

ENERGY MATERIALS CONFERENCE

The October two-day conference and exhibition "Energy Materials: Meeting the Challenge", organised by the Energy Materials Group of Materials UK, provided an excellent forum to highlight the key recommendations from the Powdermatrix report "The Future of Power Generation: The Role of Particulate Materials".

During the course of the conference, several speakers delivered messages that lent strong support to the Powdermatrix recommendations.

One of the most consistent themes was the need for the development of high integrity materials systems for increasingly aggressive operating conditions across a wide range of power generation technologies. David Clarke of the Energy Technologies Institute introduced the message that improved component corrosion resistance will emerge as a major issue. This requirement was reiterated by several speakers, particularly in the Fossil Energy session that covered Steam plant, Gas Turbines and Carbon Capture and Storage (CCS), who saw that advanced surface engineering solutions must play a vital role in these new material systems.

This guidance resonated well with our key recommendation that particulate-based surface coating solutions should be developed to combat increasingly arduous conditions in all items of combustion technology plant. Specific reference was made during the conference to the new

ASPECT project (see separate item in this newsletter), which is aimed at addressing fireside corrosion and steamside oxidation issues in ultra-super critical boilers, as co-firing of biomass and oxy-fuel firing (as an aid to CCS) are adopted. The need for similar projects to address steam turbine and gas turbine components was identified.

Renewable generation received significant coverage in two sessions. The core of Andy Morris' presentation (E.On) concentrated on the need to model and evaluate deterioration of wind turbine components to develop cost effective operation and maintenance strategies. Most of E.On's work relates to turbine blade performance, where there is the need for a UK facility to link small-scale testing to full-scale use. Powdermatrix is keen to complement this research by improving another turbine component – the NdFeB magnets which are used in the generators and are subject to corrosion, particularly in moist saline conditions.

The keynote international speaker, Bob Romanoski from the US National Energy Technology Laboratory, spoke of his group's work to improve the performance of refractories used in slagging gasifiers. Their budget for materials research relating to fossil fuels alone is between \$20M and \$30M. He confirmed that the next challenge in this area is to reduce the chromium content of the refractories used, mirroring exactly the Powdermatrix proposal outline to develop materials for this application. We hope to be able to collaborate with the US groups to meet this goal.



Changes at Powdermatrix



John Little, Operations Director of Powdermatrix, is moving on to pastures new in 2009. John has been a key driving force in making Powdermatrix a successful organisation through its varied meeting schedule, SPARK Award scheme, Associate programme and the larger collaborative projects it organises.

Mike Hicks, Powdermatrix Chairman and Materials and Mechanical Behaviour Executive,

Rolls-Royce plc, in commenting on the future of Powdermatrix said, "I must thank John for his invaluable contribution to the development and direction of Powdermatrix. We are committed to seeing this continue through Stuart MacLachlan, who is to become the new Powdermatrix Operations Director, subject to confirmation at the upcoming board meeting. This move will ensure consistency at this very important time as Powdermatrix bids for a new funding round and the future unfurls. I am sure that Stuart will stamp his own style on Powdermatrix."

You will no doubt join everyone at Powdermatrix in wishing John the greatest success in his new role at EMDA, leading an innovation in construction network.

To learn more about Powdermatrix Energy activities or to get a free copy of the roadmap contact [David Whittaker \(david.whittaker@ceram.com\)](mailto:David.Whittaker@ceram.com).

Core partners

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

UK Magnetics Society Seminar

on Advanced Electric Machines through Materials

Organised with the UK Magnetics Society, and hosted by TRW Conekt at Solihull, this seminar disseminated the findings of the Technology Strategy Board project "Advanced Electric Machines through Materials". Launched in 2005 and led by PowdermatriX, the project focused on technologies for more efficient power systems, particularly for the aerospace and automotive industries, with the aim of reducing CO² emissions.

This three-year, £2.4M project, which involved sixteen partners from the UK Magnetics Industry supply chain, was set up to develop improved magnetic materials, processing technologies, measurement facilities and computer modelling capability for electric machines.

As an example, with novel designs and high strength magnetic materials, weight savings of 15% could be achieved on aero engines of the future if the electric generators could be located within the gas turbine which would reduce the weight penalty of drive shafts and gearboxes. The challenges that this presents to the designers of the electric machine and to materials scientists are immense but the project has produced prototypes for a high temperature insulation for electrical conductors and a high speed, high temperature rotor core. Further contributions from the software designers, test houses, electric motor manufacturers and permanent magnet manufacturers made this a very interesting seminar of nine presentations. It was an ideal opportunity to present the results of the Magnetics Project to over 40 delegates drawn from across the sector and PowdermatriX is developing follow-on project proposals resulting from these researches.

The corrosion of NdFeB magnets

The development of the neodymium-iron-boron (NdFeB) rare earth magnet industry over the last twenty-five years has transformed the global permanent magnet and consumer electronics industries. Over recent years, with the ever-increasing problems associated with global warming, there has been an increasing demand for energy generation from renewable sources, with the emphasis on wind and marine energy generators. In particular, the wind turbine industry has developed rapidly with a consequent demand on the supply of NdFeB magnets as each 3MW generator requires about 1.7 tonnes of permanent magnet material.

Wind turbine generators are being placed in marine environments to maximise the benefits of on-shore winds (wind farms) but these environments are very corrosive to NdFeB magnets.

The magnetics project, through Magnet Applications Ltd. and Birmingham University, has addressed the problems of corrosion on bonded permanent magnets and has identified some of the processes which can cause the deterioration in the strength of the magnet in more extreme environments. New projects are now being proposed to address these problems and to continue this key area of magnetics research and the development of anti-corrosion processes.

Magnetic measurements

A fundamental requirement of the magnetics project has been the establishment of new methods of measurement to determine the performance of magnetic materials under the operational conditions of electric machines. All magnetic materials are specified against established standards which require traceable and reproducible methods of measurement under reference test conditions. Whereas this process is essential when comparing and specifying materials, the reference test conditions may be very different from the actual operating conditions in the electrical machine.



Development work carried out at the National Physical Laboratory, The Wolfson Centre at Cardiff University and TRW Conekt has resulted in an extended range of test methods which are now available for hard and soft magnetic materials, for example –

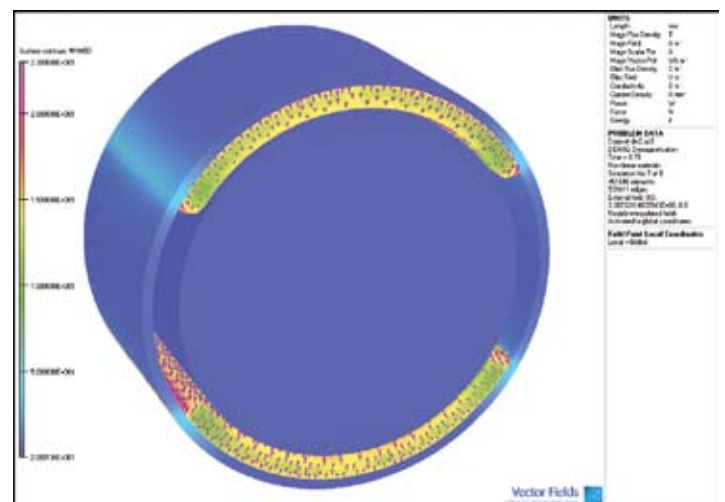
- Improved permeability and hysteresis loop measurements on permanent magnet materials
- d.c. measurements on soft magnetic materials under applied stress
- a.c. measurements over an extended range of frequency to cover power loss and permeability under complex waveform excitation to model the magnetic conditions in an operating machine.
- magnetic measurements under extreme operating conditions such as elevated temperature and applied stress.

Software developments

The software modelling companies, Vector Fields and Motor Design Ltd, have worked closely together, and with the prime technology companies, to develop a new generation of software tools that meet the future needs of electrical machines designers, for example –

- Vector Fields developed their permanent magnet magnetization and demagnetization solvers in OPERA-2d and OPERA-3d to allow designers to model accurately the performance of permanent magnet machines, especially for operation under increased temperature and de-magnetizing armature currents. In addition, the capability to model hysteretic effects in soft magnetic materials has been developed.
- Motor Design Ltd. developed a method to expand the electric motor thermal models automatically constructed in the Motor-CAD software to include the surrounding system within which they are built.

Through the Magnetics Project the two modelling partners have established improved data links between their products to the benefit of the magnetics industry. New software packages encompassing these developments are now available.



World Leading EPD Technology

In early October, three members of the Technology Strategy Board supported project "Nano Structured Thermal Barrier Coatings" presented to the Third International Conference on Electrophoretic Deposition in Japan. Ian Shapiro and Hui Xu are both PowdermatriX Associates researching the electrophoretic deposition process at the Materials Science Centre, University of Manchester. John Blackburn is Managing Director of Ionotec, a research and development company focused on materials science related to electrochemistry and the manufacture of ceramic materials and components. John commented, "The conference was the most relevant to Ionotec's business that I have ever attended and brought together world-leading expertise from both academia and industry."

With conference proceedings to be published early next year, planning has already started for the Fourth International Conference to be held in 2011 in the Americas.



PowdermatriX welcomes Danish Nadeem to the Associate Scheme

Danish, a recent graduate in Biomedical Engineering from Imperial College, joined the Biomaterials Engineering Group (BioMEG) at the University of Bristol in September 2008. His PhD work is sponsored by an EPSRC CASE Award nominated by PowdermatriX and Medcell Bioscience Ltd, a Cambridge-based innovative healthcare company. Danish's project is concerned with the development of bioactive glass and composites with designed architecture and macro/micro/nano-structure from powder processing. In his studies, he will explore the use of natural polymers in the fabrication of novel, interconnective bioactive composites for dental, orthopaedic and tissue engineering applications. He will be jointly supervised by Dr Bo Su (Bristol) and Dr Simon Baker (Medcell Bioscience).



A Major New Online E-learning Resource Goes Live

"Design for PM", a new online e-learning training course in powder metallurgy, went live in September. Design for PM is directed mainly at industrial designers and engineers with little or no previous experience of powder metallurgy. It consists of a series of compact modules, which will help them to design superior components/products, manufactured using the (PM) production process.

The main target sectors are the automotive, construction and light engineering industries. Four training organisations: CETIM in France, IMR SAS in Slovakia, CIMNE in Spain and Autotrain in the UK will deliver the package as part of their existing portfolios. A further objective of the course is to educate designers and engineers of the future. To this end, two of the project partners, the Politecnico

di Torino and the Universidad Carlos III de Madrid, have already incorporated some of the Design for PM content into their Mechanical Engineering courses.

The EPMA has led the two-year project which forms a key part of its ongoing promotional strategy on behalf of the PM industry. Some 74% of the cost has been contributed by the EU's Leonardo da Vinci vocational training programme, with the balance provided by the EPMA and its European PM industry partners.

The FREE online courses cover the PM Structural Parts, Hard Materials and MIM sectors. The course is now available in English, French, German, Italian and Spanish. To register online and see the course visit www.designforpm.net



Super-Critical Fluid Processing Of Drug Powders

Critical Pharmaceuticals, an SME based at Bio City, Nottingham, working with Nottingham University.

The Challenge

Blending drugs with biodegradable polymers opens up the possibility of a single injection leading to a slow release of healthcare drugs into the body over time. This avoids patients having to go through the inconvenience of daily injections.

However, where temperature is employed as part of the blending process, the biological activity of the drug can be reduced. Using a supercritical CO₂ mixing approach, the potential exists for polymer chains to be intimately mixed with active drug without the use of solvent or heat. Release of the mixture through a nozzle back into atmospheric conditions should then generate a powder. The rate of release can be adjusted to change powder particle size.

The Project

The objective of the project was to firstly gain a better understanding of how process variables (pressure, temperature, wt% drug, polymer molecular weight etc.) impact on the final particle size and morphology of powders. Final porosity of powders was seen as a key property. Powders' properties could then be correlated with performance during in-vitro and then clinical trials. Ultimately, sufficient knowledge would be gained to allow the process to be optimised / controlled for a range of biodegradable polymer / drug combinations. This, in turn, would stimulate licensing opportunities for Critical Pharmaceuticals.

What happened?

Significant knowledge was gained, leading to Critical Pharmaceuticals being able to demonstrate the reproducible production of injectable micro-particles. In addition, it was shown that the process did not adversely affect delicate protein ingredients. This has given Critical Pharmaceuticals increased confidence in approaching clients with a view to negotiating further research work.

PSA 2008

PowdermatriX was pleased to not only attend, but also to sponsor, the session focussing on nano-material characterisation at Particulate Systems Analysis (PSA) 2008. Held at Stratford-upon-Avon in early September, PSA 2008 attracted 170 delegates representing academia and industry. In addition to the expected UK delegates there was an encouragingly strong presence from Europe and the rest of the world.

PSA is a key event for suppliers and users of analytical equipment to characterise powders in the dry and wet (suspension) state. Daily plenary lectures are augmented by parallel presentation sessions covering a range of topics (for example "concentrated suspensions and rheology", "measurement of size, shape and surface structure" and "monitoring particles in processes"), poster sessions and an exhibition of analytical equipment. Phil Jackson, PowdermatriX Technology Translator, chaired the nano-material characterisation session and picked up on the wide range of analytical techniques now available. Lasers feature strongly in many of these techniques with processes such as multiple light scattering, back-scattering, second harmonic generation or simply capturing reflected images to track nano-particle motion being employed. Acoustic and electro-acoustic approaches to nano particle sizing were also in evidence.

For further details you can contact Phil on phil.jackson@ceram.com

Where is the student?

Catherine is currently writing up her thesis as well as a technical paper for publication in a prominent journal. Once her PhD is complete, Catherine plans to take a few months break to travel the world. On returning, her plans are to pursue a career in pharmaceutical R&D.

What did the company get out of it?

Thanks in no small part to Catherine's work, Critical Pharmaceuticals are currently negotiating R&D projects with 3 Biotechnology / Pharmaceutical companies. The company has also developed some specific drug products that will be the subject of clinical trials from next year onwards. Ultimately, Critical Pharmaceuticals would hope to clinch deals with larger companies on the scale-up and supply of these novel formulations. A further measure of success is the decision by Critical Pharmaceuticals to fund a second CASE award to optimise nozzle design.



Standardizing Nanotechnologies Goes Global

PowdermatriX is helping to take its work with BSI British Standards on specifying nanoparticles onto a global stage. Working with ISO Technical Committee TC229, PowdermatriX is leading work on developing the Technical Specification "Guidance on Specifying Nanomaterials".

In January 2008 BSI British Standards launched six standards dealing with nanotechnologies terminology and three guides to underpin the rapidly expanding fields of nanotechnologies and nanosciences. Areas covered include:

- Safety testing, legislation and regulation
- Worker, public and environmental safety
- Commercialisation and procurement
- Patenting and Intellectual property rights
- Communication about the benefits, opportunities and potential problems associated with nanotechnologies

The documents were developed by experts from industry, academia, Government and professional organizations, brought together by BSI. Following a ballot of the ISO Technical Committee, TC 229 Nanotechnologies, the UK, through BSI and PowdermatriX, are leading preparation of this new Technical Specification "Guidance on Specifying Nanomaterials"; demonstrating the UK's support for this emerging discipline and showing how standardization can be used to help ensure its successful global development and growth.

To download the BSI publications and find out more about BSI's work in the field of nanotechnologies please visit www.bsigroup.com/nano.

For more information about the technical specification development contact [Stuart MacLachlan](mailto:Stuart.MacLachlan@ceram.com) stuart.maclachlan@ceram.com

Healthcare – a possible new market sector for PowdermatriX members?



PowdermatriX members possess key technologies that may well find markets in medical devices in the large healthcare sector.

As well as higher technology items such as implants, surgical devices and diagnostic equipment, medical devices include disposables such as paper products, syringes and surgical instruments (an increasing market), all of which open opportunities for members from manufacturing components to supplying special powders, biomaterials and novel coatings.

A study of the healthcare sector by PowdermatriX has indicated the areas in which industrial and academic

members may be well-placed to find markets. These include:

- imaging and sensing technologies
- remote surgery
- dentistry
- drug delivery
- surface and interface design and control

The study is currently being reviewed before publication and will be available soon as a briefing document. PowdermatriX members with knowledge of the Healthcare sector are encouraged to view and comment on the draft by contacting [Bob Blake](mailto:Bob.Blake@ceram.com) on bob.blake@ceram.com or on 07961 370 116.



NEW MEMBER TO THE RESCUE!

Just prior to Technology Translator Phil Jackson making an initial visit to new member Sympatec, PowdermatriX received an urgent request for help from its host company CERAM Research Ltd.

A client company of CERAM Research Ltd, relying on a tried and trusted polymeric

binder to process their ceramic, had recently learnt that their supplier was withdrawing the product. Attempts to use alternative products had failed. One route available was for a second PowdermatriX member, Hosokawa Micron, to mill a polymeric feedstock with comparable molecular weight distribution. However, the client was unable to find out any details on the particle size distribution of the old binder and was unaware of equipment capable of accurately characterising dry powder samples with a tendency to agglomerate.

During his introductory visit to Sympatec, Phil explained the dilemma. Mark Ware, Sympatec, immediately offered to run the sample as a way of demonstrating the analytical offerings available at their new Bury offices. Using unique dispersion technology, that employs finely tuneable dispensing and dispersing technology to break agglomerates without introducing milling effects, Sympatec obtained accurate particle size distributions from both laser diffraction and dynamic image analysis. The agreement between the two techniques was impressive and CERAM's client now has a way of retaining process yields and efficiency.

PowdermatriX members interested in dry powder and suspension characterisation should be aware that Sympatec is holding an open day to launch their new UK premises early in 2009. Further details can be found by contacting [Mark Ware](mailto:Mark.Ware@sympatec.com) at mware@sympatec.com or by visiting their web-site (www.sympatec.com).

Also to learn about Hosokawa Micron's milling services contact [Iain Crosley](mailto:Iain.Crosley@hmluk.hosokawa.com) at icrosley@hmluk.hosokawa.com and view www.ceram.com for CERAM's services.



ASPECT and NASTRAC Projects started

Two Technology Strategy Board (TSB) projects that Powdermatrix Technology Translators Phil Jackson, David Whitaker and Steve Harmer helped create, have recently started.

"NASTRAC" aims to demonstrate improved advanced ceramic component properties through the creation and retention of a bulk nano-structure. Phil Jackson worked closely with Bala Vaidyanathan and Jon Binner at Loughborough University to create a project that will take initial laboratory investigations through to small-scale industrial evaluations along two supply chains that focus on barium titanate (electronic) and zirconia (abrasion / chemical resistance) components.

"ASPECT" (Advanced Surface Protection to Enable Carbon abatement Technologies), developed in response to the Materials for Energy call, is aimed at creating surface engineering

solutions to combat the increasingly arduous operating conditions for components in ultra-supercritical steam-raising boilers for power generation, which will arise as co-firing with biomass and/or oxy-fuel firing (as an aid to Carbon Capture and Storage) are adopted. The surface coating technologies to be developed will aim at significant improvements in corrosion resistance on the fire-side of the boiler components and in oxidation resistance on the steam-

side. A powerful consortium has been assembled, involving the leading boiler manufacturer, Doosan Babcock, and two major electricity generation companies, E-ON and RWE npower, with the surface engineering expertise being provided by a combination of Cranfield University, Sulzer Metco and Monitor Coatings Ltd and specialist high-temperature steam oxidation testing coming from NPL.

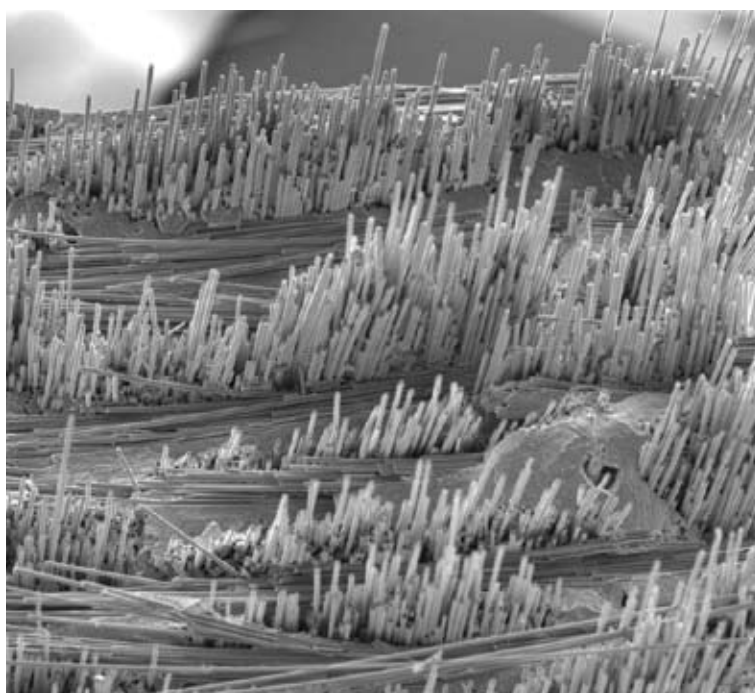
Structural Ceramics Network Takes the Lead

"Understanding and enhancing toughness" was the first of three meetings of the Structural Ceramics Network (SCERN) aiming to define the problems associated with a specific theme to be addressed in structural ceramics research.

Supported by Powdermatrix, this discussion meeting, which was attended by over 30 delegates from every part of the ceramics supply chain, built on the findings of SCERN's recently published structural ceramic roadmap.

Short presentations provoked discussion of the future research needed to widen the application of structural ceramics. Appropriate measurement of toughness, industry requirements for enhanced mechanical properties and material developments such as ceramic composites, nanostructures and increased plasticity were highlighted.

SCERN is continuing to be active after three years' support by EPSRC with two further workshops on non-destructive testing and joining of ceramics and will be producing a more detailed strategic research agenda.



For more information about the SCERN roadmap and future activities contact [Dr. Julie Yeomans \(j.yeomans@surrey.ac.uk\)](mailto:j.yeomans@surrey.ac.uk).

Dates For the Diary

Dates in Full	Event	Venue	Organiser	Contact
20th-21st January 2009	Storage and Discharge of Powders	Chatham Maritime	University of Greenwich	www.gre.ac.uk/wolfson/education
26th February 2009	4th Surface Analysis Workshop	Stoke-on-Trent	CSMA	www.csma.ltd.uk
12th -14th October 2009	EuroPM2009: Congress and Exhibition	Copenhagen, Denmark	EPMA	www.epma.com/pm2009

Add a Colleague

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Accelerating business innovation; a Technology Strategy Board programme