# SYMPOSIUM PP

## Communicating Materials Science–Secondary Education for the 21st Century

November 28 - 30, 2004

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* Invited paper

# TUTORIAL

**FT PP: Demoworks–The Fine Art of Materials Science Demonstrations**
**Sunday November 28, 2004**
**1:30 PM - 5:00 PM**
**Room 200 (Hynes)**

This workshop is designed to showcase materials science demonstrations in order to improve the quality of science education worldwide. The targeted audience consists of scientists looking for outreach demonstrations, junior professors who are developing new courses, and senior professors who desire to jazz up their material. MRS university chapters, MRSEC members, and those developing outreach vehicles would greatly benefit from this workshop as well. This workshop is also suitable for high school teachers, since age-appropriate explanations will be used.

Todays teachers are responsible for preparing their students to confront the highly technological world of the 21st century. The best way for students to learn science is to do science. This workshop will provide teachers from all levels with tools (including a materials science demonstration cookbook) to engage students and make science more dynamic and compelling. The workshop is designed so that active discussions can take place between participants who are seeking ways to demonstrate materials science principles.

Topics include:
• An overview of materials science education
• Demonstrations in crystal structure, kinetics/diffusion, mechanical properties, magnetism, electrical/optical properties, polymers, and corrosion

**Instructors:**
**Amy Moll**
Boise State University

**Ainissa G. Ramirez**
Yale University

SESSION PP1: Education, Curriculum and Reaching Students
Chair: Fiona Goodchild
Monday Morning, November 29, 2004
Back Bay B (Sheraton)

**8:30 AM *PP1.1**
**Citizen Scientists – Advocate Educator.** Dennis M. Bartels, President, TERC, Cambridge, Massachusetts.

Former NSF Director Neal Lane spoke eloquently for the need of a cadre of "Citizen Scientists" who actively engaged the public in important questions of science, ethics, and civic engagement. This talk will develop further Dr. Lane's notion of the Citizen Scientist to elaborate on a special case, which for the sake of a term will be known as the Advocate Educator. A historic tension in science education is the seemingly dual goals of universal science literacy and building a seamless pipeline into scientific careers. Some current trends suggest we may be retreating from our commitment to universal science literacy. Dr. Bartels will develop an argument that these two goals are inextricably linked and to allow one to diminish the other will create a significant crises for this country's scientific enterprise. Much of the leadership and care for the health of the entire K-20 science education system needs to come from scientists, but lies well beyond more commonplace participation, like the model of a scientist in a K-12 classroom for a day. The idea of an Advocate Educator may better capture the set of possibilities for scientists who respond to this call.

**9:00 AM PP1.2**
**Materials Science and Technology: A Curriculum That Works.** Tom Stoebe[1] and John Rusin[2]; [1]Materials Science and Engineering, University of Washington, Seattle, Washington; [2]Engineering, Edmonds Community College, Lynnwood, Washington.

Materials Science and Technology is a curriculum developed at Battelle Pacific Northwest National Laboratories, which emphasizes hands-on, minds-on studies of materials science and technology. This curriculum has been taught to over 1000 middle and high school teachers nationwide in a series of week-long institute programs, and is used in classrooms in 17 states. Evaluations have shown that the curriculum is highly effective in getting students interested in science and technology, and in encouraging them to study more science. This paper will give the basics of the curriculum and its approach. It will also discuss the types of venues used for promoting the curriculum and the teaching methods used. Full evaluation results will be discussed, including the assessment of increased student interest and increased student involvement their own learning. Means of adapting the program to a local situation will also be reviewed. This program is supported in part by the Advanced Technology Education program at the National Science Foundation. Teacher educational programs are supported by NSF and by the ASM Educational Foundation. A commercial version of the curriculum is available from Energy Concepts, Inc.

**9:15 AM PP1.3**
**Exploring Constructionist Learning Environments for Middle-School Science Students: Problem-based Scientific Inquiry Using Electron Microscopy.** Andrea J. Harmer and Sujata Jagota; Materials Science, Lehigh University, Bethlehem, Pennsylvania.

Given an authentic and relevant problem, how do learners who are given the opportunity to construct sharable artifacts engage in scientific inquiry and process knowledge? As result of their opportunity to construct, analyze and present, do students feel more ownership of the problem, their solution, and their solution process? Do they apply scientific problem-solving techniques using their artifacts? Do they share artifacts for analysis and are their presentations stronger when using their constructed artifacts? In an effort to begin answering some of these questions, fourteen groups of 4-5 sixth-grade students from within a typical northeast, US suburban middle school environment were asked to use scientific inquiry to formulate a plan for containing the deadly West Nile Virus that has been found in their county and to demonstrate their solution in a final, group presentation. Students had access to two Web-based tools for solving this problem: the Web-based Inquiry Science Environment (WISE) and ImagiNations. WISE (http://wise.berkeley.edu) is a Web-based inquiry science environment. Through WISE, students had access to fifteen researcher-selected newspaper clippings about the West Nile Virus and two Websites deemed relevant for analysis of the problem. ImagiNations (http://www.lehigh.edu/ inimagin) is part of an outreach program intended to introduce K-8 students to electron microscopy and nanotechnology. Over a 2-week period, four 45-minute class periods were allotted to the problem-solving activity. Teams were encouraged to discuss their problem solving outside of class through online discussion using WISE-based tools. Students were also asked to journal their daily thoughts and activities through drawings, writings, and photos. Students were observed for the extent to which they related the problem they were solving to their lives, interacted with each other to solve the problem, applied new knowledge to solve the problem, and shared their artifacts with one another. In addition, the researcher interviewed the student groups, inquiring about their perceived level of problem and solution ownership, construction of artifacts, and perceived strength of final presentation. The researcher also interviewed the teacher for his/her impressions about the students sense of problem and solution ownership, construction of resources, accuracy in the scientific inquiry process, and students justification skills during this project. Finally, on the last day of the problem-solving activity, the researcher collected students journals and videotaped the groups presentations for subsequent qualitative analysis. A web-based module will be developed to (i) outline the scope of the problem and the data provided with relevant animations/ interactive pieces on imaging and magnification, (ii) present and analyze the results obtained from the study.

**9:30 AM PP1.4**
**Teaching Materials Science and Engineering through the Writing and Use of "The World of Materials" Essays.**
Paul R. Howell, [1]Materials Science and Engineering, Pennsylvania State University, University Park, Pennsylvania; [2]E-Education Institute, College of Earth and Mineral Sciences, Pennsylvania State University, University Park, Pennsylvania.

The author has developed an essay-based approach for teaching and evaluating Materials Science and Engineering, centered on the writing, and use of thematic essays, which have the grand title, "The World of Materials". The essays concentrate on one material only, e.g., salt (salt or sodium chloride will be my prototype): and each essay is constructed around the four elements of Materials and Science and Engineering: structure, properties, processing and performance. However, each essay also contains relevant societal and historical information on the use and importance of that material. For example, the crucial role of salt in the development of various trading centers in Iron-Age Europe are explored in the essay on Salt. Where appropriate, biographical information on persons who are associated with that material is also included in the essay. The essays serve several functions including: 1. They may be used to teach Materials Science and Engineering through an in-depth description of particular materials (specificity) rather than by the traditional route, which de-emphasizes particular materials, but concentrates on particular concepts (generality). 2. In any one essay, which is written by teacher

or student, a student will be exposed to a broad range of scientific concepts, related to materials, minerals and Earth Science. 3. Students can be encouraged to develop their critical thinking ability

material makes it possible to increase rate and quality of teaching, and the students find the experience of the real scientific research activity of initial level. Development of problem-solving abilities

flocked to the Princeton Scientist demonstrations and the scientists and the public came away with a positive experience. The public learned about materials science and the scientists became skilled at public interaction and had fun in the process.

**2:30 PM PP2.3**
**Materials Matter: Demonstrating Material Science to the General Public.** Beth Tinker[2], Andrew Greenberg[1,3] and Ronald D. Redwing[1,4]; [1]Center for Nanoscale Science, Penn State University, University Park, Pennsylvania; [2]The Franklin Institute, Philadelphia, Pennsylvania; [3]Department of Chemistry, The Pennsylvania State University, University Park, Pennsylvania; [4]Department of Physics, The Pennsylvania State University, University Park, Pennsylvania.

Through a partnership with Philadelphia's nationally renowned science museum The Franklin Institute and Penn State University, "Materials Matter: It's a Nanoworld After All" has been produced and distributed to 22 science museums nationwide. Also provided are demonstrational materials and supplies to equip a show for a year at each museum. This 60-minute cart-based interactive exploration has been viewed by an estimated 300,000 (many of them school-aged) visitors in 2003. The show includes demonstrations and macro-scale models that explore the "micro" mechanisms behind the unusual and surprising "macro" behavior of materials such as aerogels, shape-memory alloys, polymers, electronic ink, and zeolites. A development team consisting of graduate students and faculty members worked with five members of the program development staff at The Franklin Institute to develop the show. We are currently working to produce a second museum show on nanotechnology to be distributed in the spring of 2005.

**3:00 PM *PP2.4**
**The NanoKids Project.** James M. Tour, CNST, Rice University, Houston, Texas.

The NanoKids Project answers an intense need for innovative instructional materials that inspire and motivate students in grades 6 - 12 to learn nanoscale science and engineering, and at the same time, nurtures collaboration between research scientists, science educators, and school district curriculum administrators to develop and implement these materials. Core concepts of chemistry, physics, molecular biology, and their application in materials engineering are presented in 3-D animated lesson/adventures with original contemporary music, and reinforced in the interactive digital student workbooks that include learning-based video games and exercises. A comprehensive teacher guide, bilingual parent guide, and support website round out a total immersion concept. Aligned with state and national standards, the materials are integrated into existing curricula, and specifically address issues of diversity in learning and teaching. Formative evaluation results garnered by an independent firm from the pilot testing of the NanoKids materials in 11 middle schools and two high schools will be included in this presentation.

**3:30 PM PP2.5**

**Exploring Materials Science with LEGO® Brick Models.** Dean James Campbell, Chemistry and Biochemistry, Bradley University, Peoria, Illinois.

Various physical and chemical principles related to materials science and technology can be demonstrated with LEGO® models. Three-dimensional models are excellent tools for grasping structure-function relationships. Additionally, many people are familiar with LEGO® bricks, and most models can be built with a level of mechanical sophistication that does not intimidate or frustrate the user. LEGO® bricks typically have many connection sites, allowing tremendous flexibility in the structures that can be built. The bricks can be used to model both the structures of materials and the techniques used to study them. Many models can be built with varying degrees of sophistication, even incorporating electronics, enabling the user to focus on relatively simple concepts or more subtle details. The variety of models available also enables LEGO® bricks to fit into a variety of user budgets. This presentation will feature models of the structures of materials, including unit cells, discrete molecules, and polymers. It will also feature models of analytical tools used to study materials, including models of a scanning probe microscope and a photometer. Details and building instructions of these and other models are featured in the book "Exploring the Nanoworld with LEGO® Bricks". This book may be downloaded from the Internet at: http://mrsec.wisc.edu/edetc/LEGO/index.html.

**3:45 PM SPECIAL PRESENTATION BY HIGH SCHOOL TEACHERS**

SESSION PP3: Coupling Materials Science Education with Research and Technology
Chair: Susan Rosevear
Tuesday Morning, November 30, 2004
Back Bay D (Sheraton)

**8:30 AM *PP3.1**
**Research Experience for Teachers at MIT: From the Laboratory to the Classroom.** Michael F. Rubner, [1]Materials Science and Eng., MIT, Cambridge, Massachusetts; [2]Center For Materials Science and Engineering, MIT, Cambridge, Massachusetts.

The Materials Research Science and Engineering Center (MRSEC) at MIT supports a wide range of educational outreach programs. One of them, the Research Experience for Teachers, is designed to connect teachers to MIT research and to help them bring this experience into the classroom. After working for one summer within a research laboratory, teachers are challenged to develop materials and modules for use in their classrooms. Researchers at MIT have found this arrangement to be highly stimulating and rewarding. Teachers bring a level of maturity and enthusiasm to a research group that often stimulates and motivates other group members. In addition, one can never underestimate the enthusiasm that faculty display when they work with teachers to break down their research ideas and make them understandable to middle and high school students. Examples of how this process works and the various modules and classroom activities that have been developed will be discussed.

**9:00 AM PP3.2**
**Scienceline: How Scientists Make Connections with K-12 Schools.** Fiona Goodchild, California NanoSystems Institute (CNSI), Santa Barbara, California.

This presentation will discuss the operation and impact of Scienceline, an Ask a Scientist project at the University of California. The talk will consider the critical factors in maintaining internet communication between scientists and K-12 students and teachers.

**9:15 AM PP3.3**
**Turning Cutting-Edge Research into Secondary Curriculum.** Greta M. Zenner[1], Wendy C. Crone[1], J. Aura Gimm[1], Ken W. Lux[1], Paul M. Voyles[2], Anthony P. Cina[3], Ann Pumper Comins[4], Johan Tabora[9], Pamela Tuchscherer[5], Tyson Tuchscherer[6], P. John Whitsett[7] and Cindy G. Widstrand[8]; [1]Engineering Physics, Univ. of Wisconsin - Madison, Madison, Wisconsin; [2]Materials Science and Engineering, University of Wisconsin-Madison, Madison, Wisconsin; [3]O'Keefe Middle School, Madison, Wisconsin; [4]Madison Memorial High School, Madison, Wisconsin; [5]Gearhart School, Gearhart, Oregon; [6]Daly Middle School, Lakeview, Oregon; [7]Fond du Lac High School, Fond du Lac, Wisconsin; [8]Stoughton High School, Stoughton, Wisconsin; [9]Northside College Preparatory High School, Chicago, Illinois.

Traditional science classroom activities rely on topics and experiments that are distant from the forefront of scientific research. As a result, students view science as stagnant and far removed from real life. Through a National Science Foundation-funded Research Experiences for Teachers (RET) program, we at the University of Wisconsin-Madison (UW) Materials Research Science and Engineering Center (MRSEC) work with secondary teachers to transform cutting-edge research in nanoscale science and engineering into curriculum that is appropriate for middle- and high-school classrooms. This benefits everyone involved: teachers learn about innovative science and the process of research; UW MRSEC personnel learn about science education and the state of today's schools; and students get to test and engage with new curriculum about breakthrough research. This past summer our RET participants conducted research on and developed curriculum about "smart" papers with microencapsulation technology, fuel cells, nano biosensors and liquid crystals, glassy metals, Wells models, and molecular sieves. During the presentation, several of these topics will be discussed along with the structure of our RET program.

**9:30 AM PP3.4**
**Research Experiences for Teachers in Materials Science: Building an Apparatus for Making Magnetic Fluids.** Michelle Strand[2] and Diandra Leslie-Pelecky[1,3]; [1]Department of Physics, University of Nebraska, Lincoln, Nebraska; [2]Pius X High School, Lincoln, Nebraska; [3]Center for Materials Research & Analysis, University of Nebraska, Lincoln, Nebraska.

Federally-funded projects increasingly are providing summer research opportunities for high-school teachers; however, it can be a major challenge to develop a project for that takes into consideration the skills and abilities of the teacher, as well as the desire of the researcher to make tangible research progress. We present here the perspectives of a teacher and a scientist who collaborated as part of

the University of Nebraska MRSEC during the summer of 2003. From the teacher's perspective, the opportunity to contribute to "real" research was almost too good to be true, but it presented some significant risks: Not knowing what to expect, and not knowing what was expected were perhaps the most uncomfortable aspects for the teacher. From the researchers' perspective, finding a project that would utilize the teachers' skills and leave her with a realistic - but overall positive - view of research had to be balanced with the time constraints of the students and postdocs in the lab. The solution was a project focused on building a deposition apparatus to make magnetic fluids for biomedical applications. The apparatus had been designed on paper and the scale of the project allowed for the possibility of making significant progress in eight to ten weeks. In collaboration with two undergraduates, the teacher-researcher refined the apparatus design and learned about scientific machining and vacuum system theory, all the while experiencing some of the rewards and frustrations of research. The teacher and the scientists involved in the project were very pleased with the collaborative process, and with the resulting research. The basic apparatus was completed during the summer and is now producing nanostructured magnetic fluids. The teacher is a co-author on a poster and a paper, and she takes great satisfaction in being able to discuss scientific research with her students based on her first-hand experience. Although the experience was deemed successful by both parties, reflecting on the experience has identified common concerns on the part of researchers and teachers, and some strategies for addressing those concerns. We will discuss issues including teachers worrying about not knowing enough physics, balancing work with their family commitments, balancing the educational and research aspects of the RET program, and helping scientists understand how to work with teachers in a laboratory setting. This work was supported by the Nebraska Research Initiative, the MRSEC Program of the National Science Foundation under Award No DMR-0213808 and the Center for Materials Research & Analysis at the University of Nebraska

**9:45 AM PANEL DISCUSSION WITH HIGH SCHOOL TEACHERS**

**10:30 AM *PP3.5**
**Multilevel Education Activities in Polymer Science and Chemistry: Multimedia Materials, Teacher Workshops, Undergraduate Research Center and NSF IGERT Program.**
Lon J. Mathias, Department of Polymer Science, University of Southern Mississippi, Hattiesburg, Mississippi.

Education resources and programs in polymer science and related fields are extensive at the University of Southern Mississippi (USM). Resources consist of multimedia materials in print and web or CD. Periodic workshops are held both at USM and at national meetings. On-campus programs include a new course (Living in the Material World) aimed at non-science majors. An example of the on-line resource materials available is the Polymer Science Learning Center (PSLC). The PSLC provides entertaining, multimedia polymer and materials education experiences for all levels, ages and audiences. Perhaps the best-known component of the PSLC is the Macrogalleria (http://pslc.ws/macrog/index.htm), a free educational web site that covers the basics of polymer chemistry and engineering. Another well-known component of the PSLC is the city of Polydelphia (http://pslc.ws/polydel/index.htm), a free site that illustrates how polymers affect the more routine parts of every day life. Music lovers can visit the Polydelphia Conservatory to learn about present-day uses of polymers in musical instruments. At the Macroplex, movie buffs can find out how polymers have been used in the film industry. Learners interested in life in the oceans can amble over to the Polyquarium to learn about polymers from the sea. Visitors who feel like sleuthing can help the PSLC mascot Paul Lemur investigate who is behind the burning of the Polydelphia Playhouse. PSLC visitors also can participate in virtual expeditions such as The Story of Rubber which takes viewers on a journey through time to experience uses of polymers in the past, present, and into the future (http://pslc.ws/macrog/exp/index.htm). Paul Lemur, a cartoon character created by the PSLC staff, appears throughout the PSLC web site. Paul has his own web page (http://pslc.ws/macrog/paul) where visitors can learn about lemurs. At this site visitors also can download Pauls Coloring Activity Book, take a guided tour through Polydelphia with Paul at the helm, play the video game titled Paul Lemurs Big Adventure, and visit the Kids Macrogalleria. The Polymer Science Learning Center is also a physical resource that has provided learning experiences for K-12 teachers and faculty. Teacher created examples include multilevel modules on Thats the Way the Ball Bounces(http://www.pslc.ws/macrog/activity/ball/main.htm) and Polymer Science Saves Lives: Fire Prevention and Fire Fighting (http://www.pslc.ws/macrog/proposal/fire/firemain.htm). Last, the School for Polymers and High Performance Materials at the University of Southern Mississippi and the School of Pharmacy at The University of Mississippi, funded by an NSF IGERT grant, have teamed to provide new PhD programs at the interface of Polymer Science and Medicinal Chemistry. Students will learn leading-edge science from two synergistic disciplines and combine this with business-related courses and training in creative and entrepreneurial skills.

**11:00 AM PP3.6**
**Conducting Interactive, On-line, Web-Based SEM Lessons Around the World.** Scott Chumbley[1], Amy Chumbley[1], Gary Casuccio[2] and Heidi Barron[2]; [1]Iowa State University, Ames, Iowa; [2]RJ Lee Group, Monroeville, Pennsylvania.

Since the mid 1990s Iowa State University (ISU) has been developing capabilities to allow teachers and students in K-12 classroooms to access and operate a web-based scanning electron microscope (SEM) from their classrooms. The current stage of development is embodied in the WebSEM, an instrument located on the ISU campus in the Materials Science and Engineering Department, that users can access via a simple web interface. Developed in conjunction with RJ Lee Group, the WebSEM allows educational users to conduct advanced SEM investigations at no cost with no additional software or hardware requirements other than a computer with a standard web browser. Users have control over the microscope for image acquisition as well as the energy dispersive spectrometer (EDS), which is integrated into the microscope. Teachers and students can select from secondary or backscattered imaging modes, control magnification, brightness and contrast, and move the stage to view various samples. X-ray spectra can be obtained and the peaks identified, and images and spectra can be saved to the classroom computer. Access to the SEM is through a web site that contains tutorials on scanning electron microscopy aimed at different age groups, as well as a library of SEM micrographs and example lesson plans for teachers who might be considering using the system. When logging in the initial computer controls the WebSEM while the image can be viewed on up to seven additional computers in the classroom. Connections have been made with institutions as far away as England and Australia and lessons have been conducted with elementary and secondary schools. This talk will briefly discuss the design of the system, including hardware and software configurations, and how the system operates. Example scenarios of how the WebSEM has been used in various classrooms will be discussed, along with pitfalls encountered along the way that others may want to avoid when considering developing a similar system.

**11:15 AM PP3.7**
**On the Use of "Flash Movies" for Instruction and Assessment in High School Science Curricula.** Ralph H. Locklin[2], Andrew J. Wiesner[2], Michael W. Fleck[1], Ian R. Harrison[1], Eric J. Spielvogel[3] and Paul R. Howell[1,3]; [1]Materials Science and Engineering, Penn State University, University Park, Pennsylvania; [2]Schreyer Institute for Teaching Excellence, The Pennslyvania State University, University Park, PA 16802, Pennsylvania; [3]E-Education Institute, College of Earth and Mineral Sciences, The Pennslyvania State University, University Park, PA 16802, Pennsylvania.

Over the past several years, the authors have been developing a series of flash modules and on-line quizzing tools for use in teaching and assessing the fundamentals of Materials Science and Engineering. The original thrust was aimed at non-science majors at university, but the modules are also being designed for use in high school curricula. In the current presentation, we shall present our philosophy for the presentation and assessment of materials' related subject material, by describing two particular modules. The first, on Historical Aspects of the science of materials, and the second, on Electronic Materials. We will also describe the application of an on-line quizzing tool Perception, which allows us to embed Flash movies in our assessment strategy. We shall present examples of Drag and Drop questions, and we will also show that the quizzing tool can be an integral part of the educational process by providing rich feedback on questions related to the materials contained in the Flash movies. Finally, we will show how the teaching and assessment tools could be integrated into a high school curriculum.

**11:30 AM PP3.8**
**Enhancing Science Teaching through Business/Education Outreach Programs based on High-Technology Instrumentation.** Gary S. Casuccio[1], Hank P. Lentz[2], Stephen K. Kennedy[1] and L.Scott Chumbley[3]; [1]RJ Lee Group, Inc, Monroeville, Pennsylvania; [2]RJ Lee Group, Inc., Phoenix, Arizona; [3]Metals and Ceramics, Iowa State University, Ames, Iowa.

RJ Lee Group (RJLG) is a small business that specializes in materials characterization including industrial, environmental and criminal forensics. RJLG has been developing the Schoolhouse Project combining the use of high-technology instrumentation and the problem-solving approach with the needs of science education. The objectives of the Schoolhouse Project include 1) motivating students to pursue advanced education, especially in mathematics, computer sciences, engineering, and basic sciences; 2) providing technical assistance to teachers and students working on real world materials

science projects; and 3) enriching the educational experience beyond that commonly available to students. One component of the project is to bring modern high-tech instrumentation into the classroom. Microscopy, including the scanning electron microscope (SEM), was selected as the first suite of instruments to deliver. With its ability to provide highly detailed images of microscopic features as well as information on composition, the SEM an ideal analytical tool to incorporate into STEM curricula. The SEM stimulates student curiosity as they are learning content and developing thinking skills. Furthermore, the students find it fun to operate. The educational experience using the SEM can be delivered using 1) real microscopes, 2) accessing microscopes over the Internet, or 3) using interactive microscope simulators. Over the past five years, RJLG has worked with the West Greene School District (WGSD) to create an SEM laboratory in their Middle/High School (near Waynesburg, PA). With RJLG and Appalachian Regional Commission funding assistance, WGSD has purchased an SEM that is used to enhance high school biology and chemistry classes. After the school day, the SEM is being used in a School-to-Work program under the direction of RJLG. In this program, high school and college students are hired and trained in the operation of the SEM and perform business and research activities. Complementing the use of the local microscope, RJLG has developed the WebSEM that allows internet access to the SEM at remote locations. However, the high costs make it inaccessible to most schools. Some SEMs are becoming available over the Internet, including the RJLG WebSEM, but because only one student can operate them at a time, remote instruments provide limited access to students. Effective SEM simulation would retain the excitement of the experience while permitting all students to have access to the technology throughout a school year. To further extend accessibility, RJLG is developing a family of microscope simulators (a microscope on a CD) with National Science Foundation support. The simulator employs the functions of a real microscope (e.g., SEM or optical) to investigate samples contained on the CD. Prototype microscope simulators are currently being evaluated using a rocks and minerals classification curriculum module developed following state and national standards.

**11:45 AM PP3.9**
**Long Term Integration Plan of Nanotechnology and Material Science into Fourth and Fifth Grade Science Curriculum.**
S. Zekri[1], L. Clayton[2], Ashok Kumar[1], G. Okoogba[3] and L. Martin-Vega[3]; [1]Department of Mechanical Engineering, University of South Florida, Tampa, Florida; [2]Department of Chemistry, University of South Florida, Tampa, Florida; [3]Department of Industrial and Management Systems, University of South Florida, Tampa, Florida.

An ongoing plan to integrate nanotechnology and material science concepts is being conducted as part of a National Science Foundation GK-12 project at the University of South Florida. The objective of GK-12 STARS (*Students, TeachersandResourcesintheSciences*) program is to foster systemic change in elementary by enriching math and science curricula and encouraging long-term professional development for teachers in the K-5 band. The program also aims to decrease the current educational gap in science and math curricula prevalent among certain schools within the same school district, which is reflected in the outcome of the Florida Comprehensive Assessment Test (FCAT). This paper addresses nanotechnology and material science module development and implementation in fourth and fifth grade. Both qualitative and quantitative assessments of the developed modules will be illustrated. Teacher training is a second aspect to the integration of this innovative approach. Teachers are scheduled for training sessions that introduce basic nanotechnology and material science concepts. The aim behind this approach is to increase the content knowledge of the participating teachers in cutting edge technology fields. The last program that aims at integrating nanotechnology and material science concepts in the proposed grades involves field trips to the university's material research related laboratories (i.e. polymer chemistry, microelectronics, nanotechnology, geotechnics, corrosion, etc.) offered to students during the scholastic period and research experience for teachers during the summer break. This paper summarizes findings compiled during the previous two years regarding the integration of nanotechnology and material science into the fourth and fifth grade science curriculum.

SESSION PP4: Demonstrations of Materials Science for Outreach in Secondary Schools–Mini Tutorial
Chair: Shenda Baker
Tuesday Afternoon, November 30, 2004
Room 200 (Hynes)

**1:30 PM *PP4.1**
**Improving Materials Science Education with Demonstrations.**
Ainissa G. Ramirez[1] and Amy Moll[2]; [1]Mechanical Engineering, Yale University, New Haven, Connecticut; [2]Dept. of Mechanical Engineering, Boise State University, Boise, Idaho.

This session is design to showcase materials science demonstrations in order to improve the quality of science education worldwide. Traditional science classes often extinguish a student's innate enthusiasm for the subject by stressing memorization rather than creative thinking and hands-on discovery. This workshop will provide teachers of all levels with tools (including a materials science visual aid handbook) to engage students and make science more dynamic and compelling with demonstrations. Tentative demonstrations topics include: crystal structure, kinetics/diffusion, mechanical properties, magnetism, electrical and optical properties, polymers, and corrosion.

SESSION PP5: Materials Science Education: Ties with Industry/Focus on Middle School
Chairs: Shenda Baker and Fiona Goodchild
Tuesday Afternoon, November 30, 2004
Room 200 (Hynes)

**3:00 PM *PP5.1**
**Materials Education for the Twenty First Century Workforce: A Report on the 18th Biennial Conference on National Materials Policy, Washington D.C.** Aris Christou, Materials Science and Engineering, University of Maryland, College Park, Maryland.

This presentation a summary report of the 18th biennial conference on National Materials Policy, held May 24- 25, 2004 at National Academies Keck Center, Washington DC. This conference addressed the educational needs in materials science for the 21st century through a series of presentations which focused on all aspects of materials education including elementary (K-12), undergraduate as well as graduate education and continuing education. This meeting is a follow up of the 2002 meeting sponsored by the Federation of Materials Societies, FMS, and supported by the National Science Foundation and the Defense Department (DOD) on Materials Education for the 21st Century. A number of key recommendations resulted from the 2002 meeting including the emphasis on K-12 educational activities among the professional societies. The educational committee of FMS has spent the last two years organizing these outreach activities, especially with respect to secondary school science teachers. We have sought to make teachers aware of the broad range of educational tools involving materials which are now available from the professional societes. Other related conferences have included the 2000 National Materials Advisory Board (NMAB) Forum on "Materials in the New Millenium, Responding to Society's Needs". This meeting addressed four key themes: the critical role of materials in advancing technology, the industrial and societal needs that require materials development, materials research areas with the greatest potential in meeting these needs, and federal and industrial initiatives that can help the materials community. In meeting the purpose of the conference, four areas of interest were specifically selected by the steering committee: " The changing undergraduate and graduate materials curriculum (including issues related to accreditation and continuous improvement), " Programs to enhance K-12 education in materials and technology, " Continuing education and the role of the community colleges, and education for the non-materials professional, " Meeting the needs of industry in metals, metallurgy, microelectronics and soft materials through an emerging global workforce. The venue of the conference included invited presentations covering the above topics, and panel discussions with recorded recommendations developed by each session. The steering committee selected appropriate speakers so that a meaningful discussion of the four areas could be developed. Financial support from the National Science Foundation, the Air Force, American Society of Metals (ASM) and TMS was attained in order to bring invited speakers to the conference, to support publication of the workshop results, and to support the attendance of secondary school students and their mentors. A truly innovative session was the "materials mini camp" carried out concurrently during the conference with the participation of high school students and their teachers.

**3:30 PM PP5.2**
**NSF Sponsored Academic/Industrial Research Programs for Undergraduates and Teachers.**
Charles G. Wade[1], Dolores C. Miller[1], Joseph Pesek[2], Maureen A. Scharberg[2], Marni Goldman[3] and Curtis W. Frank[4]; [1]Materials Analysis and Characterization, IBM Almaden Research Center E1, San Jose, California; [2]Department of Chemistry, San Jose State University, San Jose, California; [3]Center for Polymer Interfaces and Macromolecular Assemblies, Department of Chemical Engineering, Stanford University, Stanford, California; [4]Department of Chemical Engineering, Stanford University, Stanford, California.

Two NSF sponsored partnerships for academic/industrial research

support research in chemistry and materials for undergraduates and teachers at the IBM Almaden Research Center (ARC). Since 1993 an NSF GOALI grant with San Jose State University has supported undergraduates and masters students doing research on collaborative, publishable projects at ARC. In addition, this grant has provided summer internships for about 20 students and 3-4 high school teachers from across the U.S each year for the past eight years. Since 1994, ARC has been a member of an NSF Materials Research Science and Engineering Center for Polymer Interactions and Macromolecular Assemblies (CPIMA). This partnership includes Stanford, UC Davis, UC Berkeley, several European institutions, and a number of industrial affiliates. It also has an active summer research internship program for undergraduates and teachers, many of whom are at ARC. These interns are joined by those from two other programs, one in partnership with the American Physical Society (Research Internship for Undergraduate Women) and one with the National Society of Black Engineers (Student Research Award IBM Research). Materials related research activities at ARC include: polymer synthesis, photolithography, thin film magnetic and polymer structures, computer modeling of protein folding, optical physics, quantum cryptography, and materials characterization. During the summer each intern becomes a member of a mentor's research group, does publishable research, attends a weekly seminar on research frontiers, attends a one-day graduate school workshop ands a one-day career decision conference (both sponsored by CPIMA) and participates in a poster technical meeting. Student and teacher response to these programs is excellent; equally strong support comes from the faculty and industrial mentors. About 2/3 of the students proceed to professional or graduate school. Efforts are made for diversity in the participants: approximately half are women, 10-15% are from underrepresented groups, and about half are from 2 and 4 year institutions. The presentation will focus on the SJSU program, covering the general aspects of the program, examples of the research activity, and benefits of the partnership to the students, to the teachers, to the faculty, and to IBM.

**3:45 PM PP5.3**
**Integrating Materials Science into the Uruguayan Curricula.**
Laura Fornaro, Hector Espinosa and Gustavo Laborde; Compound Semiconductors Group, Faculty of Chemistry, Montevideo, Uruguay.

In a similar way than in other Latin-American countries, science, technology and innovation had played a less significant role in the Uruguayan development than in other regions. Historical, social and economical factors have brought out in the country a more humanistic than scientific oriented society. This fact had influenced in a variety of items, included the education. The Uruguayan curricula have a wider contribution of sciences, related to other Latin-American countries ones. However, basic sciences predominate in the high school curricula, in several university careers and also in the research activities (with some exceptions such as health and natural resources fields). There are only a few references to Materials Science in the complete Uruguayan curricula. They are usually immersed in other subjects: Materials Science is not taught as an explicit item. On the other hand, the high school teachers of the country are trained in an especial institute, not in the University, and they are therefore isolated from the research activities. Over the last years, Masters in Science oriented to science education are been implemented in the University as a further training level for high school teachers. One of this Masters in Science is devoted to integrate Materials Science into the curricula, at the high school, at the high school teacher institute and at the university. The work here reported includes the survey of the current curricula and the proposal of the introduction of material science related classroom and laboratory activities, as well as especial multidisciplinary modules. Theoretical, experimental and teaching aspects are being taken into account for each activity. The educational work is being performed directly from one of the research groups that work on Materials Science in the country. Thereby, it is a very interesting experience of collaborative efforts of materials scientists, university and high school teachers. As there is an unique curricula at the high school level in all the country (three millions population), and research in science is mainly performed at the public university, results of this work may be directly proposed to the corresponding authorities for their future actual application.

**4:00 PM *PP5.4**
**Development of Computer Game Based Instruction: The Periodic Table Game.**
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A collaboration between The Materials Research Science and Engineering Center (MRSEC) and the Integrated Science (IS) program run by the Center for Communication and Education Technology (CCET) at The University of Alabama has been developing a computer game based approach to teaching Periodic Table concepts and facts to middle school students. We have targeted this age group because it is during the 5th-7th grade years that many students lose interest in science. The idea of using computer games as an instructional tool seemed a natural one given the popularity of such games with both genders in this age group. The team working on the project draws from both the MRSEC and CCET. The MRSEC provides support for two Research Experiences for Teachers (RET) participants who provide content and direction for the designers and programmers. These teachers have been drawn from schools served by the IS program, and so are very familiar with the target audience for the computer game. The game is broken into seven different sections. There are three information centers which are each paired with a game, and there is a "dream room" which provides an incentive for students to master the subject matter of the game. The three information centers focus on learning the elements, their positions in the periodic table, and trends in physical and chemical properties. The games then test the students' knowledge of the concepts and facts in the information centers. The games allow students to request hints, which provide a further avenue for the students to learn about the elements. The game is currently approaching a beta version which will be tested on groups of middle school students during the summer and the Fall 2004 semester. Plans for evaluation of the impact of the program on middle school students are currently in development and it is expected that a preliminary analysis of the evaluation data will be presented. Distribution to schools participating in the IS program will be through CCET. Means of distributing the program to other schools are still being developed.

**4:30 PM PP5.5**
**Broadening Middle-School Student Images of Science and Scientists.**
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One factor influencing K-12 students' decisions not to study science and engineering is the common perceptions of what scientists and scientific careers are really like. The 'mad scientist' stereotype is alive and well - and not an image most kids can (or want to) identify with. Project Fulcrum is a NSF GK-12 program that teams science, math, engineering, and technology (SMET) graduate students with middle-school 'Lead Teachers'. The program is designed to help future researchers understand the challenges of K-12 education and their place in addressing those challenges. The Role Model Project addresses the goal of broadening student images of science and scientists. Although teachers often do have scientists visit their classrooms, this project asked the teacher/graduate student teams to gather information specific to their classes and use that information, along with the results of a pre-survey of student attitudes, to design their projects. Although all of the activities involved scientist visits, the implementation and the activities surrounding the visits were different so as to address the unique needs of each classroom. Sudents at one school wrote that "all scientists do is work", so the team had the students investigate the visiting scientists' hobbies and other outside interests. Students at another school felt that all scientists are 'nerds' or 'geeks'. These students were asked to guess whether classroom visitors were scientists and explain their reasoning in writing. These answers provided interesting information about the origin of student stereotypes. For example, one scientist was identified as a non-scientist because he was on crutches due to a sports injury (and we all know that scientists don't play sports!). Assessments developed by the teachers included having students make Venn diagrams that compare their interests and skills with those of the visiting scientists. Other teachers had students design posters comparing and contrasting the different types of scientists. Teachers wrote up their activities and reflected on how their assessments suggested changes for future activities. The Role Model Project provided an excellent opportunity for participants from the University of Nebraska MRSEC to share their research, as well as their personalities and outside interests, with middle-school students. Participating in the context of a broader project leverages the researchers' contributions, increases university/K-12 school contact, and allows assessment of the researchers' participation. This work was supported in part by the MRSEC Program of the National Science Foundation under Award No DMR-0213808 and the GK-12 program under DGE-0086358

**4:45 PM PP5.6**
**"Advanced Potions: A Journey Into the Nanoworld." A Nanoscience Camp for 5th-8th Grade Students.**

Andrew Greenberg[1,2], Jackie Bortiatynski[2] and Dan Sykes[2]; [1]Center for Nanoscale Science, The Pennsylvania State University, University Park, Pennsylvania; [2]Department of Chemistry, The Pennsylvania State University, University Park, Pennsylvania.

Using current interest in Harry Potter and Lord of the Rings as a portal into the magical world of nanoscience, student participants will discover the secrets of the Apprentice's Stone. Ancient philosophers sought the wisdom of the Apprentice's Stone recognizing it as the key to unlocking the connections between Art, History and Science. Each day at the Penn State Center for Nanoscale Science Department of Chemistry's "School of Potions and Wizardry", the Professors and Prefects in our prestigious Chemistry Houses guide students as they explore a different property of the stone through a set of related hands-on laboratory activities. Day 1: "What we see is not necessarily all that is there." Activities Putting the nanoscale in perspective Paints extracted from natural products Day 2: "Knowledge can induce change" Activities Make magic wands using materials that change color when heated or exposed to UV radiation Create a mosaic and fresco from their own paints and natural materials Build polariscopes Day 3: "The power of attraction" Activities Make a magnetic "etch-a-sketch" Build nanoscale motors using photolithography Day 4: "The power of selection" Activities Growing mega zeolites Chromatography Day 5: Reversibility and Irreversibility" Activities Creating scratch and sniff paint using microencapsulation Shifting shapes with shape-memory metals inks of invisibility