

## Hotter discs save jet fuel

Project PANACEA has developed a new way to enable gas turbines in jet engines run hotter and burn less fuel. Large commercial aircraft will emit less CO<sub>2</sub> while airlines save on fuel bills.

### The need

Global aviation contributes about 2% of the carbon dioxide emissions attributable to fossil fuel use and demand for these planes is expected to rise. To counter this, the European aviation industry set a target in 2001 to reduce fuel consumption by 50% per passenger kilometre by 2020.

Fuel burns more efficiently at higher temperatures, so designers need components that can operate in a more arduous environment. The problem is that engine components, such as gas turbine discs, must multitask; different parts of a single component are exposed to different temperatures. This called for new tailored materials that no one had successfully manufactured before.

### The results

In this Technology Strategy Board co-funded R&D project, Rolls-Royce led a consortium of industrial and academic partners to develop Processing of an Advanced Nickel Alloy for Critical Engine Applications (PANACEA). The aim is to have 'dual microstructure' discs ready for the new engines to power the Airbus A350XWB, due to enter service in 2014.

In the past, researchers focused on changing the chemistry of metals, but this approach has reached its limit. This project looked at engineering the material by heating it up to adjust the grain size. When viewed through a microscope, metals look like a collection of tiny particles (grains), whose size influences material properties. For example, very strong metals have fine grains, while coarse-grained metals do not go out of shape (creep) in extreme heat.

The discs in large gas turbine engines are typically 1m in diameter, weigh 150kg and rotate at 10,000rpm. The centre (core) operates at about 200°C and must have high strength, which calls for fine-grained metal. The rim runs at 'dull red heat', about 700°C, where larger grains would be ideal. So the challenge was to make disc-shaped components with both fine- and coarse-grained parts. The result is a nickel-based gas turbine disc material with a 25°C step change in temperature tolerance, which will run at 725°C.

Starting with fine-grained metal, the process for growing grain size on the rim is to heat the disc in a furnace while keeping the core insulated. Then a new technique was developed to cut the 'teeth' in the rim of the disc.

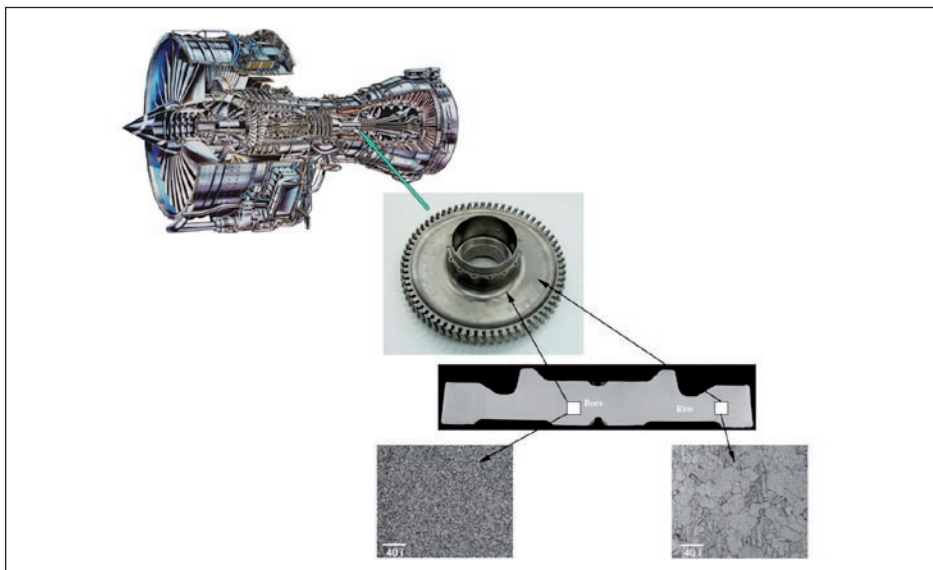
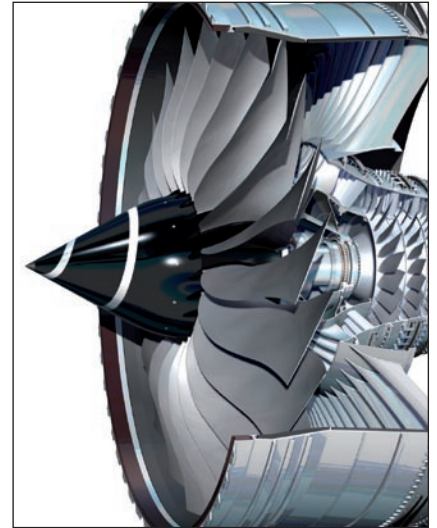
## Competitive advantage

Rolls-Royce is determined to build on its share of the world market in large aircraft engines. It is a business where greater efficiency translates into more sales.

The immediate impact of the dual microstructure disc will be to reduce specific fuel consumption by about 0.3-0.5%. At face value, this does not look much. However, the volume of fuel

consumed is so large that the annual saving will be about \$50,000 on each jet engine. So an airline with 15 twin-engine wide-body aircraft would expect to save about \$1.5m over a year from PANACEA disc technology.

This is one of a series of innovations Rolls-Royce is developing to reduce fuel consumption and help secure its competitive position.



‘PANACEA disc technology will save 0.6 tonnes of CO<sub>2</sub> every time an aircraft crosses the Atlantic.’

Rolls-Royce

## Making it happen

**The project was too broad for any single company to tackle; hence the consortium:**

- Rolls-Royce researched and developed the dual microstructure discs at its large aircraft engine plant in Derby, with academic support from the Universities of Birmingham, Manchester and Swansea.

- Nottingham University did the initial research towards the step change in machining methods. The development passed to the Advanced Manufacturing Research Centre (at University of Sheffield) and Sandvik Coromant.
- Besides the immediate benefit to the Rolls-Royce Trent XWB engine, Sandvik Coromant is pursuing a spin-off development in machining disc components for use in other engines.

### Technology Strategy Board

Driving Innovation

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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**Project** 22012

#### Project partners

Rolls-Royce plc, Advanced Manufacturing Research Centre (at University of Sheffield), Sandvik Coromant UK, University of Manchester, University of Birmingham, University of Nottingham, Swansea University

#### Technology Strategy Board investment

£1.2m

#### Total project investment

£2.4m

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