JULY 2001

Center for Innovative Sintered Products

CISP

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Message from the Director

Although the Center is still very young, we have experienced many changes and are witnessing significant shifts as companies were bought, merged, sold, and acquired by each other. As with the national economy, many in industry are experiencing the impact of changes in economic growth. During these times of economic change having a trained workforce is critical for the future. CISP has responded to this short term economic impact in the very large number of students involved via scholarships, research assistantships, summer jobs, and research experience positions. With the large number of students being trained in sintered materials, CISP is enabling more rapid industrial growth. For example, Pennsylvania generates 100 new engineering jobs in sintered materials per year. Although our student output is not near that level, we recognize the value added by providing effectively trained new engineers. For every graduate, soon to approach 30 per year, there is a 20-fold increase in hourly workers. Thus every CISP graduate is leveraged 20-fold in the economy. In turn, each new manufacturing job in sintered materials results in a net economic gain of ten jobs across the community. Hence CISP's actions to increase the workforce of sintered materials engineers has the potential of generating 6,000 new jobs per year (30 engineers x 20 factory workers x 10 service economy gains). At an average income of $25,000 per year this catalyzes a net economic impact of over a hundred million dollars. By lacing together education via research, CISP is able to achieve its education goals while developing new, industrially relevant technologies.

Already some of the early research efforts are showing substantial promise, such promise will take years to reach fruition. The work on rapid tooling has the potential to impact on a fraction of the US $23 billion tooling market. Estimates of a maximum penetration of 10% by 2020 still suggest a net gain of millions of dollars per year. Likewise recently completed CISP research on sintered distended aluminum has the potential for adding hundreds of jobs for such possible uses as automobile bumpers, radiators, and safety systems-again adding $20 million to the economy over the next few years. Therefore, as we move into year 2 of operations, our emphasis on education, outreach, research and technology transfer will remain key to CISP's missions.

PENNSTATE *Center for Innovative Sintered Products*

Upcoming Events

August 8
P/M MetLab
State College, PA

September 18 –19
PIM Tutorial
State College, PA

September 26
Sintering
Ridgway, PA

October 15
Sintering Topic
Roundtable Workshop

October 15-16
Industry Member Meeting

October 24
P/M Processing Part 1
Ridgway, PA

October 31
P/M Processing Part 2
Ridgway, PA

MET LAB
Metals Laboratory Workshop

A one day workshop will be offered at University Park on 8 August 2001. This course will cover the evaluation of metal powders and parts by providing a background of information and theory, interspersed with demonstrations. Topics range from powder testing and carbon control to metallography and mechanical testing, along with hands-on demonstrations. Contact: Susan Beyerle at scb4@psu.edu or Kristina Cowan at kcc126@psu.edu.

Executive Director Message

It does not seem possible that our first year is drawing to a close. This year has proved both challenging and rewarding as it provided me the opportunity to to build and evaluate the Center. During this past year I have seen a change in the industrial environment as the market shifted. Keeping the Center on target is more critical than ever. The Center is now a flurry of activity as we are now into the summer program and have over 60 graduate and undergraduate students. Our continuation proposal for year 3 funding in the amount of $1 million was recently submitted to Pennsylvania Technology Investment Authority. I anticipate hearing the results of the request in early December. This will allow us to recruit top-notch graduate students during the prime recruiting period. To make sure the Center is meeting the needs of the industry I intend to focus much of my attention on corporate contacts via direct meetings and follow-up. This will be no simple task as the Center is so large, but the long-term vitality will depend on listening and meeting the needs of our members.

Research Update

One of the major changes in our operations as we transition from year 1 into year 2 is the restructuring of our research. As a result of an increase in new members and changes to our current membership we changed our research portfolio slightly. The Center will fund more projects while approximately keeping the budget flat. This will allow for more projects that can benefit industry members in the short-run. While projects are still grouped into three thrust areas and one cross-thrust area, we have expanded our portfolio to meet industry needs as proposed by members. New areas that CISP will expand into include additional in-situ monitoring and control, precision concerns in powder injection molding, new finishing techniques for sintered products, innovative spark plasma sintering investigation, the machinability of sintered products, and the processing and properties of high strength alloys. Coupled with continued projects this gives CISP a broad portfolio of research projects to support the sintered materials industry through new technology and expanded markets. For additional information on CISP sponsored projects or an opportunity to mentor a project, contact: cisp@psu.edu

THE PROJECTS

- Laminated Metal Carbide-Binder Structures for High Performance Cutting Tools
- Fundamental Studies of SPS sintering
- Machinability of Sintered Metals
- Experimental Documentation of Status of Rapid Tooling Technologies for PIM Dies
- Chemical-Vibro-Mechanical Mass Finishing/Polishing
- Multiple Axis In Situ Monitoring of Dimensional Changes in Debinding, Delubrication, Sintering, and Heat Treatment
- Dimensional Producibility of High Precision Sintered Components
- Lubricant Effects on Green Density Gradients and their Relation to the Dimensional Precision and Properties of P/M Components
- Dimensional Control of Stainless Steels, Titanium, and Superalloys
- Qualification of High Strength P/M Alloy Laser-Ultrasonic Sensors for "In-situ" Monitoring of the Sintering Process
- Process Enhancements for Powder Injection Molding for Six Sigma Precision
- Enabling Technologies for Mass Production of Powder Injection Molding
- Sintering Process Simulation for Dimensional Control (formerly: Model for Thermoelastic-Viscoplastic Material Simulation of Sintering)

Dimensional Control
of Stainless Steel, Titanium, and Superalloy

CISP researchers, Don Heaney and Neal Myers will begin a study on variables effecting dimensional control of stainless steel, titanium, and superalloys in July. Carbon, oxide level, oxygen species, alloy content, and furnace atmosphere oxygen level all play an important role in the sintering response of these alloys. In this study, the dependence of these variables and combinations of variables on dimensional change will be investigated. Methods will be developed to compensate for dimensional variations imparted by variations in powder chemistry, oxygen species, and processing binder/lubricant residues. These methods may include additions to the powder, altering the partial pressure of oxygen or carbon potential in the furnace atmosphere, and heating schedule modifications. For more information contact: Don Heaney at dfh100@psu.edu or Neal Myers at nsm104@psu.edu.

Qualification of High Strength P/M Alloys

An industrially important high strength ferrous alloy system will be powder processed and evaluated for mechanical behavior response. A process map will be developed to establish the relationship between process conditions and mechanical properties. The process conditions will consist of raw material selection, compaction pressure, alloy addition type and content, and sintering conditions, while the properties evaluated will establish the influence of processing on the resulting strength and fracture resistance. The relationships between processing, microstructure, failure mode, and properties will be identified. The end product of this effort will be the process/properties relationship for a class of industrial selected alloys. This tool can be used to justify and qualify alloy and process improvements. Contact: Don Heaney at dfh100@psu.edu or

Testing Tailored to your Requirements

As part of the testing and services offered by CISP, the Material Testing Systems (MTS-318.10) is capable of doing a full line of fatique, tensile and compression studies. For complete property testing of your part or speciman contact: Lou Campbell-lgc102@psu.edu

Chris Scott, undergraduate prepares a tensile bar for fatigue testing.

Official NSF/REU Site

CISP was recently awarded ($260K for three years) a Research Experience for Undergraduates (REU) site by the National Science Foundation. Under the direction of Dr. Renata Engel, Associate Director of Education this ten week summer program will host ten students representing nine universities across the United States. The program attracts undergraduate engineering and materials science students nationally for participation in the research projects of the Center. A rich program that engages them in research, provides technical content seminars, instruction in research methods, and an introduction to the industry via industrial tours has been developed that will tie together the gas suppliers, raw material suppliers, equipment manufacturers, fabricators and end users. In addition to attending a professional two-day short course on powder characterization, the students will receive instruction in sintering, rapid prototyping, wear and machining, intellectual property, and powder injection molding.

Multiple Axis In Situ Monitoring of Dimensional Changes

Debinding and sintering are tremendously important steps in powder metallurgy, especially when there are density gradients, thermal gradients, setter drag, or phase transformation induced dimensional changes. Scheduled to begin in July under the direction of Randall German an environmental laser dilatometer will be built for in situ monitoring during debinding and sintering. This will provide first-hand guidance to cycle design, component geometry modification, and forming process improvement. The connection between microstructural variations and macroscopic dimensional changes will be established. This will provide important information for differential shrinkage, warpage, and cracking commonly seen in sintered products. Since increased precision can open significant new markets CISP has focused new efforts to compliment existing efforts in the area. Contact: Rand German at rmg4@psu.edu

PSU

Kennametal Team, Spring 2001

Team Members are (L to R):Laney Jordan, Esli Feliz, James Woods, Meghan Scanlon, Kennametal's Design Project Manager, Gary Condon, Sherry Brimmeier.

A very successful experience was shared by a team of undergraduate students and CISP member, Kennametal, who sponsored a Senior Capstone Design Project. The team was responsible for developing a more efficient identification and testing procedure for in-service mining tools. The group of five students won an honorable mention award for their website design (http://www.me.psu.edu/me415/spring01/Kennametal/), second place for their poster and also second for best process. Here are some things that they had to say about the experience. "This project was a great experience and is a vehicle to help students get more involved in projects that are actually done in industry" "It was a wonderful learning experience with hard work, long nights, and tremendous rewards." "This project provided an opportunity to work with a company and learn about that company and their products, something that is not offered in other classes." "This project allowed me to get to know my classmates and others in different majors, while gaining valuable industry experience".

Scholarship Winners

The Center recently awarded the CPMT-Clayton Family Scholarship for Studies in Powder Metallurgy and the AMETEK Scholarships to Mr. Brian Marx and Mr. Patrick Hahn. Brian is a senior in Material Science and Engineering with a metal science option. Patrick is a junior majoring in Mechanical Engineering and Nuclear Engineering. Patrick is also a Center student and is currently working under the direction of Dr. Joseph Rose in the Ultrasonic NDE Lab. He has worked with Dr. Sundar Atre on performing sound velocity measurements on green parts. Congratulations to these outstanding undergraduate winners.

CISP Profiles

Dr. Chantal Binet

Chantal Binet joined CISP on 1 June. Dr. Binet gained industrial experience as a research and development project engineer for SNC Technologies, Canada. She holds a PhD in metallurgical processing from University of Quebec in Chicoutimi: practical processing, computer modeling using finite element and experimental validation studies and a Masters in metallurgical processing at École Polytechnique de Montréal. Dr. Binet's areas of expertise include solid/liquid and solid/gas reaction, kinetics and thermodynamics, semisolid processing, design of experiments, transport phenomena (heat mass and movement), rheology of suspension and mixing in multiphase chemical reactors. Areas of interest include process modeling of thermodynamics and kinetics, transport phenomena, laser technology, and coating. Contact: Chantal Binet at cub9 @psu.edu

Debby Blaine

Debby Blaine is studying for her PhD in Engineering Science and Mechanics. She started at Penn State in Fall 2000 and is focusing her research on a computer simulation of sintering kinetics. Debby is from Cape Town, South Africa where she studied for her Bachelor and Masters degrees in Mechanical Engineering at Stellenbosch University. Through the course of her studies she has worked in various fields from computational fluid dynamics, to power generation using solar chimneys, to optimization of cooling towers. Currently she is working with ABAQUS and using the dilatometer and other tools in the lab to develop rheological models for sintering.

MPIF Conference

16 CISP Faculty, researchers and students recently attended the MPIF 2001 International Conference on Powder Metallurgy and Particulate Materials (PM^2 Tech2001) in New Orleans. Over 1200 people attended the 4 day international conference. The program featured a technical program of 300 presentations showcasing the latest in metal powders, P/M processes and applications. The conference also included approximately 90 exhibitors.

MPIF Poster Awards

Researcher & students recognized:

Lou Campbell, 1st place in the R&D division. "Microstructural Causes of Variations in Dimensions and Mechanical Properties of a Wear-Resistant Material".

Ravi Bollina, 2nd place in the student category for "Evaluation of solder joints fabricated by firing a lead free solder".

Brian Marx, 3rd place in the R&D category for "Macropore Evolution in Microgravity Sintered Sample".

Thinking of Joining CISP. Vist our web site at:

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