October 2001

Center for Innovative Sintered Products

CISP

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Message from the Director

The world is fragile and human life is precious. In the last few weeks we have seen the best and worst of mankind. All of us were affected by the tragedy and want to thank the many international friends who passed on their sympathy. It is in times like this we must reflect on our priorities, values, and vision.

With regard to vision, we have noted a dramatic shift in sintered materials. Historically, the largest consumers of sintered technical materials were for applications in metalworking, automotive, lighting, and lawn and garden industries. These were largely intended for use as mechanical components and were differentiated by their ability to carry high loads and endure in severe environments. Now there is a dramatic shift. First precursors came about 10 years ago when the data storage field started to use sintered materials for disk drives, sputtering targets, and recording devices. This has been followed by growth using sintered materials in magnetic recording, capacitors, instrumentation and sensors, hybrid microelectronics, cellular telephones, thermistors, varistors, and other electronic devices. This shift was first evident in ceramics, where sintered electronic ceramics have exploded, as evident by the annual meeting of the American Ceramic Society. Now the annual American expenditure on electronics has passed that for automotive, ranking second only to the expenditure on food and housing. Likewise, the financial advisors are telling us that medical care and pharmaceutical production are the next financial waves - these economic segments have shown the characteristics during the downturn to lead during a recovery. So how do these factors impact our long-range planning in CISP? We feel CISP must focus our teaching, research, and education-outreach on the employment prospects for the future. Accordingly, we are looking at expanded activities in medical, life science, electronic, magnetic, and instrumentation applications.

CISP is now engaged in company proprietary projects associated with controlled porosity heat pipes for electronics, controlled filtration systems for separation of protein molecules, glass-metal electronic packages, high heat dissipation materials for microelectronics, high performance magnets, and foamed materials for energy absorption. We have even performed first experiments looking at fuel cell fabrication via die compaction and now see enormous possibilities in sintered aluminum for the postage-stamp sized disk drive (1 GB capacity). Although these are hard times we want to convey a positive sense for the future. Our member companies can be best served by our efforts to identify and structure growth toward these future opportunities. Now we are thinking through strategies to help our members identify appropriate opportunities, while reflecting on a very crazy world.

PENNSTATE

Center for Innovative Sintered Products

EXPANDING the Boundaries

The Center was recently awarded 3,500 square feet (325 square meters) of additional space in Research West. This brings the total space for the CISP - P/M Lab to over 20,000 square feet (1,858 square meters). The space will be used to house additional research equipment and offices. Some of the recent acquisitions that will occupy the space is the Arburg model 270 S 250-60 injection molding machine, Lödige Ploughshare dry blending and mixing machine and the KYK Oxynon furnace.

Upcoming Events

October 15, 2001
Industry Member Meeting

October 24, 2001
P/M Processing Part 1
Ridgway, PA

October 31, 2001
P/M Processing Part 2
Ridgway, PA

February 25-26, 2002
Industry Member Meeting

March 18-19, 2002
PIM 2002
San Diego, California

May 13-14, 2002
Understanding Binders & Lubricants
Vienna, Austria

Coming Spring 2002
Fundamentals of Powder Compaction
Advanced Powder Injection Molding
Metallography

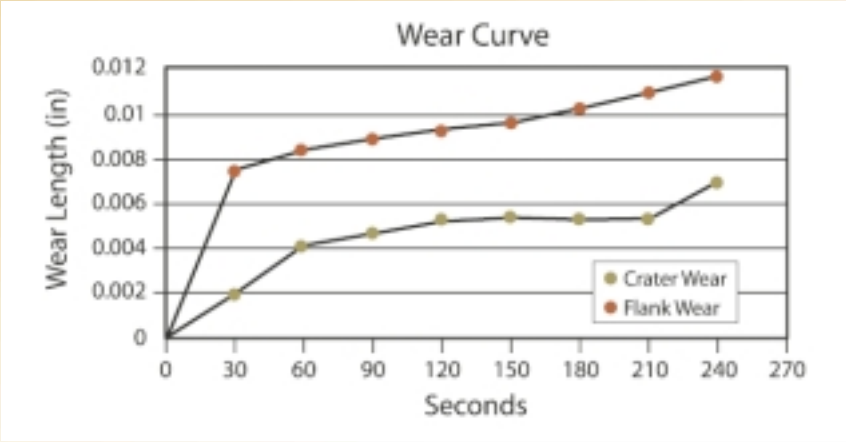
CM Furnaces Hydrogen Box Furnace

The P/M Lab at CISP took delivery of a CM hydrogen box furnace in mid August. With a hot zone capacity of one cubic foot this furnace will provide the Center with even greater sintering capacity. This furnace is capable of a maximum operating temperature of 1400°C. Temperature control is accomplished with a 2400 series Eurotherm temperature controller allowing for many different combinations of heating rates and hold times. If you have any questions about this furnace please contact Tracy Potter at (tjp4@psu.edu) or Mike Laing at (cmfurnaces@aol.com).

Pictured is Thomas Fisk undergraduate in Mechanical Engineering.

Micrograin and Nanograin Cutting Tools

The Laminated Carbide Structures project has recently partnered with a Japanese company marketing an innovative sintering process to produce nanograin carbide tools. This project extension has developed wear curves for "standard grain" (2∝m) WC-Co tools with 6% Co in the machining of Ti-6-4. Two micrograin tools have already been tested but yielded inferior results. Several nanograin tools using hot pressing and spark plasma sintering have been successfully fabricated and the results will be presented at the next member meeting in October.



Sintering Simulation Research

Sintering simulation research has advanced due to improvements in the representative constitutive model, particularly with regard to the viscoelastic response. Over the past several months, the research team has been examining the effect of particle size distribution on the shrinkage and grain growth during sintering. The two dimensional sintering model has incorporated the material parameters associated with particle size distribution, i.e., the viscosity. The model now includes viscosity as an exponential function of temperature. The porosity is updated during the simulation. Gravity, thermal expansion and other heterogeneous factors are also considered. Efforts to measure the cross-sectional density distributions, and the axial and radial shrinkage, and correlating those results to the input material parameters are underway with preliminary findings showing excellent agreement with the numerical predictions of the axial shrinkage for 316L stainless steel cylindrical parts.

The research team acknowledges the material contributions of N.A. Höganäs and Hoeganaes, the discussions on compact modeling with Spang Magnetics, and the optical metallography assistance from Struers. Contact Renata Engel at (rse1@psu.edu).

Green Machining

Recent work in green machining has produced interesting results. This preliminary study has done initial cutting on 316L stainless, M2 tool steel, FeNi, alumina and a new proprietary material. Video tapes of the cutting process have revealed differences in material removal mechanisms and the role of binders as well as grain size and shape. Milling tests have measured cutting forces and surface finish as well as the impact of climb versus conventional milling. Additionally, the minimum feature and step size have been determined for some materials. Future work will focus on new materials and the determination of final machining conditions for the manufacture of parts and dies. For more information contact Sundar Atre (814-865-2121) or Paul Cohen (814-863-2357).

INDUSTRY MEMBER MEETING

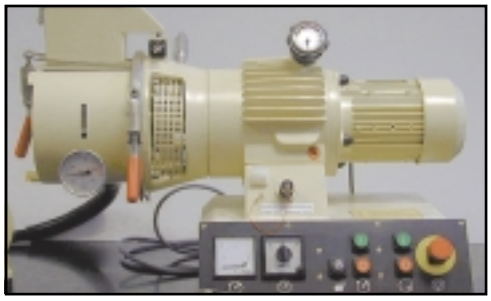
15 October 2001
Nittany Lion Inn
University Park, PA

- Research Updates
- Collaborations
- Panel Discussions
- Poster Sessions
- Outreach & Education

New Powder Injection Molding Machine Arrives

Arburg GmbH has consigned a second injection molding machine to CISP. This second molding machine is a model 270 S 250-60 that, like the previously consigned machine, is specifically instrumented for PIM. It is equipped with a position-regulated screw, wear resistant screw/barrel assembly, and a torque limiting screw/barrel assembly. This action by Arburg reaffirms their commitment to the PIM technology and to CISP as one of the premier places for the development of PIM technology. We are excited to have this new machine here since it will be used in the Center's Six Sigma Project to understand the dimensional reproducibility of the PIM process. We will also be using this machine to evaluate and develop other emerging PIM technologies such as controlled porosity, new materials, and co-injection. For information contact: Donald F. Heaney (dfh100@psu.edu, 814-865-2121).

Ploughshare Batch Mixer at CISP



Lödige Process Technology has installed a Ploughshare Batch Mixer at CISP. The mixer uses a mechanically fluidized bed to achieve complete mixing action of liquid and solid ingredients. The batch temperature can be controlled by using a heating or cooling jacket. The equipment can also be used for drying and agglomeration operations. One project is underway to evaluate the mixer for lubricant-powder blends for die compaction. Another project is planned to evaluate homogeneity of mixtures of powdered metals. The mixer can be scaled from 5 liters to 15,000 liters. For further information, please contact: Sundar V. Atre (sva101@psu.edu, 814-865-2121).

ARCiNA
AUSTRIAN RESEARCH CENTERS
in NORTH AMERICA

Austrian Research Center

Sharing costs and work force, Austrian Research Centers has located Rudolf Zauner and Gunter Igler in the P/M Lab at CISP. The ARC joined CISP in February 2000 and recently founded their US branch ARCiNA (Austrian Research Centers in North America) at University Park. A joint research project has begun on the precision and dimensional variability of 316L PIM parts (project title: Process Enhancements for Powder Injection Molding for Six Sigma Precision). The goal of the two-year project is to develop an experimentally verified model for quantifying and predicting the dimensional variability induced by raw materials, feedstock preparation, molding, debinding and sintering. The project, which officially started in July 2001, is well under way with the first results expected by the end of this year. The anticipated first result will be a "baseline" process capability for standard process conditions and raw materials. Contact information: Donald Heaney (CISP) dfh100@psu.edu or Rudolf Zauner (ARCiNA) rcz1@psu.edu

NSF/Research Experience for Undergraduates (REU)

Ten participants representing 9 universities recently completed the first of the ten-week REU programs to be offered by the Center. The three year program is open to undergraduate engineering and material science students nationally for participation in research projects, seminars, research methods instruction, and industrial tours. This first group of students had little or no prior knowledge of sintering. Each student completed the program by presenting experiences from their specific research project. Acting as ambassadors for the industry, they will present the same program at their respective universities.

We would like to give a special acknowledgement to the companies who were able to provide the students with industrial tours. This visual understanding offered most of the participants the first glimpse of the industrial world. A special thank you to: Gasbarre Press, DuBois, PA; Sinterite Furnace, St. Marys, PA; Kennametal, Labrobe, PA; AMETEK, Eighty Four, PA; Air Products & Chemicals, Allentown, PA; and GKN, Emporium, PA.

REU student, Rollie Leeman from the University of Minnesota, works on samples for the Green Machining research project

New Faculty Hire

Dr. Ivica Smid

The Center is pleased to welcome Ivica Smid to a tenure track faculty position effective 1 January 2002. Dr. Smid has been with Austrian Research Centers Seibersdorf since 1990. He worked in numerous fields of materials R&D, including modeling and materials selection, development of components for high-temperature/high-heat-flux applications, optimization of industrially relevant production processes for hard metals and laser sintering, and supervision of graduate students.

Following graduation from the University of Vienna in 1987, Ivica spent more than 6 years working in different research establishments in Japan, Germany, France and the U.S. While in the U.S., Dr. Smid worked as a researcher at Sandia National Laboratory, New Mexico.

CISP Profiles

Major Connie Schlaefer

Maj. Connie Schlaefer is a second-year Ph.D. student at the Center. She is sponsored by the U.S. Air Force to earn her doctorate at Penn State. Upon completion, Maj. Schlaefer will have a subsequent assignment to the USAF Academy in Colorado Springs as a faculty member in the Department of Engineering Mechanics. Connie earned her B.S. in engineering mechanics from the AF Academy in 1988, and her M.S. in mechanical engineering from UCSB in 1993. In addition to teaching, Connie has had assignments in the Atlas space launch squadron at Vandenberg AFB in California, the AF Operational Test and Evaluation Center and the Air Base Wing at Kirtland AFB in Albuquerque, NM. Connie is studying evaluation techniques to characterize pre-densification sintering phenomena. She will be working with our newest piece of test equipment, the soon-to-arrive Anter laser flash thermal diffusivity system, to evaluate changes in thermal diffusivity and conductivity in both die-compacted and MIM materials and relate these changes to strength evolution during sintering.

P/M PROCESSING

Powder Metallurgy Processing Seminar

A two day workshop in P/M Processing will be offered at the Industrial Technical Educational Center, Ridgway, PA on 24 and 31 October. Organized by the Continuing Education, at Penn State DuBois and CISP, this seminar will cover metal powder production, P/M lubricants, testing and characterization of metal powders, compacting, sintering practices, furnaces and processing cycles, machining, heat treatment, metallography, and injection molding metal and other special processes. For additional information contact: K. Poitras, PS DuBois at 814-375-4715 or kap16@psu.edu.

CISP Faces the Challenge

As a Center and more importantly as human beings, we are spending much time reflecting on recent events and attempting to map order from chaos. Although our Center is diverse and complex, we must collectively stand together to deal with the challenges that face us all. Our mission has always been to provide direction and focus. Now more than ever, we must be vigilant in monitoring this industry and charting a course.

Sharon Elder
Executive Director

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