December 2000

Center for Innovative Sintered Products

CISP

The Pennsylvania State University
P/M Lab, 147 Research West
University Park, PA 16802-6809

Phone: (814) 865-2121 • Fax: (814) 863-8211 • E-mail: CISP@psu.edu • Web: http://www.cisp.psu.edu

Upcoming Events . . .

CISP

Feb. 28 - March 2, 2001
PIM 2001 Conference
Orlando, FL

March 15, 2001
Ferrous Powder Metallurgy Short Course
Ridgeway, PA

March 19-20, 2001
Understanding Binders & Lubricants
State College, PA

March 20-21, 2001
CISP Industry Member Meeting
State College, PA

April 12-13, 2001
PIM Tutorial Spring 2001
Atherton Hotel
State College, PA

April 19, 2001
Sintering Theory
Ridgeway, PA

MPIF

Dec. 5-6, 2000
Hot Isostatic Pressing Seminar, Crowne Plaza
Columbus, OH
(614) 461-4100

Dec. 7-8, 2000
P/M Industry Technology Roadmap Workshop
Hilton at Walt Disney W.
Lake Buena Vista, FL
(407) 827-4000

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Message from the Director

Now that CISP is an official entity, many shifts in our attention have occurred. Most important was the first cycle recruiting of new students. This was at the same time that CISP was undergoing restructuring to become a fully independent entity in the College of Engineering. We have been in a constant process of membership solicitation to gain broad support for our mission - including many company visits, networking through the University, and reporting to the Pennsylvania Technology Investment Authority. Further, we have finalized partner agreements withmany research organizations, professional societies, and trade associations. This was during a period of significant personnel changes. We now have the first faculty position for CISP and excellent resumes from investigators are arriving in response to the opening.

Many small corrections and redirections are taking place as CISP matures and reaches steady-state. Clearly, one of the industry priorities is an enlarged pool of talented young engineers with skills in powder processing technologies. The dynamic industrial environment is constantly causing changes in our membership profile as companies are bought, sold, merge, and acquire each other. To offset the impact from such changes, I have focused much of my attention on corporate contacts via direct meetings with about 20% of the member companies in this first quarter of operation. Meetings have been arranged with 12 (non-member) candidate companies to promote CISP participation and that is having fruition with about 50% success in gaining new members. The new laboratory service component of the CISP mission has been an outstanding success with many member companies taking advantage of this mail-in analytical service. To further broaden the impact of CISP, we have participated in technical conferences scheduled by many professional groups (ASM, TMS, MPIF, SME, ACerS, PSU, and so on) and that has helped with reaching out beyond our current membership. Thus, it has been a busy time and we are still collecting input, refining the program balance, and listening to members. These are not simple tasks, but the long-term vitality of CISP depends on recruiting top quality faculty, students, employees, member companies, and partners. As always, your insight is valuable and please feel free to provide guidance in ensuring CISP meets your needs.

Randall M. German

Seeking Industry Partners for Compaction and Sintering Simulation Project

In CISP, there is a small group of people working on integrated computer modeling for sintering processes. Activities include finite element analysis for cold powder compaction, sintering, and heat transfer; stress and thermal fatigue investigation for composite materials; computational fluid analysis for powder injection molding; software development for sintering processing and microstructure reconstruction.

We are currently looking for industry partners for the following two projects:

1. "Process Specification for Powder Metallurgy Component Fabrication to Target Features & Quality: An Inverse Problem," funded by National Science Foundation (NSF), finite element simulation of cold powder compaction.
2. "Model for Thermoelastic-Viscoplastic Material Simulation of Sintering," funded by CISP, finite element analysis of sintering process.

The partner(s) will provide real industry parts and parameters to testify and calibrate the numerical models. At the same time, our models will provide the first hand information of density variation, possible flaw position, stress and strain distribution, inhomogeneous shrinkage, and distortion profile. Contact Yang Liu (yxl21@psu.edu).

Rapid Prototyping Production

CISP is leading the way in rapid prototype productions under the guidance of Donald F. Heaney, (dfh100@psu.edu) the Center's Director of Process Development. Test vehicle parts in quantities of 10 to 20 are being fabricated directly from CAD files. Different materials are being used to fabricate complex geometries with controlled properties such as porosity and density. Rapid prototyping of powdered metal parts is opening the door for the production of complex geometries with some very unique properties that were never before attainable.

Lou Desanzo inspects a part made in the DTM machine.

Selective Laser Sintering of Aluminum

This cooperative program between DTM Corporation and the P/M Lab aims to create complex three dimensional parts in DTM's Sinterstation systems from an aluminum-based powder. The green parts will be built layer by layer in the Sinterstation by melting the admixed binder with a laser, then sintered to near full density in a retort furnace. The total processing time will be less than three days, starting with a CAD file for the geometry. Sintering of aluminum powder in the absence of compaction is difficult due to the stability of the aluminum oxide layer on each particle, requiring sintering aids to compensate. Other challenges include selection and amount of binder, flow properties of the powder – binder mixture, and Sinterstation parameters. This work is undertaken by staff researcher Neal Myers (nsm104@psu.edu) and Randall German (rmg4@psu.edu).

Producibility of High Precision Sintered Components Project Update

Customer demands for tighter dimensional tolerances on PM parts continues to grow. Similarly cost reduction drives the goal of reducing or eliminating post-sintering repressing operations. Two specific research areas must be addressed before these goals can be reached.

Participating companies for this CISP sponsored Productiblity of High Precision Sintered Componets project have been identified and initial dimensional and process control data has been collected. Companies are providing both green and sintered parts for careful studies along with corresponding process data, powder data and tooling information. Strategies for error budgeting have been developed. To inquire about direct participation contact Michael Sherwin (mds210@psu.edu) or Robert Voigt (rcv2@psu.edu).

Service and Testing Facilities

With CISP absorbing the P/M Lab, the service and testing facility is busy as usual. Enjoying a strategic position within the university, the Center offers its members a wide variety of tests and analyses at a not-for-profit cost, with CISP members receiving a 10% discount.

The most routine tests requested are particle size distributions by laser diffraction on ferrous and alumina powders, densities, determining optimum solids loading of powder-binder mixtures by torque rheometry, and metallography for microstructural evaluation of sintered parts.

Recently requests for work have included SEM on fractured surfaces, Archimedes density on superalloy material, and surface area and pore size distribution on a catalyst material. Our Coulter SA3100 placed in the lab by Beckman Coulter allows us to analyze surface area ranging from 0.01 m2/g to 2000 m2/g and can also measure pore size radius ranging from 1.5 to 100 nm. The Pascal 140 and 440 mercury porosimetry units placed in the lab by Horiba Instruments operate over a range of 0-58 psi (0.1-400kPa) on the low pressure unit, and from 15 to 58,000 psi (0.1-400MPa), respectively. Used together they can measure pore size radius ranging from 58,000-1.8nm. Both of these instruments accept samples in powder or solid form.

If you have samples you are considering or anticipate testing, contact: Lou Campbell (lgc102@psu.edu) or Kristina Cowen (kcc126@psu.edu) at 814-865-2121.

American Ceramic Society Donation

The Student Branch of the American Ceramic Society is actively involved in spreading the materials science message to communities throughout Pennsylvania. In the past six months, the students have conducted a number of fund raisers to purchase and distribute several dozen copies of Larry Hench's Boing Boing the Bionic Cat and Dave Richerson's The Magic of Ceramics to local libraries and schools. This is an ongoing educational outreach activity spearheaded by our students. If you wish to help in their endeavor, donations to permit the purchase of more books can be sent to John Hellmann, 133 Materials Research Lab, University Park, PA 16802.

Pictured is Debby Blaine PhD Candidate from South Africa

Large Volume Atmosphere Retort

Due to the P/M Labs requirements for large volume low temperature sintering and debinding a need arose for a larger retort. Until recently the P/M lab only utilized atmosphere capable metallic muffle retorts with a maximum temperature of 1100°C. These retorts had a maximum volume of 0.2 cubic feet, which greatly limited the size and quantity of parts that could be processed. The requirement to be able to process larger parts, driven primarily by efforts in the rapid prototyping area, further reinforced the need for a larger furnace.

In searching for a larger retort furnace we found that to get a furnace to fit our needs, the best avenue was to build our own. Our new retort started with heating elements and temperature controls purchased from a furnace company specializing in ceramics processing. Inconel and mild steel were chosen for construction of the retort muffle. The muffle was constructed of corrugated inconel with the lid and flanges constructed of mild steel. Viton o-rings are used to provide a seal between the lid and muffle to allow gas tight operation, which is vital in the thermal processing of metals.

The volume of the new retort is 5 cubic feet with the capability to operate in inert and/or combustible atmospheres. With a maximum continuous operating temperature of 950°C this retort can easily debind all binder/lubricant systems. Metallic systems that have lower sintering temperatures such as aluminum and bronze can also be processed. For additional information contact Tracy Potter at (814) 863-8209 or (tjp4@psu.edu).

Industry Member Meeting:

The first Industry Member Meeting after begining full operations was held on 3-4 October 2000 at the Nittany Lion Inn, University Park, PA. Approximately 90 faculty, students and industry representatives attended. The next meeting will be 20-21 March 2001 at the Nittany Lion Inn.

Understanding Binders and Lubricants

A 2-day workshop, "Understanding Binders and Lubricants" will be held on 19-20 March, 2001 at Penn State. The workshop will be on the principles and applications of organic additives used in powder consolidation. These additives are variously referred to as binders, lubricants, dispersants, solvents and surfactants, depending on their use in various segments of the powder industry. The central theme of the workshop is to appreciate the similarities while recognizing the differences in the function of these additives when used in a broad range of materials and manufacturing techniques. The materials include metal and ceramic powders. The manufacturing methods include the traditional powder consolidation methods of die compaction, slip casting, tape casting, and spray drying as well as the relatively newer technologies involving powder injection molding and extrusion. The physical and chemical principles and properties governing the selection and function of the organic additives will be explained in the context of the materials and manufacturing techniques.

The most important benefit from this course is to enable people already familiar with some form of powder processing to understand the principles relevant to their own technology while providing them the knowledge to take advantage of other opportunities in related manufacturing sectors. The relationship of various processing and materials considerations to the vast industry of filled polymers will also be introduced. The classroom lectures will be complemented by a 3-hour lab session involving demonstrations and one-on-one discussions. For further information, please contact Sundar V. Atre (814-865-2121, e-mail: sva101@psu.edu).

Upcoming Events . . .

MPIF

Jan. 16-17, 2001
Board Orientation & Strategic Planning Meeting, Hyatt Sarasota
Sarasota, FL
(941) 953-1234

Feb. 6-7, 2001
Compacting/Tooling Seminar, ONNI Charlotte
Hotel, Charlotte, NC.
(704) 377-0400

Feb. 27-28, 2001
Secondary Operations Seminar
Hyatt Regency.
Louisville, KY
(502) 587-3434

March 14-17, 2001
PMEA/APMA Winter Business Mtg.
Marco Island Hilton
Marco Island, FL
(941) 394-5000

March 18-21, 2001
PMPA Winter Bussiness Meeting, Renaissance Valley Resort.
St. Petersburg, FL
(727) 894-1000

March 28-29, 2001
MPPA Winter Meeting
Sheraton Atlantic City,
Atlantic City, NJ
(609) 344-3535

April 18-20, 2001
Spring Board Meeting
-TBA-

In-situ Sintering Study through Atmospheric Laser Dilatometer

In-situ sintering research has been tremendously important in the powder metallurgy industry, especially when there is phase transformation induced dimensional changes. Routinely, push-rod dilatometer is employed to monitor dimensional variations during sintering. However, a force is unavoidably applied to the sample and can change the process of sintering. Also, only the generalized dimension at one location can be identified. With the advancement of technology, non-contact measurement is becoming extremely important. Non-contact laser dilatometer has shown proven success in the ceramic area. Huge potential exists in powder metallurgy for in-situ sintering study. The goal of this proposal is to provide this versatile tool on a wider prospect, which includes nitrogen, argon, and hydrogen atmosphere sintering. The sample dimensional change will be monitored along the length of the sample rather than at one specific position. This provides important information for differential shrinkage, warpage, and cracking commonly seen in sintering industries. The connection between microstructural variations and macroscopic can thus be established. Contact: Kathy Lu (pklu@psu.edu).

Students Corner

Jeremy Miller is planning on graduating in December 2000 with a degree in Mechanical Engineering. His hometown is Bedford, PA. With interests in internal combustion and automotive design and manufacturing, Jeremy has worked at the P/M Lab since May 99 as a hands-on engineer with materials processing experience. Under the direction of Tracy Potter, Jeremy has assisted in the maintaince and repair of the Gasbarre press, stokes mechanical press, M.R.F. vacuum furnace, C.M. retorts and pusher furnace. He has experience in metallography, binder and sintering systems and the microwave sintering of P/M parts.

Experience for Undergraduates:

The Center's Associate Directors of Education and Research recently submitted an NSF proposal to secure funding for a 3-year Research Experience for Undergraduates Site. If funded, the 10-week program will attract students nationally, and include instruction in powder processing, research methodology, seminars and discussion groups to raise awareness of the industry, and significant opportunities for research practice.

WuWen Yi is planning on graduating in December 2000 with a Ph.D. He has accepted a job offer from Honeywell in Spokane, WA. His area of research is microstructure manipulation to achieve densification without distortion in liquid phase sintering.

Thembani Togwe is planning on graduating in December with a Masters Degree in Engineering Science. His studies are in rapid tooling, rapid prototyping and powder injection molding. He is currently interviewing for a position.

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Dr. Randall M. German, Director
Phone: 814-863-8025
e-mail: rmg4@psu.edu

Dr. Paul H. Cohen, Assoc. Dir.- Research
Phone: 814-863-2357; e-mail: phc3@psu.edu
Dr. Renata S. Engel, Assoc. Dir.- Education
Phone: 814-865-3164; e-mail: rengel@psu.edu
Dr. Irene J. Petrick, Assoc. Dir.- Tech. Transfer & Comm.
Phone: 814-863-7133; e-mail: ijpetrick@engr.psu.edu

For additional information contact
Ms. Sharon L. Elder, Executive Director
Phone: 814-865-1914, e-mail: CISP@psu.edu