

Designing for better electric motors and generators

Designing better magnets and materials for use in electric motors and generators offers the potential for significant improvements in efficiency and will aid the development of environmentally friendly transport.

Key benefits

- innovation and collaboration across the magnetics industry offers the potential for significant break-throughs
- new techniques for electric motors and generators could have a huge impact on the development of environmentally friendly transport
- the aerospace and automotive industries worldwide represent huge potential markets for UK companies able to develop leading-edge technologies

Electric motors and generators are increasingly important in a wide range of uses in transport, industry and the home. In particular, they are widely used in cars and aeroplanes.

Aeroplanes generate their own electricity using generators placed outside the actual jet engines. To reduce costs and improve efficiency, the aircraft industry wants to generate more electricity, for example so that ailerons (the moveable flaps on an aeroplane's wings) currently powered by hydraulics can instead be powered electrically. To generate this much power, the electric generators will need to be located within the jet engines themselves. These are extreme operating conditions and conventional electric generators cannot withstand the heat and stresses present in such an environment.

In cars, electric motors and generators (here collectively known as electric machines) are found under the bonnet and throughout the vehicle, for example powering windscreen wipers and electric windows. Reducing the weight and improving

the efficiency of these motors would cut fuel costs and emissions. Increasingly, environmentally friendly technologies such as high-powered electric engines are being used in dual-powered cars. These kinds of engines require powerful magnets to make them work, but these need to withstand very high temperatures and stresses. They would also need to be created in the right shapes and sizes to fit vehicle design.

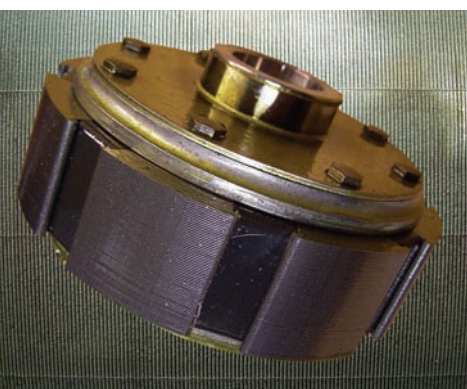
The research, under the project title 'Advanced Electric Machines through Materials', is looking at how magnets perform under such conditions, and how to develop more effective materials for use within these environments.

The project is led by the Powdermatrix Faraday Partnership operated through CERAM. Other organisations involved in the project include Rolls-Royce PLC, Vector Fields Ltd, DANA Automotive Ltd, Goodrich Control Systems, Cogent Power Ltd, Newage AVK SEG, TRW Ltd, Smiths Aerospace Mechanical Systems, QinetiQ Ltd, Motor Design Ltd, Magnet Applications Ltd, SG Magnets Ltd, and NPL as well as the universities of Loughborough and Cardiff.

The three-year project started in May 2005. The total project cost is £2.4 million, with £1.2 million provided by the Technology Programme, and the rest coming from industry.

Objectives

The project will contribute to more environmentally friendly transport by selective replacement of mechanical and hydraulic systems with electric machines. The introduction of new electric control systems will also reduce the fuel consumption of cars and planes.



To realise these advantages, the consortium will develop measurement, modelling and materials that can be taken forward in product developments.

Solutions

The project has six work packages each addressing key technology needs.

The first concentrates on improving ways to measure the magnetic properties in the conditions under which these electric machines will need to operate. Only by testing materials under the conditions that they will actually experience is it possible to design an electric generator that will operate most efficiently.

Work package two focuses on creating integrated 3D modelling tools combining magnetic, mechanical and thermal properties. These will be an essential component of the product development work.

The third work package is focused on the use of soft magnetic materials that will improve the design of electric engines and generators.

Work package four is looking at ways to create magnets that can withstand conditions of 450°C and 450 megapascals.

Work package five is investigating new materials and techniques for creating magnets in customised shapes. This will result in the development of high energy-product bonded neodymium iron boron (NdFeB) magnets.

The final work package is developing new ways to create electric wire that will be able to operate at temperatures up to 600°C (the present limit is 220°C).

Results

The six work packages are all initially working independently, and the various parties have met and agreed the way forward and project management tools are in place. Initial results will start to be collated towards the end of the first year. As the project progresses, the six work packages will start to work together, sharing their findings. Ultimately, new materials, new modelling techniques and new measuring capabilities will result in the building and testing of new types of electric motors and generators designed specifically to work under extreme conditions and to offer significant improvements in design, performance and efficiency.

As Dr John Liddle, Director of the PowdermatriX Faraday Partnership, says, "The UK has strong

capabilities in this field and for a modest investment the returns could be staggering. The level of innovation is significant as it combines several simultaneous advances in materials, processing and machine technology, and so pushes well ahead of current leading-edge work."

"This collaboration of so many diverse parties in the magnetic industry and research community is something completely new, and could only have happened thanks to the existence of PowdermatriX, and the funding that has been made available."



Project contacts

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Collaborative Research & Development

Collaborative Research & Development is one of two business support solutions within the Technology Programme, the other being Knowledge Transfer Networks (KTNs). Its primary objective is to enable the industry and research communities to work together in strategically important areas of science, engineering and technology in order to develop successful new products, processes and services. It also enables the latest thinking and understanding to flow between universities, other research centres and business.

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