



# THE **matrix** NEWSLETTER

## Powdermatrix

ISSUE 8. Autumn 2005

## Powders help form Industry Solutions

**The industry led project, "Advanced Electrical Machines through Materials", held its launch meeting at CERAM, Stoke-on-Trent, in late May. Managed by Powdermatrix and supported under the DTI Technology Programme, the project's Work Packages include the use of powdered materials to form magnetic components and the development of high temperature insulation coatings.**

Destined for automotive, aerospace and land-based electrical power applications, always in the high power density quadrant, materials are now expected to withstand demanding environmental extremes and deliver exceptional electromagnetic and mechanical performance. Over a series of six articles in The matrix, each of the Project's Work Packages will be described along with some of the technical challenges.

### *Magnetic Materials Test & Measurement Under Operating Conditions*

Magnetic measurement data traceable to National Standards, suitable for inclusion in Finite Element databases and useful for end-user designers and manufacturing specifications are the aims of this Work Package. Seen as a cornerstone of the project, the more accurate materials data generated will improve design and reduce cost in prototype build and subsequent manufacturing. In the world of electro-magnetic machine design, the acquisition of suitable data has been restricted by standard test regimes (DC, 50Hz / 60Hz sinusoidal, 20°C) that are no longer representative of a modern electrical machine's operational environment, or duty cycle. Mechanical stresses and thermal environment significantly alter the response of magnetic materials and magnetic properties must be measured under actual conditions of use, which include harmonics up to 20 kHz and magnetic flux densities of ~2T. Eddy current losses in high speed



machines operating at 60,000 to 100,000 rpm are of particular interest and efforts will focus on the development of test facilities to encompass the implied magnetic behaviour, the influence of mechanical stress (up to 400MPa) and high temperature environments (up to 450°C). Surprisingly these conditions are not specific to aerospace applications, but may also be found in today's efficient power generation modules and automotive ancillaries.

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## Martin is a jolly good fellow

**Dr Martin Jackson of Imperial College, has been awarded a prestigious 5 year Royal Academy of Engineering/EP SRC Fellowship to pursue his researches into "The Consolidation Behaviour & Continuous Solid State Processing of Titanium from Emerging Reduction Methods". Martin is currently supervising Faraday Associate, David Tricker, on the continuous consolidation of titanium powders, a Powdermatrix Industrial CASE studentship supported by Outokumpu Holton.**

David's work will have considerable implications for the potential growth in the use of titanium and its alloys. Several new processes, which reduce titanium ore to metal

and could substantially lower the metal cost, tend to produce particulate or granulate. Technically robust and cost effective methods of consolidating the powder metal into semi-finished or near net shape forms assume great importance.

The Fellowship recognises this potential value to the UK and global economy. Alongside this work, Martin will develop the operating parameters to produce particulate with optimum consolidation characteristics.

Powdermatrix is proud to be associated with this leading edge work and to have supported Martin in his application for the Fellowship.

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Dr Martin Jackson

### Core partners:

| CERAM | Institute of Materials, Minerals and Mining | EPMA | British Hardmetals Research Group | NPL  
| University of Birmingham | University of Manchester | Loughborough University

# Awards SPARK success

**The current call for proposals for PowdermatriX SPARK awards has again proved popular and is now closed for this year. In its second year, the scheme has helped Members improve their industrial performance through £5,000 awards to support problem solving, proof-of-concept, technology demonstration and development activities by subcontract research providers and university departments.**

The twenty six awards PowdermatriX has made cover a wide range of technical areas including sensors, pharmaceuticals, prosthetic implants and functional ceramics.

Filtronic Comtek, the world-leading manufacturer of customised RF, microwave and millimetre wave components and subsystems, obtained valuable data to help strengthen its production processes through a SPARK award.

The main product in Filtronic's ceramic range must have a specific electronic property, temperature coefficient of resonant frequency or TCF, with a value close to zero. The ceramic is manufactured by mixing four powders, which introduces potential batch variations in TCF and can cause lengthy product lead times.

The SPARK project helped to assess process reproducibility by calling on expertise at CERAM to

analyse the zeta potential of powder suspensions and optimum dispersion conditions for powders and mixes in the process.

Using a Zeta probe to assess dispersion levels, CERAM was able to suggest a new process route which involved the separate mixing of two well dispersed materials and subsequently adding the mixture to a suspension of the other two components.

Subsequent production tests at Filtronic showed the approach has the potential to significantly improve powder processing and overall product reproducibility.

This SPARK project has helped to set the company's future development path and has provided a valuable springboard for improvements in the manufacturing processes used by the Ceramic Division of Filtronic Comtek.

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# All eyes on Nano Mission

**Nanoparticles are now beginning to be used in many manufacturing sectors to introduce new properties and add value to products. In April 2005, PowdermatriX coordinated a DTI Global Watch Mission to Europe, which assessed the state-of-the-art in nanoparticulate manufacture and the potential for the UK to adopt emerging technology.**

Visiting centres of excellence in Finland, Germany and Switzerland, the nine mission members returned home in no doubt that nanoparticles are starting to penetrate the market, but also with a conviction that, at this early stage of commercialisation, the UK has everything to play for. The potential of nanoparticles to improve, add value and create new products in many market sectors is encouraging the mission team to expect a diverse range of industries to be represented at the mission seminar at the Science Museum, London on 11th October 2005.

**To attend the October seminar or for a copy of the mission report, contact Charlotte Leiper on 01664 501551 or email: [events@globalwatchservice.com](mailto:events@globalwatchservice.com)**

# Innovation and Growth Teams – A Framework for Future Research and Development

**Over the last few years the DTI has been supporting the formation of Innovation and Growth Teams (IGT's), which are sector specific and have a remit to provide a strategic approach to research, skills, infrastructure and training needs.**

The Aerospace Innovation and Growth Team (AeIGT - [www.aeigt.co.uk](http://www.aeigt.co.uk)) has already produced its main project and the technology implementation reports which can be found at [www.aeigt.co.uk/news/keydocs.asp](http://www.aeigt.co.uk/news/keydocs.asp). While not specific to the powder industry, these reports describe the strategy and framework that the aerospace industry needs to deliver both the required technical advances and the demonstration of these advances prior to implementation in products. In particular the technical implementation report covers:

- Building a national strategy
- Mechanisms for delivery
- The technology strategy
- Defence industrial policy
- Proposed management

and makes specific recommendations. The documents have been accepted by government and now form the core of the National Aerospace Strategy. These documents can thus now be used to demonstrate that aerospace oriented proposals fit a national framework recognised and supported by the Aerospace industry.

A recent example is the PowdermatriX project "Advanced Electric Machines through Materials". This 3-year programme is funded through the Environmentally Friendly Engine theme in call 2 of the DTI Technology Programme, and deals with the development of materials for high power density electrical machinery. As part of the bid, specific reference was made to the AeIGT report, showing how the programme linked to the environmentally friendly engine theme and demonstrator programme identified in the report and also how this made an impact on environmental emissions.

Several IGT reports in different sectors are now being published. The Materials IGT is currently active and due to publish its outcomes in the last quarter of this year. Awareness of all the IGTs' conclusions and future

direction is essential to funding of future research and development programmes.



# HADI puts his CASE

**Hadi Zarringhalam is a manufacturing engineer who is currently studying towards a PhD at Loughborough University, and The matriX asked him to tell us more about his background and the project he is working on:**

I first learned of CASE sponsorship from my supervisor at Loughborough – Dr Neil Hopkinson.

My CASE studentship commenced in October 2003 and the work quickly generated positive results showing the effects of cooling rate on mechanical properties of Selective Laser Sintering (SLS) parts, which is relevant to both machine users and those involved in R&D. These findings were presented at the 3D Systems SLS/SLA user group conference in California last year and further work was presented at the Solid Freeform Fabrication Symposium in Texas in August this year. I have also enjoyed presenting at the 2004 and 2005 PowdermatriX annual meetings.

I am currently conducting analysis of microstructure and crystallinity in SLS parts in more depth than has been done before and this work is promising further findings which will give new understanding of the SLS process.

SLS of polymers is a relatively new process and is comparable to sintering of metals in some ways and moulding of polymers in others. As such, analysis of specimens is not always straightforward; simple techniques such as Differential Scanning Calorimetry (DSC) involved hurdles in sample preparation (which were overcome!) and optical microscopy

provided surprising results clearly showing variations in the degree of melt of the polymer particles.

The industrial sponsors 3D Systems (UK) and Solid Concepts are keen for research to focus on material properties, part accuracy, surface finish and being able to reliably achieve all three. For this EPSRC Industrial CASE award they set a specific objective of increasing ductility of Nylon 12 parts and a preference for an in-process improvement or process control, rather than additional processes. The example application given was air ducts for F/A-18 military aircraft. When they are produced as a single component by SLS they are more difficult to install than the multi-component parts and must be more flexible and ductile.

I would like to see SLS technology develop to the point that manufacturers would not hesitate to select it as a manufacturing method for suitable applications. Ductility of parts needs to be improved, as this work looks at, but improvements to other aspects will also increase application areas and confidence in the process. Such factors include build time, surface quality and reproducibility of properties.

As far as my future career is concerned I am still considering my options. At the completion of my studies I should have gathered considerable knowledge and experience in SLS as well as demonstrated the ability to sustain a research project for 3 years! This should stand me in good ground whether I decide to continue in academia or step into industry.

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results from the first CASE projects, such as Hadi's, that we supported two years ago, as well as underlining commitment to developing materials and technologies to advance their businesses.

The projects supported in 2005-6 include; Multiscale Modelling of Gas Atomisation in Production of Metal Powders, Micro-particulate Powders for the Delivery of Protein Based Drugs and Toolkit for Air-Induced Segregation in Powder Handling and Flow for Compaction Processes.

We hope to have a further call for CASE project proposals in early 2006.

**For more information, please contact:**  
[stuart.maclachlan@ceram.com](mailto:stuart.maclachlan@ceram.com)



## Choosing the Right Tools

**The 25 delegates, who attended the PowdermatriX Compaction Tooling Awareness Meeting at CRDM Buckinghamshire University College on 10th May, had the benefit of expert up-dates on recent developments in tooling materials and toolmaking technologies (including rapid toolmaking and tool-less manufacture) and associated issues such as lubrication methods and assisted die filling technologies.**

But, more than that, they had the opportunity to network and explore areas of common interest, which are illustrated by these three examples.

A parts manufacturer and a toolmaker were able to establish a relationship that could deliver future benefits to both companies.

Another parts manufacturer was able to enlist the expert assistance of two major tool steel suppliers in a new tooling optimisation programme.

A group of advanced ceramics companies discovered that compaction simulation techniques, in regular use in the pharmaceutical sector, might be used to address some of their compaction concerns. Indeed, this potential cross-fertilisation of ideas between these two sectors may well form the basis of a further Interest Group meeting later this year.

**For more information about PowdermatriX meetings, please visit:**  
[www.powdermatrix.org](http://www.powdermatrix.org)



## We're on the CASE

**Funded jointly by companies and the Engineering and Physical Science Research Council (EPSRC), CASE studentships enable industry to take the lead in defining projects for students and selecting an academic partner of their choice. Projects are jointly supervised by the academic and industrial partners.**

PowdermatriX is supporting twelve Industrial CASE studentships, which will not only contribute to valuable developments within our core sectors of advanced materials, but will also help to advance the pharmaceutical sector, which is a regular user of powder technologies. Companies are starting to see positive

results from the first CASE projects, such as Hadi's, that we supported two years ago, as well as underlining commitment to developing materials and technologies to advance their businesses.

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## Proposal with the DTI

PowdermatriX has worked with our industrial and academic partners to submit a full proposal to the fourth call of the DTI Technology Programme following success at the outlines stage.

Nanostructure Thermal Barrier Coatings aims initially to develop Electrophoretic Deposition to coat complex, three dimensional gas turbine components. The increased protection from the coating will lower fuel consumption and emissions of gas turbines. The process also has the potential to open up many more opportunities for high temperature, wear resistant and self lubricating coatings: for example, internal combustion engines using hydrogen based fuels, printing applications, fuel cell components and wear parts.

*For more information about this and future DTI calls, contact:*  
[stuart.maclachlan@ceram.com](mailto:stuart.maclachlan@ceram.com)

## Add a Colleague

*If one of your colleagues would like to receive the PowdermatriX newsletter, please email your name and address with 'matrix' entered into the subject box to [powdermatrix@ceram.com](mailto:powdermatrix@ceram.com)*

## Pride of place for PMX

Pride Park, the home of Derby County, is the venue for a powder characterisation meeting organised jointly by PowdermatriX and the Particle Characterisation Interest group of the Royal Society of Chemistry.

Taking place on 30th November 2005, the event will comprise a series of short industrial presentations describing issues relating to powder processing and how characterisation techniques are used to deliver solutions and improve performance. By involving industries ranging from food and pharmaceuticals to ceramics, minerals and paint, a good cross-fertilisation of ideas will result.

*For more information, please visit:*  
[www.powdermatrix.org](http://www.powdermatrix.org)  
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## Nano Interest Group gets physical

The National Physical Laboratory (NPL) hosted the latest PowdermatriX Nanotechnology Interest Group meeting on 7th July.

Presentations showed the wide scope of nanotechnology activity in PowdermatriX member companies; TSI Instruments Ltd are offering nano-particle characterisation equipment; Ping Xiao, Manchester University, is using hydrothermal routes to produce nano powders in a crystalline state without the need for a post-sintering step; NPL is at the forefront of several initiatives in nanoparticulate measurement and standardisation. For example the recently formed MNT Measurement Club focuses on metrology and related issues such as national and international standards and regulations.

As with all Interest Groups, PowdermatriX gave industry and university members an excellent opportunity to share views and will lead to future collaboration.

*For more information about PowdermatriX meetings, please visit:* [www.powdermatrix.org](http://www.powdermatrix.org)



## Forthcoming events

### EuroPM 2005

2-5 October 2005, Prague, Conference  
- EPMA [www.epma.com/pm2005](http://www.epma.com/pm2005)

### NANOMAT: Nanomaterials manufacture and applications

11 October 2005, London, Seminar  
- Globalwatch UK [events@globalwatchservice.com](mailto:events@globalwatchservice.com)

### Powder Characterisation

30 November 2005, Derby, Workshop,  
PowdermatriX and Particle Characterisation Interest Group,  
- RSoC [phil.jackson@ceram.com](mailto:phil.jackson@ceram.com)

PowdermatriX

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### Funded by

dti

Department of Trade and Industry

EPSRC

Advantage West Midlands

PowdermatriX is a Faraday Partnership providing industry focused technology, research and training

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