Society of Plastics Engineering – Annual Technical Meeting

CHICAGO, ILLINOIS May 16-19, 2004 – John Vlachopoulos, Professor of Chemical Engineering, and director of MMRI's Centre for Advanced Polymer Processing and Design, received the distinguished Achievement Award from the Extrusion Division of the Society of Plastics Engineers (S.P.E.) during SPE's Annual Technical Meeting (ANTEC) in Chicago, on May 18th, 2004.

Graduate student, Art Tinson, received the Best Student Technical Paper Award in the Rotational molding division. The title of the paper was: "The Effect of Surface Tension on the Sintering of Polyethylene Copolymers and Blends in rotational Molding". Elizabeth Takacs and John vlachopoulos were the co-authors of the paper.

A plaque and an honorarium of $1,200 was given to Dr. Vlachopulos in recognition of his contributions to polymer extrusion technology and to the plastics industry. SPE is the world's largest association of plastics professionals with membership of 25,000.

Mr. Glenn Beall presents the SPE Rotational Molding Division (RMD) Award for the best rotational molding related ANTEC technical paper presented by a student, to MMRI Graduate Student, Art Tinson.

New automotive processes

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taneously. This is the research focus of the bimetallic machining work that is currently being done at the McMaster Manufacturing Research Institute.

Machining of bimetallic materials can present a host of problems. Properly machining iron and aluminium usually requires an entirely different set of parameters for each cutting material. Therefore, to find machining parameters to suit both different materials is a challenge, as each has a very distinct mechanical and thermal behaviour. Moreover, surface integrity issues in terms of work-piece roughness, burr formation, residual stress and part dimensional accuracy are factors that further complicate the selection of optimal machining parameters.

Initial research carried out at the MMRI has shown that with proper optimisation of machining parameters, tool geometry and tool material the machining of bimetallic components can be done simultaneously. This has been found to increase productivity by 300%, provided the process stays within a very narrow operating boundary. Operation outside this boundary can lead to catastrophic failure of the cutting tool. Research also shows that a near dry cutting environment is suitable for bimetal machining operation. This can potentially reduce production cost by an additional amount of up to 30%.

Such research will improve Canadian competitiveness in the global automotive industry and help sustain our economy. The research team is funded by the AUTO21 Network and is led by Dr. Mo Elbestawi, Dean of the Faculty of Engineering at McMaster University, who coordinates the work of researchers from the University of Windsor, the University of Waterloo, Ecole Polytechnique and the University of New Brunswick. International industrial collaborators include: Honda Motors-America, Citco-USA, Sandvik Coromant-Canada, OSG-Canada and Element Six- Ireland. ■

Students from University of Hannover, Germany visit MMRI and local industry.

North America is one of the most advanced industrial areas. Many new and innovative technologies have their origin here. With the ongoing process of globalization, the knowledge of foreign countries and economies are more important for the education of students. Study trips have a long tradition at the University of Hannover as they provide a great opportunity for students to get in contact with these foreign structures and get impressions of another culture. This year a group chose the region around Lake Ontario and Lake Erie with travel to visit Dana in Peterborough, VLN Advanced Technologies in Ottawa, CSA and Pratt & Whitney in Montreal, Ingersol in Rockford, Jacobs Sverdrup in Detroit, Siemens-Westinghouse in Hamilton, and the Hydro-Electric Power Plant in Niagara Falls. Their visit to McMaster University and MMRI included meetings with MMRI Faculty, touring of the MMRI Labs, and visits to local industries. They are pictured here outside Husky with Dr. Stephen Veldhuis, Assistant Professor Mechanical Engineering, and Andrew Weaver, MMRI Graduate Student.

Heat treating

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10 million pounds of carbon dioxide and 22,000 pounds of nitrogen oxides. If we can reduce the processing time by only 10%, we could prevent about one million pounds of carbon dioxide and 2,200 pounds of nitrogen oxides from entering the environment each year.

When we consider that carbon dioxide is the gas responsible for global warming, while nitrogen oxides are the group of gases that destroy the ozone layer, that's a large benefit indeed. ■

For further information about the Thermal Processing Lab, contact Dr. Mohamed Hamed, Assistant Professor, Department of Mechanical Engineering, McMaster University, at hamedm@mcmaster.ca.

MMRI
McMaster Manufacturing
Research Institute

The McMaster Manufacturing Research Institute – one of the country's most advanced and best equipped research laboratories – combines research excellence with state-of-the-art equipment to meet the sophisticated research and development needs of leading manufacturers. Created in 2000 with more than $10 million in funding from its founding sponsors – the Canadian Foundation for Innovation (CFI), the Ontario Innovation Trust (OIT) and the Ontario Research and Development Challenge Fund (ORDCF) and industry partners – the MMRI provides a focus for high-profile research and serves as a vehicle for university-industry-government interaction. In addition, the institute promotes, encourages, and performs fundamental and applied research in cooperation with its industrial partners and provides systematic mechanisms for technology transfer and infusion of knowledge and research results.

For more information

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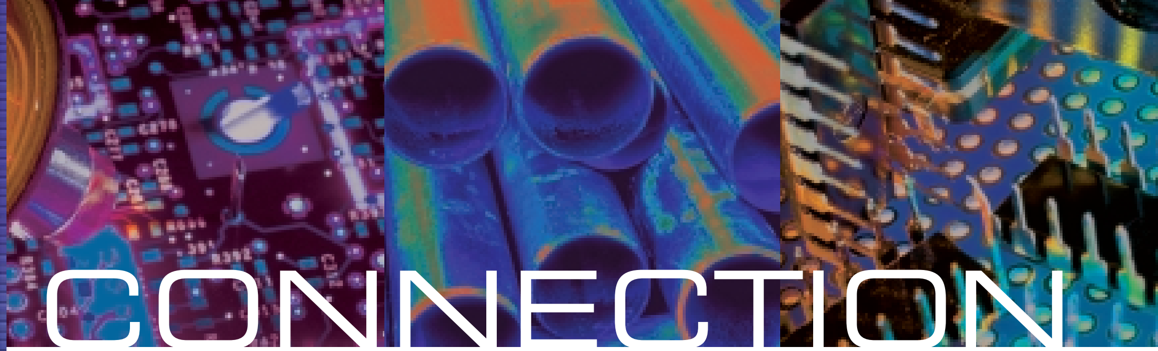

CONNECTION
Connecting University, Industry, and Government November 2004

McMaster University researchers develop new automotive processes

Stricter emission standards and high crude oil prices have forced the automotive industry to produce automobiles with better fuel economy and performance. Furthermore automotive companies must also realize significant cost saving during manufacturing to remain competitive. To address these issues new innovative processes are being developed at the McMaster Manufacturing Research Institute (MMRI).

Technology that can machine automotive engine blocks faster, cheaper and greener has been developed by a national team of researchers led by Dr. Mo. elbestawi, Dean, Faculty of Engineering at McMaster to address some of these issues. The new process achieves a 150% improvement in the amount of time required to machine an aluminium engine block. In addition to the time the new procedure saves, "it also reduces the amount of coolants normally used by 99%" said Dr. Ng, Machining Systems Lab research manager at the MMRI. Instead of using large volumes of lubricants during the cutting process, the new process uses a high-pressure mixture of compressed air and synthetic oil. Only 5ml of oil are used per hour, an amount much lower than the quantity of traditional coolant currently used, (thus making it more environmentally friendly).

Similar technology has been applied to high efficiency engine blocks based on a bimetal configuration. These configurations are made up of two separate metallic units, each occupying a distinct position in the engine. They meet the demands for light weight and high performance engines while not being as expensive to manufacture when compared to the traditional lightweight alloys used in these applications. However, the productivity levels associated with machining this design is low. In order to increase productivity and reduce production costs automotive companies must machine both materials simul-

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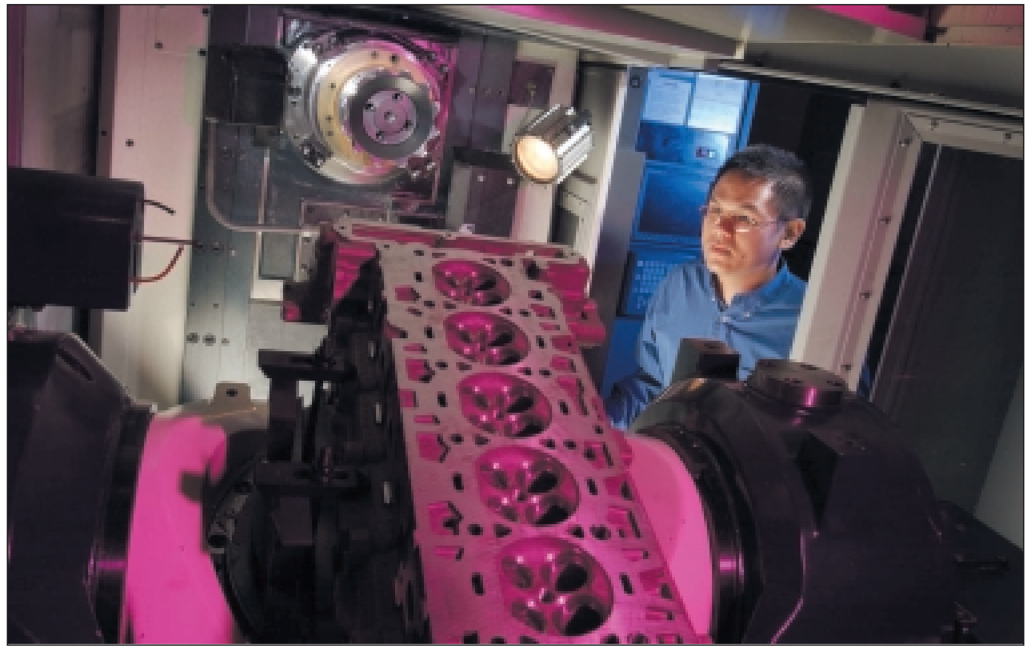

Dr. EuGene Ng, Research Manager, Machining Systems Lab, MMRI, assesses the results for machining of engine components. Photo courtesy of Auto21.

Heat Treating Industry Vision 2020 gets boost from Thermal Processing research

In September, Industrial Heating Magazine, in cooperation with the Metal Treating Institute, awarded the ninth annual 2004 Master Craftsman Award for Heat Treater of the Year to VAC AERO International, Oakville, Ontario. VAC AERO was awarded a plaque and a cash award to be used as a bursary to support education in material sciences or heat treatment. VAC AERO selected the Thermal Processing Laboratory at McMaster University as the recipient. J. Pritchard, President of VAC AERO, right, presents the award to Dr. M.S. Hamed, Director of TPL.

It's not an industry that garners a lot of public attention, but among manufacturers it gets plenty of respect. Heat treating is an indispensable process in modern manufacturing that helps us to produce stronger, lighter, more durable parts for just about any application using metallic alloys.

In North America it's a $15 billion industry. It's also energy-intensive, consuming about 500 billion cubic metres of natural gas per year. Yet, despite the industry's size and its huge appetite for energy, the processing procedures in heat treating operations are typically determined using trial-and-error methods.

In the late 1990s, leaders in the heat treating industry decided it was time to address these environmental, technology and business issues and to map out long-term goals. Their vision for the industry's future was summarized in the document *Heat Treating Industry Vision 2020*, which outlined a series of ambitious goals to be achieved by the year 2020. Key elements of that vision are:

- reducing energy consumption by 80%
- reducing process time by 50%
- reducing cost of operations by 20%
- and achieving zero (0) industry emission rates for all chemicals, heat and gases.

They also identified the areas where productivity gains could be achieved and set out a research agenda to develop technologies that would support their vision. The extensive research and development program they projected would be leveraged through collaborative efforts with manufacturers, government agencies and universities working together to implement the industry's technology road map.

Thermal Processing Lab

One of the participants in that leveraged effort is the Thermal Processing Laboratory (TPL) at McMaster University, directed by Dr. Mohamed Hamed.

Dr. Hamed has first-hand experience with the issues that heat treaters are facing. Before joining the faculty at McMaster, he worked at Can-Eng Furnaces Ltd. in Niagara Falls, the largest thermal processing equipment manufacturer in Canada. As director of research and development, he was involved in all aspects of furnace design and worked closely with customers, learning about their needs and their processing practices.

Dr. Hamed points out that there are two general approaches to improving efficiencies in the heat treating industry. The first involves developing new combustion technologies which can be used to retrofit less-efficient older equipment widely employed in the industry today. Unfortunately, this is a prohibitively expensive solution for many firms and the gains will still fall short of the Vision 2020 goals.

The other approach seeks to improve the efficiency of current heat treating operations by optimizing their processes using sophisticated software modeling. The TPL is currently working with a number of Ontario-based companies on projects precisely aimed at developing these kinds of optimization tools.

A key difficulty researchers face in modeling heat treating is that it requires dealing with many interrelated variables such as: the different types and sizes of furnaces; the shape, weight, volume and metallurgy of the materials being processed, the many possible processing temperature cycles; the compositon of the atmosphere within the furnace; the desired metallurgical outcomes; and many other factors. Traditional numerical analysis falls short in a situation like this. To deal with all these variables Dr. Hamed is investigating Artificial Neural Networks modeling (ANNS) to optimize the heat treating process. Unlike traditional analytical procedures, ANNS models have the ability to be trained using experimental data that can be generated in the lab or in the heat treater's own operations.

Some of the data that informs Dr. Hamed's models will be gathered in the MMRI's Thermal Processing Lab. The lab is furnished with a multi-purpose furnace, quench system and plasma surface treatment unit, purchased with a $331,000 grant provided by the Canada Foundation for Innovation and the Ontario Innovation Trust, with support from the Faculty of Engineering and industry sponsors.

Based on the outcome of this research, it should be possible to develop sophisticated control systems which will enable heat treating companies to perform their operations in a more efficient and energy-conscious way.

Benefits

While the most obvious beneficiary of Dr. Hamed's work is Ontario's heat treating industry, the environment stands to benefit as well. Dr. Hamed points out that a typical heat-treating operation rated at 10 million BTU/hour consumes about 72 million cubic feet of natural gas per year, producing about

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Innovative Solutions in Aluminum Casting A Focus for New Orlick Research Chair

Dr. Sumanth Shankar

The bare walls of his office and the still-empty bookshelves bear testimony to Dr. Sumanth Shankar's recent arrival at McMaster. He hasn't yet had time to unpack his books, but already the newly appointed Braley-Orlick Chair in Advanced Manufacturing has some big plans for his work at the MMRI.

An expert in the solidification processing, casting and heat treating of aluminum and other light metals, his interests neatly mesh with the research agendas of several other recent recruits to the Faculty of Engineering, which is acquiring a growing reputation for its expertise in metallurgy, casting, heat treating and metal forming.

Dr. Shankar brings to McMaster his experience as a research scientist at Worcester Polytechnic Institute (WPI) in Massachusetts, where he was involved in several projects working with aluminum alloys and was the co-inventor of a technique that enables the casting of aluminum-based wrought alloys.

Dr. Shankar's research interest – solidification processing – focuses on the process by which metals and metallic alloys transition from liquid to a solid state. Understanding how this happens has practical importance in manufacturing because the desired physical properties of the final cast part depend not only on the chemical composition of the alloy, but also the process by which the metal solidifies.

This process is particularly interesting to the automotive and aerospace industries, which would like to be able to cast aluminum alloys with higher strength to weight ratio and superior performance properties. Currently, there are a number of aluminum-based wrought alloys that have the superior physical properties manufacturers are looking for, but they cannot be successfully cast because of defects that develop during the solidification process.

Casting Wrought Alloys

The defects that arise in the casting of these alloys result from the way in which aluminum solidifies when it is poured into a mold. In the mold, the metal cools from the *outside-in*, as heat is extracted from the mold walls. As the metal cools (more quickly at its outer surface), a tree-like "dendritic" structure of solid-phase material forms in the microstructure of the metal, trapping liquid-phase material in closed spaces. It is those closed spaces that become the site of "holes" (defects) as the solidification process continues.

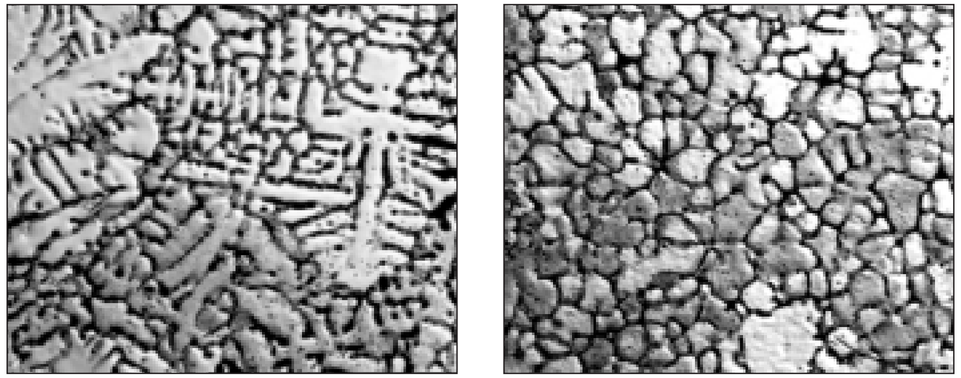
While at WPI, Dr. Shankar and his colleagues developed a novel approach to casting that disrupts the formation of this dendritic structure, replacing it with a more uniform globular microstructure where liquid phase metal is not trapped and defects do not form. This process, called *Controlled Diffusion Solidification (CDS)*, involves mixing two streams of liquid metal of different compositions and temperatures. The violent mixing process and the modified temperature gradient within the mold results in a non-dendritic microstructure that is free of the defects traditionally associated with the casting of wrought alloys.

The "Eureka" moment for Dr. Shankar and his colleagues was when they realized it might be possible to modify the casting process so that the metal cools from the inside-out, rather than the *outside-in*. By refusing to accept the constraints of traditional casting techniques they were able to accomplish what had previously been impossible. As a result, aluminum and other light-metal alloys may now find many new applications in important areas of manufacturing.

Industry Support

Dr. Shankar's pursuit of this promising line of research has the support of one of Canada's leading auto parts manufacturers, Orlick Industries. Orlick is providing financial support and has donated a die casting machine and two industrial furnaces to Dr. Shankar's lab, which will be used to continue his investigations into CDS and other related projects.

Looking toward the future, Dr. Shankar would like to see a research centre established at McMaster that addresses solidification and thermal processing issues. Such a centre would have a cross-disciplinary character, drawing on the expertise of researchers in several engineering and physical sciences departments. Critical to this vision would be support from diverse industry sources, including primary metal producers, casters, heat treaters and manufacturers, all of whom share a community of interest in the outcome of the research. ■



Optical Micrographs of cast alumminum wrought alloy samples. Image at left is from a conventional cast sample showing dendrites of primary aluminum and image at right is from a sample cast using CDS method showing globular/non-dendritic primary aluminum phase.

For more information, please contact: Dr. Sumanth Shankar, Department of Mechanical Engineering, shankar@mcmaster.ca.