Power Electronics

IeMRC Flagship Project

Academic Collaborators: Nottingham University, Greenwich University, Newcastle University, Oxford University & Manchester University

Power electronics has revolutionised the control of the flow and conversion of electrical energy in applications ranging from hand-held power-tools and personal computers through electrical machine drives and industrial processes to systems that are capable of controlling the flow of energy in the electricity transmission and distribution network. Increasing demand for the efficient and flexible control of electrical power has stimulated an increasing market for power electronic systems which can be expected to grow throughout the 21st century. Power electronics technology is also an enabler for developments in environmentally-friendly transport and renewable energy and is thus central to the long-term strategies of key, UK wealth-creation sectors such as aerospace, automotive, marine and energy industries.

In recent years, there has been a move away from systems based on discrete power semiconductor devices to power electronic modules (PEMs), which contain several semiconductor dies and can also include passive components, integrated control and protection functions. PEMs provide an easy route for the application user to design and construct a power electronic system with well-defined performance metrics and for this reason there is increasing interest in PEMs which are customisable or can offer greater levels of functionality. In addition, PEMs are being driven towards higher power densities as a result of increasing demands for weight and volume savings in areas such as power supply and transport technologies and into new application areas with challenging environments (e.g. aerospace, space, deep sea, high temperature). PEM manufacturers thus face a challenge, the key demands of which include a reduction in the time needed to design, develop and qualify new products against customer specifications and an understanding of how new and emerging materials and assembly technologies can be utilised to improve the performance, reliability and cost-effectiveness of manufactured products. This Flagship Project addresses the PEM design challenge by supporting research which will deliver a detailed survey of new materials and assembly technologies, a physics-of-failure based approach to the qualification of PEMs and investigate the manufacturability of selected PEM technologies.

The overall aim of the IeMRC Flagship Project in Power Electronics is to enhance the competitiveness of the UK power electronics industry through improvements to the design and manufacturing capability for power electronic modules and in particular those intended for high power-density operation, high-reliability applications and challenging environments. This ambition will be realised through the following technological objectives:

1. Establish and maintain a roadmap for power electronics modules and associated thermal management systems.
2. Perform a technology qualification study for power electronic modules and associated thermal management systems.
3. Develop an enhanced physics of failure approach to the design and qualification of power electronic modules.
4. Establish the feasibility of a range of advanced power electronic module manufacturing technologies and apply selected technologies in a manufacturing environment.

Each of the above objectives translates into a self-contained mini-project or technology theme that is integrated, under the umbrella of the Flagship Project, with other EPSRC- and DTI-funded research to maximise the financial and technological gearing.