University of Connecticut
Institute of Materials Science

IMS Associates Program Newsletter

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Sung Wins 2002 BiChuMi Grand Award in Korea

C. S. P. Sung of the Polymer Program and Professor of Chemistry won the 2002 BiChuMi Grand Award in Korea. The award, established in 2001 by Korea's Ministry of Women's Affairs and sponsored by the Samsung Life Foundation, is the biggest award for women in Korea. It recognizes leading Korean women's contributions in public service, culture and arts, and science and education. Sung's award "Bul-Lee-Sang" (Star Prize) is for her achievements in science and education. The award includes a cash prize. The award ceremony was held on November 15 in Seoul, Korea.

State Initiative On Nanotechnologies

Nanotechnology is the manipulation of individual molecules or groups of molecules to create materials, systems or devices in the intermediate state of matter (1-100 nm), which exists in the size regime between individual molecules and bulk materials. Nanostructures, devices and systems are likely to have novel properties and functions because of their small size and related properties may be combined to create novel man-made structures and devices.

An active program is underway to formalize a nanotechnology initiative in Connecticut. The goals of the program are as follows:

- Place the state in a favorably competitive and visible position in the emerging science and commercialization of nanotechnology.
- Enable the state/region's academic and research institutions to apply for and obtain more federal funding through the National Nanotech Initiative/the National Science Foundation and its related entities, and private funding sources.
- Facilitate the technology transfer and commercialization of discoveries and intellectual assets into nanotech products, to bring them to market more quickly.
- Generate interest among students, scientists and experts and businesses in the state, its academic and research institutions, and companies as a place that is proactive and committed to developing and supporting cutting-edge research and development of nanotechnology.
- Gauge interest in developing and providing a forum for support and idea exchange among those involved in nanotechnology including those in educational and research institutions, entrepreneurs, government

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and political entities, professional advisers, commercial interests and businesses.

- Provide a platform for education about nanotechnology and promotion of the field.

Potential applications of nanotechnology include:

◊ ***Tools:*** Scanning tunneling microscope, atomic force microscope, electron microscopy, optical interferometry, nuclear magnetic resonance, molecular beam epitaxy, laser tweezers, nanomanipulator, computer modeling.

◊ ***Materials:*** Fillers, coatings, textiles, lubricants, protective layers, reactors, packing materials, automotive, construction, abrasives, optoelectronics, castings, novel states of carbon, biological and medical related materials.

◊ ***Devices:*** Microelectromechanical systems levers, sensors, pumps, rotors, etc., lab-on-chip, tiny medical devices (drug release, control of prosthetics, gene injection), advanced lasers, optical, electronic, magnetic and logic devices.

◊ ***Electronics and Information Technology:*** Carbon nanotubes - conductors, semiconductors, insulators; advanced lithography/surface stamping; memory and storage; magnetic RAM, spintronics/ magnetism; data storage; magnetic storage; quantum computing; optical switching.

◊ ***Life Sciences:*** Lab-on-a-chip, genome sequencing, nanoparticle tagging, biodetectors for hazardous environments, targeted drug-delivery, topical medicinal creams and sprays, nucleus extraction and replacement, prosthetics for sight, hearing and touch, cellular manipulation, agriculture, man-made proteins, genetic engineering.

◊ ***Power and Processes:*** Catalysts to remove pollutants, fuel cell development and storage, solar cell efficiency, light sources, bioanalysis.

Preliminary organizational meetings were held this fall. All Connecticut industry is being asked their interest in participating. For more information on this initiative contact Harris Marcus (860-486-4623, hmarcus@ims.uconn.edu or Fotis Papadimitrakopoulos (860-486-3447, papadim@ims.uconn.edu).

NEW Capability
Heat Capacity Determination

Heat capacity can be determined by using modulated Differential Scanning Calorimetry (DSC). In years past, this procedure would require a minimum of three experiments and was not very accurate (±10%). With the new technology developed by TA Instruments, we are able to use our Q100 DSC to determine heat capacity over the operating temperature range of the instrument (-80° - 400°C) using only one scan with improved accuracy (±5%). We can determine heat capacities from 0.25 J/g/°C to 5 J/g/°C. If you have any interest in heat capacity measurements, please contact us for details on sample preparation.

New Faculty

This fall the Polymer Program welcomed one new faculty member, Lei Zhu, Assistant Professor of Chemical Engineering. Dr. Zhu received both his B.S. and M.S. in Materials Chemistry at Fudan University in China. In 1996 he joined Stephen Cheng's research lab at The University of Akron. His Ph.D. work concentrated on nano-confined polymer crystallization in crystalline-amorphous diblock copolymers. During his postdoctoral study, also at the University of Akron, his research expanded from polymer structure analysis into novel nanotechnology designs for optical and electrical applications. He has authored over 20 peer-reviewed publications in journals such as *Physical Review Letters, Journal of the American Chemical Society, Advanced Materials* and *Macromolecules* and has numerous conference presentations and proceedings papers. He is the leading author of one chapter in *Polymer Handbook* (4th edition).

Dr. Zhu's research interests include: polymer phase transitions in one-, two-, and three-dimensional nano-confined systems; structure and morphology of block copolymer brushes at surfaces and interfaces;

polymeric nanocomposites and nanotechnology; and biodegradable block copolymers. More details about Dr. Zhu's interests and selected publications can be found on his web page, http://www.ims.uconn.edu/polymer/faculty/zhu.htm.

Connecticut Global Fuel Cell Center

The mission of the Connecticut Global Fuel Cell Center is to be a world leader in fuel cell research, education and product development so that Connecticut will be the primary global venue for the fuel cell industry. To achieve this, the Center will:

- Perform cutting edge research and development of advanced fuel cell technology through coordinated interdisciplinary efforts that encompass all aspects of all fuel cell systems.
- Educate students of all ages to assume a leading role in the fuel cell technology workforce of the future, providing the talent for industry leadership and a magnet to attract and retain key companies.
- Energize the economy by transforming scientific knowledge into economically competitive, pragmatic applications of leading-edge fuel cell technology.
- Be the principal center of demonstration activities that exemplify innovative and critical applications of advanced fuel cell technology.

During our last Associates Program annual meeting we had the pleasure of meeting Dr. Nigel Sammes, the Director of the new Connecticut Global Fuel Cell Center. The Center continues to grow both in personnel and facilities. Details are available at http://www.ctfuelcell.uconn.edu/.

Drs. Mather, Shaw and Weiss, faculty of the IMS are involved in research in this area with interests in advanced polymeric materials for Proton Exchange Membrane stacks, phase behavior in polymer solutions and blends, aging of polymer electrolytes and development of polymer blends for electrically conductive materials for application in PEM fuel cells.

Focus on Research

In each issue of this newsletter we profile one of the active research areas at IMS. In this issue we focus on the ceramics research being led by Nitin P. Padture, Associate Professor of Metallurgy and Materials Engineering.

Advanced Thermal Barrier Coatings (TBCs)

This project is aimed at understanding the fundamental mechanisms responsible for the failure of ZrO_2-based TBCs on superalloy metal substrates under thermal cycling conditions. These TBCs are either prepared using conventional plasma-spray route (powder feedstock) or using a novel method involving plasma-spray of liquid-precursor feedstock. In the latter, which possess novel nanostructures, we are investigating the fundamental deposition mechanisms. We are also in the process of tailoring alternate ceramics, with very low thermal conductivities, for advanced-TBC applications. This project is in collaboration with Profs. M. Gell, E. H. Jordan and P. G. Klemens of UConn, Dr. T. D. Xiao of Inframat Corp., and Drs. M. Osendi and P. Miranzo of Instituto de Cerámica y Vidrio, Madrid, Spain.

Recently a review article on this subject entitled "Thermal Barrier Coatings for Gas-Turbine Engine Applications" by Drs. Padture, Gell and Jordan was published in *Science* **296** [5566] 280-284 (2002). The abstract follows:

> Hundreds of different types of coatings are used to protect a variety of structural engineering materials from corrosion, wear, and erosion, and to provide lubrication and thermal insulation. Of all these, thermal barrier coatings (TBCs) have the most complex structure and must operate in the most demanding high-temperature environment of aircraft and industrial gas-turbine engines. TBCs, which comprise metal and ceramic multilayers, insulate turbine and combustor engine components from the hot gas stream, and improve the durability and energy efficiency of these engines.

Improvements in TBCs will require a better understanding of the complex changes in their structure and properties that occur under operating conditions that lead to their failure. The structure, properties, and failure mechanisms of TBCs are herein reviewed, together with a discussion of current limitations and future opportunities.

Other research areas of interest to Dr. Padture include *in situ*-reinforced ceramic composites, contact-damage-resistant ceramics, ceramic hard coatings, functional thin films and novel thin-film nanocomposites of self-assembled metal nanoparticles. You can find the complete text to the above mentioned article as well as many other of Dr. Padture's publications and descriptions of his other research interests on his web page at: http://www.ims.uconn.edu/metal/faculty/padture.htm.

CONNSTEP Awarded Energy Grant To Work With Chemical And Plastics Manufacturers

The U.S. Department of Energy (DOE) has awarded CONNSTEP, Inc. a $180,000 grant to work with energy-intensive industries to improve their productivity and reduce waste. DOE's "Connecticut 2002 Industries of the Future Program" will be led by CONNSTEP environmental management specialist Judith Wlodarczyk and will focus on helping chemical and plastics manufacturers. The chemical and plastics industries are two of the largest energy-consuming industries in the state and represent a significant portion of the state's manufacturing economy.

"The project team will work with industry to articulate their needs," said John Ruckes of the State of Connecticut Office of Policy and Management, "and to develop a strategy to access federal and state resources that will help them reduce energy waste, prevent environmental pollution, and utilize resources more effectively."

"This will be an industry-driven effort to determine where they are today, what their needs are, and where they will have to be in the future to remain productive and competitive," said Gerard Ward, President of CONNSTEP.

A coalition of public and private organizations will work together over the next year to lay the foundation for a long-term, sustainable Connecticut Industries of the Future (IOF) Program.

For more information contact Judith Wlodarczyk at CONNSTEP (jwlodarc@connstep.org; 860-529-5120).

Spring Semester Starts

Spring semester 2003 classes start Wednesday, January 22, 2003. Some courses that may be of interest include the following.

CHEG-368	Rheology/Processing	M. Shaw
CHEM-385	Polymer Reactions	S. Huang
CHEM-384	Polymer Characterization II	G. Sotzing
CHEG-352	Polymer Properties	R. Parnas
CHEM-394-1	Conductive Polymers and Devices	F. Papadimitrakopoulos
BME 271	Biomaterials	M. Wei
MMAT-309	Transport Phenomena in Materials Processing	H. Brody
MMAT-320-1	Physical Ceramics	T. Kattamis
MMAT-320-2	Advanced Transmission Electron Microscopy	M. Aindow
MMAT-343	Corrosion	N. Greene

Some courses require pre-approval of the instructor. For further information please call Ed Kurz.

Members Corner

In each newsletter we present short descriptions of one or two of our member companies. In this issue we focus on K and M Electronics, Inc. and the Anocoil Corporation. Dr. Herm Boeglin of K and M and Dr. William Rozell of Anocoil submitted the articles. We thank them for their contributions.

K and M Electronics, Inc.

K and M Electronics, Inc. (www.kandm.com), founded in 1974, is a subsidiary of ITT Industries, Inc. (www.itt.com) and a leading supplier, designer & manufacturer of power supplies, ceramic channel electron multipliers (detectors) and high reliability components. K and M is certified to ISO 9001:2000 and military standards. The company utilizes its 150,000 square-foot state-of-the-art manufacturing facility in West Springfield, Massachusetts with fully integrated design, manufacturing and quality systems utilizing the latest tools in lean manufacturing and six sigma practices.

Our line of DC-DC high voltage power supplies offer custom and standard versions for mass spectrometry, time-of-flight and image intensification applications with output power levels of 10-30 watts. K and M also manufactures high and low voltage as well as high and low power, power supplies. Our custom supplies include designs with outputs ranging from 10V - 100kV and output power levels from 1 - 1000 watts. Finally, our experience in military applications includes supplies for night vision, missile warning guidance systems, NASA space satellite, avionic CRT displays and munitions.

Our patented CERAMAX^{TM} electron multipliers (commonly used in mass spectrometers, surface analysis instrumentation and many other scientific instruments) offer monolithic ceramic construction and advanced ion-optical design. We also offer microchannel plates (MCPs) for time-of-flight mass spectrometry (TOF/MS) and other applications.

We manufacture our own components, such as hybrid micro-circuits, high-ohmic resistors, miniature transformers, high voltage multiplier assemblies, diode arrays. Our products are installed in avionic, medical, analytical and scientific instrumentation, spacecraft and night vision equipment worldwide. In addition to these products, K and M offers turn-key manufacturing capabilities in the 150,000 square foot facility, which provides strict control over quality, cost and delivery.

The Associates Program has helped with production support for the line of channel electron multipliers that K and M manufactures. The Program has assisted in identifying the cause of several production issues that led to process improvements that significantly increased production yield.

Anocoil Corporation

Based in Rockville, Connecticut, Anocoil is the largest independent manufacturer of lithographic plates in North America. During the last 35 years Anocoil has been at the forefront of lithographic plate technology, with major innovations in the areas of aluminum treatment, anodizing and coating technology. The company continues to invest in new equipment and technology and holds over 50 U.S. and foreign patents. It has licensed its technology to major manufacturers of printing plates. Anocoil's production facilities are state-of-the-art, from aluminum surface treatment and the lay-down of sophisticated light-sensitive coatings to computerized inspection and automated converting and packaging.

Anocoil offers a wide range of presensitized lithographic plates, processing chemistries and high-volume, heavy-duty plate processors for customers in both commercial and newspaper markets. We are a major supplier of plates to the large metropolitan daily newspaper market in the U.S. Anocoil's products include conventional offset plates and the latest in thermally imaged plates for Computer-to-Plate (CTP) systems. All of our plate chemistry is biodegradable and environmentally friendly.

The IMS Associates Program has been a valuable resource for Anocoil. Lithographic printing is a process that depends on the relative surface properties of the printing and non-printing areas of the plate. We have utilized electron microscopy for topographical evaluation and micro-thermal imaging to look at the distribution of materials in our surfaces. The thermal desorption GC/MS has been a useful tool in analyzing the resin coatings that we use on our plates.

Department Seminars

Spring seminar schedules have not been finalized at this time. We will send the schedules to our members for the Metallurgy and Materials Engineering Department and the Polymer Program when finalized. This information, and the seminar schedules for most departments, will also be available on the World Wide Web. Abstracts of seminars are usually available about a week in advance. We can also put you in touch with the faculty member sponsoring the seminar to learn more about the specific seminar of interest. We suggest you call before attending to be sure the seminar has not been canceled due to illness or weather.

IMS Short Courses

We plan to present two short courses during the summer of 2003. Associates Program member companies will receive one complimentary registration per course. The exact dates will be finalized shortly. You will receive more detailed information in the spring. The courses will be as follows:

CORROSION DIAGNOSTICS

Norbert Greene

A two-day short course which examines several powerful, integrated procedures for analyzing corrosion problems. These methods, based on the principles of physical chemistry, thermodynamics, and reaction kinetics, use simple, rapid graphical procedures.

Topics:

- Overview - Determining corrosion rates
- Corrosion Chemistry - the easy, two-step approach
- Thermodynamics - Using potential-pH diagrams
- Reaction Kinetics - Using potential-current diagrams
- Corrosion Prevention - Passivity, inhibitors, cathodic protection

Applications:

- Selecting corrosion-resistant alloys
- Predicting the effects of environmental variables
- Analyzing corrosion failures
- Designing corrosion control procedures
- Monitoring corrosion rates

Problem Solving:

Numerous case histories and assigned problems will enable participants to develop skill in using these diagnostic tools. Some of the interesting results of these exercises include:

- Sea water is not more corrosive than fresh water
- Stainless steels should not be passivated
- Accelerated corrosion tests yield incorrect results
- Increasing fluid flow may increase or decrease corrosion

JOINING OF MATERIALS

Theo Kattamis

The course will familiarize the students with the basic principles of materials joining, the processes used, the selection criteria of the optimum process in each case, and the adoption of process variable values leading to sound and mechanically strong joints.

The following subjects will be covered:

- Fundamentals of bonding, solid-phase welding principles, roll-bonding, friction welding, explosive welding and cladding, ultrasonic welding
- Metal / metal; metal / ceramic and ceramic / ceramic diffusion bonding
- Principles of wetting, brazing and soldering technology, metal / metal, metal / ceramic and ceramic / ceramic brazing, transient liquid phase bonding
- Electrical resistance welding and brazing

- Joining materials using adhesives
- Weldability and its assessment; Transient and residual thermal stresses in welds, distortion
- Microstructure and mechanical failure of welds and welded assemblies
- Fusion welding, heat sources, arc welding processes, heat flow and temperature distribution considerations, high power density welding (plasma-arc, electron beam, glow-discharge electron beam, laser beam), electroslag welding
- Post-weld thermal and thermomechanical treatments, process selection as a function of materials and assembly design; Quality control, destructive testing and nondestructive evaluation
- Classification of metal welding processes
- Challenges in joining emerging materials: Joining of intermetallics, ceramics and glasses, polymers, and composite materials

Short Course Registrations

In the past a small number of people have registered for short courses through the Associates Program and not attended. The Associates Program must still pay full price in this situation. Please note that participant substitutions can be made at any time and registration can usually be canceled at minimal cost until the day before the course. We understand that occasionally plans must change but request your assistance when such changes occur.

Protein and Polymer Science in the 21st Century

Professor Jim Knox retired this year after a most distinguished career in the field of protein crystallography and characterization of drug/enzyme interactions. The Polymer Program and the Molecular & Cell Biology Department held a symposium entitled "Protein and Polymer Science in the 21st Century" in Dr. Knox's honor on September 27, 2002. The speakers were Jim's former students, friends and colleagues. Authors and titles of the presentations are listed below.

Shahriar O. Mobashery (Wayne State University)
Antibacterials as Wonder Drugs and How Their Effectiveness is Being Compromised

Samuel J. Huang (University of Connecticut)
Hydrophilic-Hydrophobic Biodegradable Biomedical Polymer

Robert A. Bonomo (Cleveland Louis Strokes Veterans Affairs Medical Center)
Never a Dull Beta-Lactamase

Eric M. Billings (National Institutes of Health)
New Approaches in Computational Biology

J. K. Mohana Rao (National Cancer Institute)
Understanding the Concept of Symmetry while Teaching and Learning Crystallography

Edward T. Samulski (University of North Carolina at Chapel Hill)
Nano-Shinola: From Glucopyranosides to Carbon Nanotubes

Jean-Pierre Wery (Concurrent Pharmaceuticals)
In Silico Drug Delivery: A Tale of Computers and Molecules

N. Sanjeeva Murthy (University of Vermont)
Small-angle Scattering from Proteins and Synthetic Polymers: Then and Now

Rex F. Pratt (Wesleyan University)
Active Site Chemistry of Beta-Lactamases: Inhibition by Phosph(on)ates

Gregg Crichlow (Yale University)
Conformational Changes in the Inhibition of a Class C Beta-Lactamase

IMS Associates Program

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We're on the Web!
www.ims.uconn.edu/assoc

Can a Materials Engineering Student Help You?

The Department of Metallurgy and Materials Engineering has five Junior and ten Sophomore level students in their new undergraduate program. These exceptionally bright and enthusiastic students are looking for intern opportunities in industry this summer. Benefits from summer internships are obvious for companies needing additional assistance during the summer months or wanting to fill future positions with carefully screened candidates. As another option, companies can enlist the help of both faculty and students in solving technical problems by sponsoring a senior design project next year. Students work with the sponsoring company and normally spend ten or more hours a week on their project for 30 weeks. For more information, please contact the Department Head, John Morral, at 860-486-4620.

Associates Program Annual Meeting

The Associates Program annual meeting is tentatively scheduled for Wednesday, May 28, 2003. Representatives from all member companies are encouraged to attend. Attendees learn of new developments, interact with other members, and have access to IMS faculty and staff. Please reserve the date. Plans are in development. It is likely these will include a tour of the recently upgraded IMS thermal analysis and mechanical testing facilities. Watch your mail for details.

Sample Preparation

In many projects that the Associates Program deals with, such as adhesion and coatings, surface analysis techniques are extremely important. The techniques used for such analysis, particularly GC/MS, Auger electron spectroscopy (AES) and x-ray photoelectron spectroscopy (XPS) are extremely sensitive to small amounts of material on the surface. It is important to make efforts not to contaminate these surfaces during sample preparation, collection and shipment. **Shipment in common plastic bags should be avoided**! Common plastic bags typically contain significant amounts of additives used to prevent the plastics from adhering to themselves and other materials. These additives will migrate to the sample during shipment and at best make interpretation difficult and sometimes impossible. It is much better to ship such samples in common kitchen aluminum foil (not industrial aluminum foil which is often coated with an oil or other release agent). Samples can also be shipped in glass containers with aluminum foil over the opening under the cap.

Alternatively special polyester bags which do not contain such additives can be purchased. One source of such bags is the Kapak Corporation, 5305 Parkdale Drive, Minneapolis, MN 55416, 612/541-0730. Typical price is about $200 per thousand depending on the exact size. Be sure to specify non-contaminating/non-plasticized material.