMT Cordah, Exel Composites, PERA, Scott Bader, Smart Fibres, Technical Fibre Products and BVT Surface Fleet

Technology Strategy Board investment
£472,000

Total project investment
£997,000

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Technology Strategy Board
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Collaborative research and development projects are one of the tools that the Technology Strategy Board uses to drive innovation in the UK. The Technology Strategy Board is a business-led executive non-departmental public body, established by the Government. Its role is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business, in order to increase economic growth and improve the quality of life. It is sponsored by the Department for Business, Innovation and Skills (BIS).

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