SYMPOSIUM GG

Impacting Society through Materials Science and Engineering Education

April 17 – 19, 2001

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SESSION GG1: INTEGRATION OF RESEARCH AND EDUCATION
Chair: Kristen Constant
Tuesday Morning, April 17, 2001
Concordia (Argent)

8:30 AM *GG1.1
INTEGRATION OF MATERIALS RESEARCH AND EDUCATION: WHAT, WHY AND HOW. Carmen Huber, National Science Foundation, Division of Materials Research, Arlington, VA.

Creation and utilization of new knowledge currently requires scientists and engineers that are able to use their education and talents in a variety of employment settings. Also, the competitiveness of today's global marketplace calls for a workforce with strong baseline skills in science, mathematics and engineering. Finally, in order to make informed decisions on complex issues involving science and technology, all members of society need a basic understanding of mathematics, science and engineering. For these reasons, an approach to development of human resources in science and technology that goes beyond the traditional R&D mission goals and that integrates research and education at all levels is needed[1,2]. The challenge is to expand the scope of the partnership between government and institutions of higher learning, by which research dollars have simultaneously supported research and postbaccalaureate education, to include science and technology education at all levels. A strengthening of this partnership is also required so that its broader scope does not imply a diminished pursuit of the traditional goals. This presentation describes efforts at the National Science Foundation, particularly at the Division of Materials Research, to promote the integration of materials research and education at all levels. Specific programmatic activities are discussed and examples of various types of projects supported by these programs are presented.
[1] National Science Foundation, NSF in a Changing World, NSF-95-24 (Arlington, VA; 1995).
[2] National Science Board, US Science and Engineering in a Changing World, NSB-96-22 (Arlington, VA; 1996).

9:00 AM GG1.2
CULTIVATING GRADUATE STUDENTS: TECHNIQUES TO INSPIRE EFFECTIVE RESEARCH. David Braun, Cal Poly State University, Electrical Engineering Department, San Luis Obispo, CA; Linda Vanasupa, Blair London, Cal Poly State University, Materials Engineering Department, San Luis Obispo, CA; Kevin Kingsbury, Cal Poly State University, Department of Chemistry and Biochemistry, San Luis Obispo, CA; Heather Smith, Cal Poly State University, Statistics Department, San Luis Obispo, CA.

Each year, U.S. institutions grant well over 10,000 bachelor's degrees in science and engineering. However, only a small fraction of those students pursue graduate study. Many who do often experience great difficulty partly due to a lack of preparation for research: the nature of research is inherently foreign to those who are accustomed to studying course material and demonstrating their mastery of it by passing an exam. Carefully involving undergraduates in research can be an effective means for inspiring students to pursue graduate study. We have found that one can create a positive research experience for the student by implementing simple techniques. In this presentation, we present these practical techniques which include: Defining a manageable undergraduate research project; marketing the project to undergraduates; enabling effective record keeping in laboratory notebooks; focussing and directing research through efficient experimental designs. Along with these techniques, we will present examples–taken mainly from our semiconductor polymers laboratory. We will also present the inherent pitfalls associated with these techniques.

9:15 AM GG1.3
BEYOND THE CLASSROOM: EDUCATING UNDERGRADUATES IN MATERIALS SCIENCE RESEARCH AND CAREERS VIA THE CPIMA SURE PROGRAM. Marni Goldman, Stanford University, CPIMA, Dept. of Chemical Engineering, Stanford, CA; Charles G. Wade, IBM Almaden Research Center, San Jose, CA; Brenda E. Waller, Curtis W. Frank, Stanford University, CPIMA, Dept. of Chemical Engineering, Stanford, CA.

Summer undergraduate research programs play an important role in materials science education. The Center on Polymer Interfaces and Macromolecular Assemblies (CPIMA), an NSF MRSEC and joint partnership among Stanford University, IBM Almaden, and University of California at Davis, established the Summer Undergraduate Research Experience (SURE) Program in 1995. Its mission is twofold: to expose undergraduate students to cutting-edge research and to help students with their ultimate career decisions. Approximately twenty-five students each summer are assigned a research project under the direction of a mentor. Students are exposed to a variety of research environments by being placed at a number of CPIMA affiliated sites including universities, industry, and laboratories overseas. Regardless of site, students participate in research group meetings and learn the research process, a valuable experience that is often not obtained during a student's undergraduate years. To complete the research experience, SURE students attend a CPIMA Forum where they present posters on their research and interact with members of both academia and industry. While undergraduates are exposed to academia, they are often not exposed to industry or alternative careers. As a majority of students will have careers outside of academia, it is vital that they learn about other options for materials scientists. SURE students learn about industrial research by visiting IBM and getting a tour of the Almaden Research Center. A Career Day is held during the Program where students are given workshops on applying to graduate school as well as talks from people in different scientific careers, both traditional and nontraditional. By the end of the ten weeks, SURE students are exposed to a number of experiences and ideas and have hopefully learned important lessons that a traditional classroom does not afford. To date, over 150 students have participated. Criteria, processes, assessment, and lessons learned will be covered.

9:30 AM *GG1.4
THE INTRODUCTION OF MATERIALS SCIENCE RESEARCH TOPICS INTO UNDERGRADUATE SCIENCE COURSES. Wm. Christopher Hughes, James Madison University, Dept of Physics, Harrisonburg, VA; Brian H. Augustine, James Madison University, Dept of Chemistry, Harrisonburg, VA.

A large number of professional materials scientists and materials science graduate students come from undergraduate chemistry and physics backgrounds. Often these students are educated at primarily undergraduate institutions with no engineering programs and it is these schools which serve the largest overall percentage of undergraduate students in this country. Introducing materials science to the undergraduate chemistry and physics major at an earlier stage in institutions such as these should serve to increase interest in the field of materials science. However, there are challenges related to the traditional physics and chemistry curriculum and the lack of materials science facilities that must be overcome. In this talk, we will discuss the way in which science majors at James Madison University are being exposed to materials science in freshman through upper-level chemistry and physics course. In particular, examples of the use of topics and facilities from ongoing research projects will be given in which students learn aspects of photolithography, corrosion, and self-assembly. For example, students at the junior/senior level perform experiments on the inhibition of copper corrosion by alkanethiol monolayers. This draws equipment facilities, and expertise directly from ongoing undergraduate research projects into the classroom. By exposing these students to such topics, we hope that many may chose materials options in their undergraduate program and be better prepared to pursue graduate level work in materials science.

10:30 AM *GG1.5
TEACHING UNDERGRADUATES AND GRADUATE STUDENTS RESULTS FROM RECENT RESEARCH AS PART OF A CLASS. L.J. Martinez-Miranda, J. Kidder, R.J. Briber, I.K. Lloyd, O. Wilson, M. Al-Sheihkly, and L.G. Salmanca-Riba, University of Maryland, Dept. of Materials and Nuclear Engr., College Park, MD.

We have integrated recent results in research in the curriculum of the University of Maryland, while leaving the basics untouched. This allows us to teach the fundamental laws and to show the students how these help us to answer questions that are of importance today. This can be done as part of a laboratory class and as part of a class. In the laboratory classes, we emphasize what is measured (the main topic), then measure samples recently in the literature. If available, we measure two samples, and have a discussion on what are the differences are. These are then related to the manner the samples have been grown. In the classes, we show the basic equation or relation, and introduce how it can answer a question that is pertinent to today's research.

11:00 AM GG1.6
UNIVERSITY OF MARYLAND MRSEC RESEARCH EXPERIENCE FOR UNDERGRADUATES: CULTIVATING TOMORROW'S RESEACHER. Jennifer Stott, University of Maryland MRSEC, College Park, MD.

The University of Maryland MRSEC Summer Research Experience for Undergraduates (REU) provides students with a well-rounded educational experience doing materials science research. Supplemental activities enhance the lab experience and provide students with opportunities to advance future graduate school and science careers. Approximately 6-8 sophomore and junior students with science and engineering backgrounds participate in the intensive 10-week program. During the summer, students gain laboratory experience while working on a research project with a MRSEC faculty member. The REU program offers a diverse range of research topics and includes a weekly seminar series, industrial tours of UM facilities, and a tutorial on how to conduct oral and poster presentations. The students also observe and learn how research is performed at other labs through tours of neighboring government and industrial laboratories. The REU program visited NASA, NIST, the UM radiation laboratory and Grace Davidson, one of the worlds leading silica-based adsorbent manufactures. After participating in the UM REU program, one participant wrote, This summer I will be working in the Semiconductor Department at Motorola my participation in last year's MRSEC REU program has immensely helped me [as it] increased my curiosity within the sciences. The five-year-old REU program is well regarded by both the students who have participated in the program and the faculty members who mentor the students. Past participants have pursued advanced degrees in science and entered the science workforce thus fulfilling the program's goals.

11:15 AM GG1.7
ENHANCEMENT OF UNDERGRADUATE MATERIALS EDUCATION THROUGH RESEARCH AND INDUSTRY-ACADEMIA INTERACTIONS. Asit Ray, Christian Brothers University, Dept of Chemical Engineering, Memphis, TN.

The Engineering School at Christian Brothers University(CBU) offers an introductory materials course at the sophomore level followed by a course on polymer science and engineering at the senior level. The latter is supplemented by an undergraduate polymer laboratory course. Students desiring to get further exposure to materials processing are connected with local polymeric materials companies where they work as interns. The CBU chemical engineering students have the opportunities to work in the undergraduate research with Dr. Asit Ray(the author) with cooperation from local polymeric materials companies. Their works are acknowledged in terms of student paper presentation at local or regional research seminars. Because of the unique undergraduate materials program, some of the top engineering students at CBU select graduate school and are offered graduate fellowships/assistantships at universities having highly rated materials programs. In 1998, CBU Engineering School's involvement with the polymeric materials industry was expanded when local polymer company personnels were allowed to conduct proprietary researches at the institution's Polymer Engineering Laboratory with the help of paid undergraduate engineering students and the author, who would act as a consultant. The Chemical Engineering Department at CBU also initiated collaborative research with the engineering school of a local university and a biomaterials company. In order to meet the growing needs of packaging engineers in this area, local companies(polymer and others) that have packaging departments and the School of Enginering at CBU recently joined forces to develop a packaging teaching/training program for students as well as employees of these companies. This program would include packaging materials and engineering. The details of Phase I and projected Phase II of this joint venture will be described in details in the paper to be submitted for presentation.

11:30 AM *GG1.8
INDUSTRIAL/ACADEMIC INTERNSHIPS AT IBM-ALMADEN UNDER NSF PROGRAMS. Chas. G. Wade, Dolores Miller, Science and Technology, IBM Almaden Research Center, San Jose, CA; Marni Goldman, Dept of Chemical Engineering, Stanford University, Stanford, CA; Brenda Waller, MDL Information Systems, San Leandro, CA; Malinda Pauly, Dept of Chemistry, Santa Clara University, Santa Clara, CA; Joe Pesek, Maureen Scharberg, Dept of Chemistry, San Jose State University, San Jose, CA.

Industrial experience can be a significant factor in materials science education, and internships at our laboratory under two NSF programs directly impact undergraduates and high school teachers. In these programs, the participants become a member of individual, existing research groups under a mentor on a technical project relevant to IBM. The research is publishable but closely related to a technical area important to IBM. During the summer the participants become members of the research group, attending departmental meetings and informal discussions. In addition, they attend a special seminar series on industrial research frontiers, receive career-training discussions, and participate in a variety of other programs sponsored for summer interns by IBM. Every participant presents a poster at an internal technical meeting at IBM at the end of the summer. One of the programs, an NSF MRSEC "Center for Polymer Interfaces and Macromolecular Interfaces" (CPIMA), involves a partnership with Stanford University and the University of California at Davis. The CPIMA program has an active group of postdoctoral scientists, graduate students, undergraduate (summer) students and (summer) high school teachers. In addition to IBM, summer students in CPIMA may work with other industrial firms who are industrial affiliates of CPIMA. In addition, it has a public science and K-12 component in materials science in educational outreach with the The Tech Museum of Innovation in San Jose. The other program, an NSF GOALI grant on "Surface and Analytical Chemistry of Materials" with San Jose State University, involves undergraduate and graduate (masters) San Jose State University students and also has a large summer program with undergraduates from across the US and with high school teachers. The impact of the programs on the students, teachers, and institutions will be reviewed, with a special emphasis on the impact on the industrial partner.

SESSION GG2: MATERIALS SCIENCE AND ENGINEERING EDUCATION BEYOND THE UNIVERSITY

Chair: Kristen Constant
Tuesday Afternoon, April 17, 2001
Concordia (Argent)

1:30 PM *GG2.1
MATERIALS SCIENCE BASED TEACHER TRAINING INSTITUTES FOR MIDDLE AND HIGH SCHOOL TEACHERS. Brian W. Sheldon, Brown University, Division of Engineering, Providence, RI.

Members of the Engineering faculty at Brown have developed a workshop for local science and math teachers. The primary goal of this workshop is to help teachers use Materials Science and Engineering (MS&E) concepts in their basic curriculum. MS&E provides an excellent vehicle for teachers to present a number of important concepts to students, including: (1) integration of math and science, (2) examples of "real-world" applications, (3) demonstrations of interdisciplinary advances in technology, and (4) engineering design. This workshop was directed at middle and high school teachers, and was organized in conjunction with the Institute of Elementary and Secondary Education (IESE), which is part of the Education Department at Brown. It consisted of 6 sessions, 2.5 hours each, spread over a period of 2 months. The materials were presented by six members of the Engineering faculty. A local middle-school science teacher was also recruited to co-facilitate all of the sessions. The teachers who attended the workshop were given a variety of educational materials, including a summary of how the MS&E material that we presented could be used to satisfy AAAS curriculum standards. Some of the topics in the workshop were also coordinated with classroom visits, where Brown faculty and students made presentations in the teachers' middle and high school classrooms. This workshop was certified by the Rhode Island Department of Education, so that participating teachers received one "professional development credit".

2:00 PM GG2.2
THE RET PROGRAM IN THE CENTER FOR MATERIALS FOR INFORMATION TECHNOLOGY AT THE UNIVERSITY OF ALABAMA. David E. Nikles and Garry W. Warren, Center for Materials for Information Technology, The University of Alabama, Tuscaloosa, AL.

The Center for Materials for Information Technology has a mission of outreach to middle school students. For the past two years our Center has run a summer research experiences for teachers (RET) program. A primary emphasis of the Center's educational outreach activities involves collaboration with a very innovative 6th to 8th grade Integrated Science (IS) curriculum based in the Center for Communication and Educational Technology at the University of Alabama. Each summer three teachers from the IS program spent ten weeks working in the Center to develop demonstrations or activities for use in their classrooms. The emphasis was on demonstrations of magnetism and magnetic materials. In addition to these activities, the teachers have also assisted in the development of Computer Aided Instructional (CAI) software for use in their science classrooms. Both the activities and the software developed this summer will be made available to all of the teachers and students participating in the IS curriculum, approximately 1400 teachers and 170,000 students.

2:15 PM GG2.3
SCIENTISTS AS MENTORS TO SCIENCE TEACHERS. Fiona Goodchild and Carol Johnston, University of California, Santa Barbara, CA.

This presentation will report on ideas and information that research scientists find useful in the role of mentors for teachers in a summer Research Experience for Teachers (RET) program. RET programs offer teachers an opportunity to share in the culture and practice of research science. The paper will present data that was gathered from individual interviews with 6 science teachers and their research mentors in the RET program at the Materials Research Laboratory (MRL) at UCSB in summer 2000. The interviews revealed some of the images of this culture that the teachers will take back to their classrooms and what images the scientists hope will be presented. This study is part of a larger project aimed at identifying what teachers take away from these research apprenticeships, and how their research experiences and their mentor's instructional styles affected how teachers learned and talked about science in presentations to their peers. We will address the question of what these interviews reveal about:

- expectations of scientists and teachers about the RET project
- contrasting aspects of the science teaching and research cultures
- teachers' academic and research backgrounds
- effective instructional strategies for RET
- learning resources for teachers and scientists in RET programs
- the importance of appropriate matching of scientists and teachers

Building on these findings this presentation will make recommendation about how scientists can prepare to be effective mentors for teachers in summer research internships.

2:30 PM GG2.4
MATERIALS AND THE GATEWAY TO SCIENCE, ENGINEERING AND TECHNOLOGY. Steven Krauss, Don Evans, Center for Research on Education in Science, Mathematics, Engineering and Technology, Arizona State University, Tempe, AZ; Thomas Stoebe, University of Washington, Seattle, WA.

Materials as a subject is one that is highly motivational to students at all levels. It can be taught as a hands-on subject with ties to everyday life, in particular, to the things that children play with and that older students use daily. This philosophy is the basis for this project which uses Materials as a basis for science and technology curricula in the schools. Project goals include the development of curricula for the full range of science taught in the schools from a base in materials: biomaterials as the base for biology, materials extraction as the base for earth science, materials science as the base for physical science. Initial focus is on the upper elementary and middle grades since that is the part of the school curriculum that is in greatest need of revision. Further development would also include high school and introductory college levels. All curricula and instructional materials will be based on the National standards for science and technology, and most instructional material development will be focused more on adapting and upgrading existing curricular modules rather than developing new ones. This program is coordinated at Arizona State University by the Center for Research on Education in Science, Mathematics, Engineering and Technology (CRESMET). Cooperating Universities include University of Washington, Penn State University, University of Texas at El Paso, University of Iowa, Norfolk State University and Northwestern University, along with appropriate community colleges and K-12 school districts. Other faculty interested in participating in this program are invited to contact CRESMET at cresmet@asu.edu with their expression of interest.

3:15 PM GG2.5
WAYS THAT ENGINEERS CAN GET INVOLVED IN RECRUITING FUTURE MATERIALS SCIENTISTS AND ENGINEERS. Stacy H. Gleixner, San Jose State University, Dept. of Chemical & Materials Engineering, San Jose, CA.

For materials science and engineering departments across the country, recruitment of students is a critical concern. To increase enrollment, students' interest in materials science needs to be sparked early, preferably before they begin college. However, many entering college students have never heard of the major and those that are aware of the major are unsure of what a career in materials science would be like. There are many excellent resources that have been developed to target this problem directly including comprehensive career resources on the web, videos describing careers in materials engineering, and teaching materials developed for high school science teachers. One of the greatest resources is to have materials scientists and engineers interact directly with middle and high school students. The industry professionals can convey the aspects of their field that excite them and inform the students on what a career in materials would be like. Many programs already exist on a national or local level to facilitate this interaction. This paper will catalog the different programs available for engineers to become involved in their local schools or communities including science fairs, visiting classrooms, providing tours of their company, or hosting a student intern for a day or project. The paper will also detail resources available online and through professional societies to assist the engineer in developing materials based teaching modules and demonstrations.

3:30 PM GG2.6
MARQUETTE'S ENGINEERING STUDENT VOLUNTEER OUTREACH PROGRAM TO FIFTH GRADERS - A COMPARISON OF SCIENCE EDUCATION IN PUBLIC SCHOOLS AND CHOICE SCHOOLS IN MILWAUKEE. William E. Brower, Jr., Marquette University, Dept of Mechanical and Industrial Engineering, Milwaukee, WI.

Educational efforts by the MSE Profession can effect society in several ways: by producing more and better MSE graduates, by enhancing the Materials backgrounds of other engineering disciplines, by continuing education programs, and, in a nontraditional sense, by impacting the non-engineering community with outreach programs. I suggest that the effect on society of working with disadvantaged elementary school children such as inner city fifth graders is potentially far greater than efforts spent on outreach programs to high school or middle school students. The Fifth Grade Volunteer Teaching Program (5GVP) at Marquette has attempted over the last ten years to inform Milwaukee's inner city fifth graders of the existence of an engineering career while showing them that science is something they can actually do and that the doing is fun. One of our self contained, very hands on lessons which portends MSE is called, "Phases of Matter". This year I have expanded the 5GVP Program to include three of the Choice/Charter Schools which are now operating in Milwaukee. These schools differ from the Milwaukee Public Schools (MPS) and from each other significantly. Class sizes in these three schools vary from much smaller to about the same size as MPS. The three school buildings range from ramshackle to modern. The "For Profit" Charter School has science labs, whereas the two nonprofit Choice Schools do not. We will compare the science curricula and the level of science training of the teachers in the Choice/Charter Schools to those of the MPS Schools. By the April, 2001 date of the MRS Spring Meeting, we will have had most of our first year's interactions with the Choice/Charter Schools and will report our findings then.

3:45 PM GG2.7
MATERIALS SCIENCE EDUCATIONAL OUTREACH THROUGH THE COLLABORATION OF A MRSEC CENTER WITH A TECHNOLOGY MUSEUM. Catherine Hoffmann, Marni Goldman, CPIMA, Stanford University, Dept of Chemical Engineering, Stanford, CA; Charles G. Wade, CPIMA, IBM Almaden Research Center, San Jose, CA; Judith Fritz, Jessica White, The Technology Museum of Innovation, San Jose, CA.

Materials science education for elementary and middle school students is the objective of the collaboration between CPIMA (Center on Polymer Interfaces and Macromolecular Assemblies, an NSF MRSEC that is a joint partnership between Stanford University, U.C. Davis, and IBM Almaden) and the San Jose Tech Museum of Innovation. Hands-on materials science modules are being designed for presentation to grades 4 through 8 in local schools. The collaboration is structured so that CPIMA provides the materials science expertise, while the museum provides the educational knowledge as well as a van to travel to schools, materials, and personnel. The educational modules will be integrated into the long-term outreach activities of both the CPIMA and The Tech Museum. In building modules, the CA State Science Standards are used as a guide in choosing appropriate activities for each grade level. The subject matter for each grade level and module either are directly connected with or are extensions of the museum experience. Modules are structured to provide for several visits to the same classroom throughout the year so that a theme can be developed around a particular materials science topic. An advisory board of teachers was consulted to ensure that the modules would complement and enhance their curricula via hands-on activities. Whenever possible, a design challenge approach is taken to the module series. In such cases, the first few visits are meant to be preliminary inquiry sessions where a knowledge base is acquired. A final problem or challenge, requiring the students to synthesize the earlier material, is then posed for the class or teams to solve. Feedback from the early pilots of some modules has been very positive. In some cases, students reported this to be their first experience with experimental science. Comments from teachers and other advisors have led to improvements in current and future module design.

4:00 PM GG2.8
HANDS-ON, MINDS-ON: SCIENCE, READING, WRITING, AND MATHEMATICS. Donna Hammer, Materials Research Science and Engineering Center, University of Maryland, College Park, MD.

The Maryland MRSEC has developed an innovative-multidisciplinary science, mathematics, reading and writing short-course that successfully incorporates materials science into school-to-career learning goals and science standards within the existing Prince George's County curriculum. The course engages students in "real life" learning by providing challenging opportunities to observe and apply science, reading, and writing knowledge outside the classroom. Two key partnerships have made this program a success: 1) Northwestern High School, a predominately African American school, has incorporated the concepts, lessons and assessments into the curriculum; and 2) participants from the divisions of Media and Government Relations and Education at the American Institute for Physics (AIP) have donated their expertise in science writing and careers. The program is taught two days each week for seven weeks and is carried out in the physics and English classrooms and incorporates mathematics and technology. In physics class, science topics are introduced by MRSEC faculty members through demonstrations, hands-on activities, and discussions of applications in the workplace. Students visit University of Maryland laboratories and guest speakers from the University of Maryland and the AIP talk about careers in science. Science concepts are reinforced in the English classroom where students learn to read and write critically about materials science topics. Students work with science writers to learn the format and techniques used when writing for a general audience. Students learn to write about a specific material and how that material applies to the lives of their audience. In addition, students visit AIP, work with an AIP broadcast journalist and participate in a press conference. Outcomes from the program include increasing the students' understanding of materials science, the workplace, and technology; strengthening University, industry and high school relationships; and providing faculty and professionals with a service-learning experience.

4:15 PM GG2.9
MATERIALS EDUCATION THROUGH K-12 OUTREACH ACTIVITIES. John Schemmel, Mark Kuss, Kevin Hall, University of Arkansas, Department of Civil Engineering, Fayetteville, AR.

Not unexpectedly, children in grades K through 12 have a limited appreciation for the physical and mechanical properties of the materials used in the construction of buildings, bridges, pavements, and other Civil Engineering projects. An outreach program conducted within the Civil Engineering Department at the University of Arkansas addresses this issue in an entertaining and age appropriate manner. The "Be an ACE (Arkansas Civil Engineer)" program introduces students to the need for knowledge regarding a materials properties and field performance. Through various laboratory demonstrations and experiments, students discover that materials are designed to have specific properties that are both significant and appropriate for the intended application. The most popular of these demonstrations is "Smash and Crash". In this program, a wide range of materials, in the form of golf, tennis, and bowling balls, lead weights, paper products, pencils, coins, and more are compressed in a universal testing machine. Following the demonstration, the load-deformation characteristics of each material is analyzed. Another demonstration considers the use of various materials as a protective barrier for bridge piers. In "Who's the Egg?" a toy truck is released down a ramp and impacts a barrier. If the barrier material, which could be water, sand, or even Jell-O, can not resist the impact of the truck a fresh egg on top of a "bridge" is knocked over, cracks, and generates many laughs and surprised facial expressions. This paper details these, and other, experiments and demonstrations that are used to educate K through 12 students about the properties of construction materials.

4:30 PM GG2.10
THE GENESIS SPACE PROBE AS A PLATFORM FOR MATERIALS EDUCATION. Charles C. Hays and Donald S. Burnett, California Institute of Technology, Pasadena, CA.

Space science and technology have impacted almost every aspect of our lives in todays world. The exploration of space has been, and continues to be one of the most visible of collaborative efforts between federal laboratories, industry, and academia. As such, the potential for educational outreach is great. NASA space missions traditionally have a strong focus in this area. The Genesis mission continues in this tradition (see http://genesismission.org), and provides a unique opportunity for materials related outreach at all educational levels. The Genesis mission seeks to improve our understanding of the origins of our solar system through measurements of the solar wind using widely differing materials; e.g., Si, Ge, sapphire, and a new bulk metallic glass developed at Caltech. Thus, the Genesis space probe is an excellent platform for materials education. The implementation of these materials for use as solar wind collectors provides examples of semiconductor materials and technology. The implementation of the bulk metallic glass collector is an excellent example of the materials design and technology transfer process. This latter will be a focal point (by CCH) for a web-based outreach effort to undergraduates in both physics and materials science. The Genesis mission provides the physics student with tangible evidence of a current experiment aimed at furthering our knowledge of the solar composition. Thus building on a rich tradition of experiments covered in a course in modern physics. The student in materials science would see first hand evidence of the process of materials selection and design. In fact, the Genesis platform is about exploiting this process to its best advantage. In this talk we will outline our outreach strategy as it applies to the Genesis project. We look forward to feedback from the symposium attendees about how this information could be integrated into areas outside beyond the university level.

POSTER SESSION:
UNDERGRADUATE MATERIALS RESEARCH INITIATIVE (UMRI) WINNERS
Tuesday Evening, April 17, 2001
8:00 PM
Salon 1-7 (Marriott)

UMRI Winners

UMRI-1
OPTICAL ABSORPTION OF DOPED AND UNDOPED BULK SiC. Kristina Miller, Omar Manasreh, Univ of New Mexico.

UMRI-2
INVESTIGATION OF THE SPIN HALL EFFECT. Terri Lisman, Robert C. Dynes, Univ of California-San Diego.

UMRI-3
NONDESTRUCTIVE EVALUATION OF FATIGUE DAMAGE USING THERMOGRAPHY. Jacob Gloekler, Victoria A. Kramb, Univ of Dayton.

UMRI-4
PRESSURE EFFECTS ON THE CRYSTALLIZATION AND MECHANICAL BEHAVIOR OF AMORPHOUS METALS. Robert D. Boyer, John J. Lewandowski, Case Western Reserve Univ.

UMRI-5
CONSTRAINED MICROSTRUCTURE CALCULATIONS FROM FOURIER ANALYSIS. Mark Lyon, Brent L. Adams, Brigham Young Univ.

UMRI-6
TRANSMISSION ELECTRON MICROSCOPY OF NANOMETER SIZED PROJECTIONS DEVELOPED DURING ION BOMBARDMENT: IMPLICATIONS FOR DEPTH PROFILING SURFACE ANALYSIS TECHNIQUES. Jack Kollwitz, Kim W. Pierson, Univ of Wisconsin-Eau Claire.

UMRI-7
THE EFFECTS OF COMPOSITION VARIATION ON THEIN FILM Fe-Co CATALYSTS FOR AMMONIA SYNTHESIS. Jonathon Fort, Ronald S. Besser, Louisiana Tech Univ.

UMRI-8
THE EFFECTS OF COLD WORK ON THE THERMAL EXPANSION OF METALS. Jesse Garcia, Dustin Shaw, Lew Rabenberg, Univ of Texas-Austin.

UMRI-9
PREPARATION OF ANHYDROUS INDIUM NITRATE FOR USE AS A SINGLE SOURCE PRECURSOR IN THE CVD OF INDIUM OXIDE FILMS. David Flannigan, Wayne L. Gladfelter, Univ of Minnesota.

UMRI-10
FLIP CHIP MAGNETIC TUNNEL JUNCTIONS USING Fe_3O_4 ELECTRODES. John Read, Ichiro Takeuchi, Univ of Maryland.

UMRI-11
MECHANICAL BEHAVIOR OF PEROVSKITE CERAMICS. Irene Nina Gonzalez, Nina A. Orlovskaya, Drexel Univ.

UMRI-12
AN INVESTIGATION OF THE ELECTRON TRANSPORT PROPERTIES OF $Ba_2EuZrO_{5.5}$. Alex Harvey Jr., Laurence L. Henry, Southern Univ.

UMRI-13
AN INVESTIGATION OF POST-DEPOSITION ANNEALING OF TIN OXIDE THIN FILMS PREPARED BY PLASMA-ENHANCED CVD. Yen-Jung Huang, Colin A. Wolden, Colorado School of Mines.

UMRI-14
DIRECT SYNTHESIS OF ACCESSIBLE AMINE-FUNCTIONALIZED MESOPOROUS SILICA MATERIALS VIA SUPARMOLECULAR TEMPLATING. Stephen Soukasene, Sandra L. Burkett, Amherst College.

UMRI-15
SYNTHESIS, CHARACTERIZATION, AND APPLICATIONS OF CHROMIUM MANGANESE OXIDES AS CATHODE MATERIALS IN LITHIUM-ION BATTERIES. Kinson Kam, M. Stanley Whittingham, Binghamton Univ.

UMRI-16
MEASUREMENT OF THE RECOMBINATION VELOCITY OF MICROCRYSTALLINE SILICON/AMORPHOUS SILICON INTERFACES. Cameron Pedersen, Colin Inglefield, Weber State Univ.

UMRI-17
CHARACTERIZATION OF THE TEMPERATURE DEPENDENCE OF THE RESISTIVITY OF CVD DIAMOND. Kellie Martin, Mike Cushman, Karen M. McNamara, Worcester Polytechnic Inst.

UMRI-18
VISIBLE EMISSION FROM AMORPHOUS AiN THIN-FILM PHOSPHORS DOPED WITH TRANSITION METALS. Meghan Caldwell, Hugh H. Richardson, Ohio Univ.

UMRI-19
LUMINESCENCE OF TRANSITION METAL IONS IN BN THIN FILMS. Steven Allen, Martin E. Kordesch, Ohio Univ.

UMRI-20
A NOVEL APPROACH TO LATTICE ENGINEERED SUBSTRATE. David Jones, Shanthi Iyer, NC Agricultural and Tech State Univ

UMRI-21
CHARACTERIZATION OF CHALCOCITES PRODUCED BY THERMAL AND PLASMA ASSISTED SULFURIZATION. Chris Fischer, Colin A. Wolden, Colorado School of Mines.

UMRI-22
PHOTOELECTROCHEMICAL ETCHING OF III-V COMPOUND SEMICONDUCTORS. Todd Harrell, Wm. Christopher Hughes, James Madison Univ.

UMRI-23
A DENSITY FUNCTIONAL THEORY STUDY OF GAS PHASE PRE-REACTIONS IN THE METAL ORGANIC CHEMICAL VAPOR DEPOSITION OF ZnSe. Davide Moscatelli, Carlo Cavallotti, Politecnico di Milano

UMRI-24
THE EFFECTS OF THERMOCAPILLARY CONVECTION ON MICROGRAVITY MATERIALS PROCESSING. Stephen Barsi, Mohammad Kassemi, Manhattan College.

UMRI-25
ELECTROVISCOELASTIC DAMPING MATERIALS IN STRUCTURAL COMPOSITES. Phu Nguyen, John B. Kosmatka, Univ of California-San Diego.

SESSION GG3: EDUCATIONAL WORKSHOP ON RESEARCH PROGRAMS FOR SCIENCE TEACHERS

Chair: Linda Broadbelt
Wednesday Morning, April 18, 2001
Concordia (Argent)

8:30 AM GG3.1
OPENING REMARKS
EDUCATIONAL WORKSHOP ON RESEARCH PROGRAMS FOR SCIENCE TEACHERS.
Panel:
Bob Chang, Northwestern University, MRSEC, Evanston, IL
Carmen Huber, National Science Foundation, Arlington, VA.

The Educational Workshop on Research Programs for Science Teachers will be a day long event. It is devoted to developing a dialogue among all of the constituents involved in research programs for science teachers.

8:45 AM *GG3.2
SCIENCE EDUCATION: THE FUTURE OF SCIENCE AND OUR SOCIETY. Samuel A. Spiegel, Center for Integrating Research & Learning, National High Magnetic Field Laboratory, Florida State University, Tallahassee, FL; Patricia J. Dixon, Center for Integrating Research & Learning, National High Magnetic Field Laboratory, Florida State University, Tallahassee, FL.

Science education has been well established as quintessential to the advancement of science and our modern society. However, it is in recent years that we have begun to recognize the critical interplay between the scientific community, school/education community and our society. Each of these three sectors of our world are codependent on each other. The National Science Education Standards present a vision of science education which requires that all members of the "extended system" work toward science and mathematics classroom reform. Although education is often perceived by the public as being done in schools exclusively, "it also extends to those outside the system who have an influence on science education including students, parents, scientists, engineers, business people, taxpayers, legislators, and other public officials" (National Research Council, 1996, p. 9). In order to accomplish the goal of involving all educational stakeholders, it is necessary to create and run programs that impact all levels of science education. This session will examine the impact of science education on science and our society and discuss the roles that members of the scientific community must assume. We will review lessons learned from creating and implementing educational programs at a national science laboratory.

9:15 AM *GG3.3
INTEGRATING MATERIALS EDUCATION INTO THE STANDARD CHEMISTRY CURRICULUM. Ann M. Pumper, James Madison Memorial High School, Madison, WI; C. Bruce Swanson, James Madison Memorial High School, Madison, WI; Jeremiah J. Neubert, University of Wisconsin-Madison, Department of Mechanical Engineering, Madison, WI; Cynthia G. Widstrand, University of Wisconsin-Madison, Department of Chemistry, Madison, WI; Arthur B. Ellis, University of Wisconsin-Madison, Department of Chemistry, Madison, WI.

The focus of this project is to provide secondary chemistry teachers with creative, inexpensive, hands-on, minds-on ideas and resources that would enhance the introduction to and the understanding of some basic principles and concepts of materials science. Three units were developed that made for a "gradual immersion" of materials ideas into a standard curriculum. The first unit, "Memory Metals", was used as an introductory, primarily stand-alone unit to explore some of the unique properties of Nitinol. The second, "X-ray Diffraction and Scanning Probe Microscopy", detailed two techniques for demonstrating the existence of atoms and determining their relative positions, which, in turn, led into a more traditional treatment of atomic structure. Finally, a unit on "Light Emitting Diodes" was introduced to educate students about the applications of LEDs and how trends in the periodic table can be used in their design. Each unit is supported with curriculum suggestions, sample lesson plans, and unit assessments. Background information for the teacher and student is included along with investigations, demonstrations, and laboratory experiments. Both teacher and student evaluations of these units have been positive.

10:15 AM *GG3.4
THE MATERIALS WORLD MODULES PROGRAM: INCORPORATING TECHNOLOGY IN PRE-COLLEGE EDUCATION. Matthew Hsu, Northwestern University, Materials Research Center, Evanston, IL.

Materials World Modules is a unique educational program for middle and high school students. Based on the principles of inquiry and design, MWM has been designed to supplement traditional science, math, and technology courses. The program, which originated in 1993 with support from Northwestern University and a grant from the National Science Foundation, provides pre-college students with unique opportunities to apply what they learn in the classroom to real-world problems. Each of the nine modules in the series deals with a specific topic in materials science and demonstrates for students how scientists and engineers apply "textbook knowledge" to the design of new products and materials that we use every day. In fact, MWM casts the pre-college student in the roles of scientist and engineer. The modules challenge students to create prototype products designed to meet specifications. Through their work with the modules, students become more aware that the science they are learning is inextricably bound up with the technologies that they use every day. MWM is currently developing Internet technologies that will enable us to deliver customized modules directly to teachers in their classrooms. Through the use of interactive video, we hope to provide enhanced opportunities for teacher training and professional development.

10:45 AM *GG3.5
RESEARCH EXPERIENCES FOR TEACHERS - A PARTICIPANT'S VIEWPOINT. Eric Muzar, Harvard University; Kristy Lenihan, Harvard University.

We will highlight our experiences in the Research Experiences for Teachers Program held at Harvard University.

11:15 AM *GG3.6
EVALUATING RET PROGRAMS AND THEIR EFFECTS ON STUDENT PERFORMANCE. Jay Dubner, Columbia University, New York, NY; Joy Frechtling, Westat, Inc., Rockville, MD.

Various forms of Research Experiences for Teachers (RET) have been in existence for more than 20 years. Many of the estimated 70 formalized Scientific Work Experiences Programs for Teachers

(SWEPTs) nationwide have collected abundant anecdotal information indicating their Programs positive impact on teachers. What had been missing in all the RET evaluations is quantitative evidence that teacher participation has on a positive effect on student performance. As professional evaluators attest, information on student outcomes is very difficult to obtain. Even when such data has been obtained it has been difficult to assess the role of teachers in changes in student performance. The assumption that forms the RET concept is that these intensive summer work immersion experiences, coupled with appropriate follow-up activities during the school year, expand a teachers professional skills and network, and thereby improve the performance of their students. To prove this hypothesis seven SWEPTs are collaborating in a National Science Foundation-funded multi-site student outcomes study. The design of the study reflects the SWEPT philosophy and practices. Since each teacher works in a unique setting, and since each teacher applies his/her summer experiences somewhat differently when he/she returns to the classroom in the fall, there is no single test or parameter that can be used to measure the impact of a teacher's participation in the program on students. Therefore two types of student data are being collected for analysis: Attitudinal and Cognitive. Data is also being collected from the teachers regarding their changes in instructional strategies. Development of evaluation protocols and instruments and data analysis are the responsibility of Westat, Inc. Joy Frechtling, Westats Project Director, Jay Dubner, Project Coordinator and Columbias SWEPT Program Manager, will present a panel describing the study's design. In addition, Jay Dubner will present results from the Columbia RET Programs ongoing student outcomes evaluation.

SESSION GG4: RESEARCH FOR SCIENCE TEACHERS PROGRAMS

Chair: Linda Broadbelt
Wednesday Afternoon, April 18, 2001
Concordia (Argent)

1:30 PM GG4.1
PANEL DISCUSSION:
RESEARCH FOR SCIENCE TEACHERS PROGRAMS "WHAT HAS WORKED AND WHAT HASN'T".
Panel:
Fiona Goodchild, University of California, Santa Barbara, CA.
Garry Warren, University of Alabama, AL.
Denise Norris, Arizona State University, AZ.
Christine Morrow, University of Colorado, Boulder, CO.
Eric Grulke, University of Kentucky, KY.
Lon Mathias, University of Southern Mississippi, MS.
Nevjinder Singhota, Cornell University, NY.

Panel members who have directed or participated in Research for Science Teachers Programs will share their experiences with what has worked well and what still needs to be improved.

3:00 PM GG4.2
TOPICAL DISCUSSION GROUPS
Panel:
James Rayford, Georgia Tech, GA.
Naresh Thadhani, Georgia Tech, GA.
Susan Rosevear, MIT, MA.
Andrew McGhie, University of Pennsylvania, PA.
Alan Bronstein, University of Pennsylvania, PA.
Miriam Rafailovich, SUNY-Stony Brook, NY.
Ronald Occhiogrosso, Bay Shore High School, NY.

We will break up into four different topical discussion groups: program organization, program promotion, program goals and follow-up and program evaluation.

POSTER SESSION: UNDERGRADUATE MATERIALS RESEARCH INITIATIVE (UMRI) WINNERS

Wednesday Evening, April 18, 2001
8:00 PM
Salon 1-7 (Marriott)

UMRI Winners

UMRI-26
CONTROLLED ALIGNMENT OF SINGLE WALLED CARBON NANOTUBE FILMS USING LIQUID CRYSTAL GROWTH MEDIA. Amber Hamilton, David Patrick, Western Washington Univ.

UMRI-27
AEROSOL SYNTHESIS OF NON STOICHIOMETRIC BIMETALLIC NANOCLUSTERS. Heydy Ramirez, Ronald P. Andres, Purdue Univ.

UMRI-28
SYNTHESIS, CHARACTERIZATION AND EVALUATION OF MOLYBDENUM PHOSPHIDE HYDRODESULFURIZATION CATALYSTS. Diana Phillips, Mark E. Bussel, Western Washington Univ.

UMRI-29
STRUCTURE ANALYSIS OF BINARY CaO-SiO_2 GEL-GLASSES FOR TISSUE ENGINEERING APPLICATIONS. Philippe Bolard, P. Saravanapavan, Imperial College.

UMRI-30
EFFICIENT BIREFRINGENCE IN ANISOTROPICALLY NANOSTRUCTURED SILICON. Gross Egon, Dmitri Kovalev, Technische Universität München

UMRI-31
CRUMPLING OF THIN SHEET MATERIAL: STUDY OF THE CORRELATION BETWEEN THE SIZE OF THE CRUMPLED MATERIAL AND THE APPLIED FORCE. Kittiwit Matan, Sidney R. Nagel, Univ of Chicago.

UMRI-32
DECOUPLING OF TRIBLOCK COPOLYMERS. Amanda Rozar, Steven Dillman, Western Washington Univ.

UMRI-33
OPTIMIZING CHEMICAL CROSSLINKING OF POLY (VINYLIDENE FLUORIDE TRIFLUOROETHYLENE) COPOLYMERS. Chynthia Ignaszewski, Gary Buckley, Cameron Univ.

UMRI-34
MODULUS AS A FUNCTION OF COMPOSITION FOR MISCIBLE POLYMER BLENDS. John Creek, Kenneth Van Ness, Washington and Lee Univ.

UMRI-35
IMPROVED EFFICIENCY POLYMER/OXIDE HETERO-JUNCTION SOLAR CELLS. Matthew Lloyd, David Braun, California Polytechnic State Univ.

UMRI-36
MAGNETIC, ORGANICALLY MODIFIED ALUMINOSILICATE NANO-OBJECTS. Vikram Joshi, Ulrich Wiesner, Cornell Univ.

UMRI-37
PROBING BIO-MIMETIC NANOSTRUCTURED NANOPARTICLE ASSEMBLIES WITH ATOMIC FORCE MICROSCOPY. Mathew Maye, Chuan-Jian Zhong, State Univ of NY Binghamton.

UMRI-38
BEHAVIOR OF PURE LIPID AND MIXED LIPID-PROTEIN MONOLAYERS IN THE PRESENCE OF SERUM PROTEINS. Katie Lemberg, Ka Yee Lee, Univ of Chicago.

UMRI-39
BIOPHYSICAL CHARACTERIZATION OF LUNG SURFACTANT PROTEIN B AND ITS MUTANT ENGINEERED PEPTIDES. Chutima Jiarpinitnun, Ka Yee C. Lee, The Univ of Chicago.

UMRI-40
MODIFICATION OF CONDUCTING METAL OXIDE SURFACES USING SELF ASSEMBLED MONOLAYERS. Sharon Koh, Wm. Christopher Hughes, James Madison Univ.

SESSION GG5: INNOVATIVE CURRICULUM DEVELOPMENT

Chair: Stacy Holander Gleixner
Thursday Morning, April 19, 2001
Concordia (Argent)

8:30 AM *GG5.1
MICROELECTRONICS PROCESS ENGINEERING: A NON-TRADITIONAL APPROACH TO MS&E. Emily L. Allen, Stacy Gleixner, Greg Young, Department of Chemical and Materials Engineering; Dave Parent, Department of Electrical Engineering; Yasser Dessouky, Department of Computer, Industrial and Systems Engineering, San Jose State University, San Jose, CA.

Materials Science and Engineering is an interdisciplinary field, but at the undergraduate level perhaps has leaned too much towards science in the past. Introducing more engineering is one way to be more responsive to industry needs and to produce more work-ready undergraduates. Our response, because of our location in the heart of Silicon Valley, has been to create a new engineering program, based in materials science, but even more interdisciplinary. We have developed a new bachelor's level curriculum in microelectronics process engineering (μProE). The program is interdisciplinary , drawing from traditional materials, chemical, electrical and industrial engineering programs and tied together with courses, internships and projects which integrate thin film processing with manufacturing control methods. Our graduates will be prepared for entry level engineering jobs that require knowledge and experience in microelectronics-type fabrication , as well as a very strong background in statistics and other aspects of manufacturing engineering. The program objectives were defined using extensive, direct, input from industry and alumni. We market our program as part of workforce development for Silicon Valley, and have won significant support from local industry as well as federal sources. We plan to offer a vertical slice of workforce development, from lower division engineering and community college activities to industry short courses. We also encourage all engineering majors to take electives in our program. I will discuss some of the challenges we encounter in trying to develop, market and recruit for a non-traditional degree program in engineering, including enrollments, student prerequisite variations, and becoming too employer-oriented. Relying on clearly defined learning objectives helpsto alleviate some but not all of these issues.

9:00 AM GG5.2
INNOVATIVE CURRICULUM ON ELECTRONIC MATERIALS PROCESSING AND ENGINEERING. Jane P. Chang, University of Los Angeles, Los Angeles, CA.

The semiconductor manufacturing industry is undoubtedly the largest chemical engineering industry since the once-dominated petroleum industry, and is revolutionizing the chemical engineering industry and taking it into the next summit. Chemical engineers are needed to design, operate and control the sophisticated chemical processes that fabricate the chips, and continuously research and develop new processes for the next generation integrated circuits. These individuals require knowledge of mathematics, physics, chemistry, and engineering that is essential for engineering materials at nanometer dimensions. The traditional engineering education training is often inadequate in preparing the students for the challenges presented by this industrys dynamic environment, and insufficient to meet the employers criteria in hiring new engineers. Clearly, significant effort is required to change the way materials processing and engineering was taught. It is critically important to train the students in the scientific and technological areas that are pertinent to the microelectronics industries, and allow them to practice engineering principles in a laboratory environment. This paper describes a new multidisciplinary curriculum and training program at UCLA that provides knowledge and skills in semiconductor manufacturing through a series of courses that emphasize on the application of fundamental engineering disciplines in solid-state physics, materials science of semiconductors, and chemical processing. The curriculum comprises three major components: (1) a comprehensive course curriculum in semiconductor manufacturing; (2) a laboratory for hands-on training in semiconductor device fabrication; (3) an interactive learning website that provides access to students outside UCLA and industrial mentors. The capstone laboratory course comprises the most comprehensive training (seven photolithographic steps and numerous chemical processes) in fabricating and testing complementary metal-oxide-semiconductor (CMOS) devices. Students form teams with electrical engineers and material scientists to practice engineering principles using the state-of-the-art experimental setup.

9:15 AM GG5.3
WORKING WITH INDUSTRY, AND A PROFESSIONAL ORGANIZATION, TO OFFER STUDENTS A NATIONAL CERTIFICATION. John Schemmel, Frances Griffith, University of Arkansas, Department of Civil Engineering, Fayetteville, AR; Earl Glover, Arkansas Ready Mixed Concrete Association, Little Rock, AR.

Students in the Department of Civil Engineering at the University of Arkansas are required to take the course CVEG 2113, Structural Materials. This course examines the production, engineering properties, and structural applications of concrete, steel, and timber. Within the concrete portion of this course, students learn how cement, water, coarse aggregate (rocks), and fine aggregate (sand) are combined to produce the artificial rock we call concrete. In the laboratory, the students produce concrete, perform tests on the fresh concrete, and later test the concrete for its strength properties. In most instances, a contract document, or Federal law, requires those individuals who perform field tests on fresh concrete to hold either a state or national certification. Given that the students in CVEG 2113 must learn how to conduct the field tests covered by the American Concrete Institute's national certification program for Concrete Field Testing Technicians, it was inevitable that this program would be incorporated into the Department's Materials course. In order to offer our students the opportunity to become certified it was necessary to involve a local industry partner, the Arkansas Ready Mixed Concrete Association, as well as the national certifying entity, the American Concrete Institute. This paper outlines the certification process and comments on the substantive benefits gained through this program. In addition to the certification, our students have become more marketable for summer and long-term employment. Industry has also established a scholarship within the Civil Engineering Department as a direct result of the certification program. Industry has benefited by helping educate students before they enter the professional work force. By all accounts, and for all involved, this program is a major success story.

9:30 AM GG5.4
MATERIALS SCIENCE & ENGINEERING AT BOISE STATE UNIVERSITY: RESPONDING TO AN INDUSTRIAL NEED.
Amy J. Moll, Mechanical Engineering, William B. Knowlton, Electrical and Computer Engineering, and David Bunnell, Mechanical Engineering, Boise State University, Boise, ID.

The College of Engineering at Boise State University (BSU) is a young program in its fifth year of existence. Bachelor of Science degrees in Civil Engineering (CE), Electrical and Computer Engineering (ECE) and Mechanical Engineering (ME) are offered with a M.S. Degree in each discipline added this year. BSU is closely linked with industry in the Boise area. The industrial advisory board for the College of Engineering recommended enhancement of the Materials Science and Engineering (MS&E) offerings. In response, BSU has created a minor in MS&E at both the undergraduate and graduate level and increased the level of coursework and research in MS&E. The MS&E program is designed to meet the following objectives: provide for local industry's need for engineers with a MS&E competency, add depth of understanding of MS&E for undergraduate and graduate students in ECE, ME and CE, prepare undergraduate students for graduate school in MS&E, improve the professional skills of the students especially in the areas of materials processing and materials selection, provide applied coursework for chemistry, physics, and geophysics students, and offer coursework in a format that is convenient for students currently working in local industry. Three (the authors) of the twenty-six faculty in the College of Engineering have an educational background in MS&E: two new faculty members (Moll and Knowlton) and one existing faculty member (Bunnell). Each of us also have significant experience working in industry. We have held a wide variety of positions including R&D Engineer, Wafer Fab Production Manager, Process Engineering Manager, Member of Technical Staff in a start-up analysis firm. In the development and implementation of the MS&E program at BSU, we have drawn on our industrial skills and experience and applied them to the academic setting. Concepts such as continuous process improvement, customer focus, and cross-disciplinary teamwork are being integrated into the academic setting. Incorporating the industrial perspective and attempting to fulfill the diverse list of objectives have resulted in a creative program focused on the fundamental concepts of MS&E while providing opportunities to practice professional skills required in today's high-tech careers.

10:15 AM *GG5.5
TEACHING THERMODYNAMICS OF MATERIALS.
Robert C. Cammarata, Johns Hopkins University, Department of MS&E, Baltimore, MD.

Thermodynamics is a core subject of materials science and engineering, as well as for fields such as physics, chemistry, and other engineering disciplines. Given the limited time available to cover the subject in the typical undergraduate and graduate (especially Master-level) educational program, decisions have to be made about what aspects to emphasize and what areas to leave for the students independent study. It would also be desirable to integrate classroom instruction of the subject with student research and real-life experiences. Related issues include whether to use an inductive or deductive approach for developing the laws of thermodynamics, the proper balance between the classical and statistical approach, the proper balance between the fundamental and applied aspects of the subject, and how much difference there should be between the core undergraduate and graduate courses. A discussion of these various issues will be presented and suggestions offered based on the needs of different constituencies. Finally, certain difficulties and misconceptions often found in materials texts related to the thermodynamics of solids will be mentioned.

10:45 AM GG5.6
IMPLEMENTATION OF AN UPPER DIVISION GENERAL EDUCATION COURSE ON MATERIALS. D.F. Bahr and M.G. Norton, Mechanical and Materials Engr, Washington State University, Pullman, WA.

"Materials: The foundation of society and technology" is a new course developed for upper division students in non-engineering fields at Washington State University. This course, taught for the first time in Fall 2000, was designed to fulfill a general education course requirement grounded in scientific methodologies. The course aims to provide students with an understanding of the role that materials have played in human development and how materials continue to impact our lives and our world. The primary goal of this course is to provide a mechanism for increasing the awareness of materials and materials science among college graduates from non-engineering disciplines. The development and rationale for the course was presented previously. We will now report on the demographics of the course by major, the topics covered, summarize the assigned work and the students' response to the workload. The majority of the students who chose this class to fulfill their general education requirement come from technical, but non-engineering backgrounds. Initial evidence suggests that students from management information systems, agriculture, and architecture appear to be particularly aware of the importance of materials in their field. Additionally, we will discuss aspects of the course which will be modified to address our findings from this initial offering.

11:00 AM GG5.7
MATERIALS CHEMISTRY FOR FRESHMEN. Elliot P. Douglas, University of Florida, Department of MS&E, Gainesville, FL.

We have developed a new Materials Chemistry course for freshman with the goal of improving retention in the engineering program. This Materials Chemistry course is fundamentally different from other introductory materials courses in that it does not cover the standard introductory materials curriculum (diffusion, strengthening mechanisms, eutectic phase diagrams, etc.). Rather, its goal is to teach engineering applications of fundamental chemistry concepts. This course consists of four basic units: atomic, molecular and supermolecular structures; synthesis and processing; stability of materials; and biological materials. Each of these units consists of topics designed to show how fundamental concepts in chemistry can be applied to engineering problems. For example, the technology used to create condensation polymers is used to teach the concept of equilibrium constants. The course also contains a laboratory section. This paper will describe the detailed contents of the course and its relation to the engineering curriculum.

11:15 AM GG5.8
DEALING WITH VARIATION IN MEASUREMENTS & PROCESSES: EXPERIMENTS FOR AN UNDERGRADUATE LABORATORY. Linda Vanasupa, California Polytechnic State University, Materials Engineering Department, San Luis Obispo, CA; Heather Smith, California Polytechnic State University, Statistics Department, San Luis Obispo, CA; Stacy Gleixner, Greg Young, Emily Allen, San Jose State University, Chemical and Materials Engineering, San Jose, CA.

Being able to obtain and analyze quantitative data is an essential component of any undergraduate education in science or engineering. At the most basic level, this begins with characterizing the measurement system using proper statistical techniques. Although most undergraduates in the sciences and engineering are required to take a course in statistics, the knowledge gained in the statistics course does not always find its way into practice. In this talk we will present a four-part experimental module that will enable the student to: 1. assess the precision of a measurement system; 2. determine if the system is stable with respect to a number of variables; 3. quantify the amount of variation that exists within a particular sample; 4. quantify the amount of variation from sample to sample(i.e., process variation). Our module was applied to the measurement of silicon dioxide thickness from an oxidation process. However, it has general applicability to any process that involves measuring a physical quantity. Assessing these sources of variation in a process form the foundation for more advanced techniques such as process control and experimental design.

11:30 AM GG5.9
GENERATING STATISTICAL RESEARCH DATA IN LARGE UNDERGRADUATE LABORATORY COURSES. Jennifer A. Swift, Rositza I. Petrova, Bryan Cracchiolo, Georgetown University, Department of Chemistry, Washington, DC.

Developing a molecular-scale understanding of crystal nucleation and growth processes is of fundamental importance for a range of materials including small molecules, macromolecules and metals. While gel matrices have been successfully used as a growth medium for many inorganic and macromolecular crystals for many years, they are less frequently utilized for molecular crystal growth. We are currently working to elucidate the specific chemical and physical role(s) of the gel during the process of crystal nucleation. Meeting these objectives requires the generation of statistically significant crystal samples. The 120 students enrolled in Organic Chemistry Lab II at Georgetown University recently participated in a new "inquiry-based" laboratory experiment that helped to generate samples useful for research purposes. The design, introduction and general success of this experiment will be discussed.

11:45 AM GG5.10
INTEGRATING SERVICE-LEARNING TO TEACH "MATERIALS, MANUFACTURING & DESIGN" IN A SOPHOMORE-LEVEL COURSE IN MECHANICAL ENGINEERING. Edmund Tsang, Mechanical Engineering Department, University of South Alabama, Mobile, AL.

Service-learning is "a form of experimental education in which students engage in activities that address human and community needs together with structured opportunities intentionally designed to promote student learning and development. Reflection and reciprocity are key concepts of service-learning" [1]. This pedagogy that combines student learning with community service may not seem an obvious strategy in materials science education, but recent papers indicate that service-learning have proven successful in meeting student learning outcomes described in Criterion 3 of Engineering Criteria 2000, particularly those performance outcomes identified as "soft" skills [2,3,4]. This paper will describe the integration of service-learning in a sophomore-level course in the Mechanical Engineering curriculum. "Materials, Manufacturing & Design." Topics of the 1-hour laboratory course include the principles of strain hardening and annealing, the use of statistics in manufacturing, the mechanical forming operations of rolling, blanking, and pressing, the engineering design process, and communication skills. The course culminates in a service-learning design projects based on the needs of the community partners, which are the Mobile County Public School System's SECME program (Southeastern Consortium for Minorities in Engineering) and the College of Engineering Open House Committee. This paper will describe the course learning objectives, the weekly activities; and student assessment over the period 1998-2000. The assessment protocol is based on trigulating the results of evaluation by two different engineering faculty members and a retrospective student survey [2].

REFERENCE:
[1] B. Jacoby, B, "Service-Learning in Today's Higher Education," in Service-Learning in Higher Education: Concepts and Practices, ed. B. Jacoby and Associates, Jossey-Bass, 1996, page 3-25.
[2] E. Tsang, "Applying James Stice's Strategy to Teach Design to Sophomore Mechanical Engineering Undergraduates," Journal of Engineering Education, April 2000, page 231-236.

SESSION GG6: NOVEL INSTRUCTIONAL TOOLS FOR TEACHING MATERIALS SCIENCE AND ENGINEERING

Chair: Stacy Holander Gleixner
Thursday Afternoon, April 19, 2001
Concordia (Argent)

1:30 PM GG6.1
BIOMINERALIZATION – IT'S A HARD LIFE: A WEB-BASED TEACHING TOOL FOR HIGH SCHOOL THROUGH COLLEGE SOPHOMORE. Kirsten Hintze, Arizona State Univ, Dept of Plant Biology, Tempe, AZ; Eddie W. Ong, Center for Solid State Science, Arizona State Univ, Tempe, AZ; B.L. Ramakrishna, Arizona State Univ, Dept of Plant Biology, Tempe, AZ; Hong Xu, Heather Kerns, Center for Solid State Science, Arizona State Univ, Tempe, AZ; and Vincent B. Pizziconi, Dept of Bioengineering, Arizona State Univ, Tempe, AZ.

Deer and dolphins do it, so do rice plants. People could not live without doing it, but some people die because of it. Certain researchers are trying to figure out how it is done, so they can exploit it for diverse material production and manipulation. "It" is biomineralization, the process of forming mineralized structures in a biological system. Inorganic materials are incorporated within an organic matrix to form biomineral composites with distinct shapes and properties. Many of these bio-composite structures exhibit exceptional composite material properties, such as optical and mechanical properties. Also, biomineral properties, such as iridescence, hardness, fracture toughness and shear strength, are different from those of the corresponding pure inorganic minerals. The structure of these materials at the micro- and nano-scale affects their macroscopic appearance and properties. These general, interdisciplinary concepts are introduced to high school and college students in a web-based educational module developed by the Interactive Nano-Visualization for Science and Engineering Education (IN-VSEE) project at Arizona State University (ASU). Optical Microscope, electron microscope and scanning probe microscope images of biomineral structures, such as seashells, diatom cell walls, and bones help students visualize and explore the mechanisms of formation, organization and structure-function relationships. Students can "test" different biomineral material properties utilizing Java-applets and Flash interactive animations. Learning activities culminate in students designing their own experiments utilizing an on-line, real-time, remotely operated scanning probe microscope.

1:45 PM GG6.2
A CURRICULUM RESOURCE FOR MATERIALS SCIENCE AND ENGINEERING EDUCATION - ELEMENTARY SCHOOL THROUGH COLLEGE. James A. Jacobs, School of Science and Technology, Norfolk State University, Norfolk, VA; Alfred E McKenney, IBM-retired.

As a result of a fifteen-year effort, we have produced a new CD-ROM with hundreds of peer reviewed, classroom testing, demonstrations and experiments and ideas for curriculum development. This presentation will focus on using the digital resource for curriculum development while providing a demonstration on how to use the CD ROM and the useful resources for teaching courses and providing educational outreach related to materials science and engineering. The resources, available in the popular Adobe Acrobat Reader format, are useful for such courses as materials science, materials technology, mechanics and strength of materials, as well as for pre college level course and school visitations. Among the other PDF formatted resources on the CD-ROM is a full Short Course on Microscopy of Fiber-Reinforced Polymer Composite developed by Luther Gammon of Boeing Materials Technology. Additionally this easy to use digital media offers an Image Gallery showing materials applications for including optical, ceramic, composite, metals, polymers and green materials. The user will also be able to access numerous photomicrographs for a wide range of materials, a structural models gallery and hyperlinked web sites addresses. There is also a section on how we made the PDFs. The manner in which the demonstrations and experiments are written provides useful tips on securing supplies and construction of devices, and ideas for involving the community. Categories of experiments and demonstrations include structure, testing & evaluation; metals; polymers; ceramics; composites; electronic and optical materials.

2:00 PM GG6.3
THE SOCIETAL IMPACT OF MATERIALS EDUCATION IN SCIENCE CURRICULA AND CONTINUING EDUCATION. M. Stanley Whittingham, Wayne E. Jones and Chuan-Jian Zhong, Department of Chemistry and Institute for Materials Research, SUNY at Binghamton, Binghamton, NY.

The incorporation of Materials Science into the beginning chemistry curriculum for both science and engineering majors brings relevance and greater interest and participation by the students [1,2]. We have extended the penetration of materials subjects into the curriculum at all levels, including an advanced analytical course that emphasizes solids rather than liquids or gases. In this course students get an overview of most modern tools available to the materials scientist, performs projects to determine the most suitable suite of tools to apply to a given problem, and can study in-depth several of them in follow-up mini courses. Some examples from this course will be described. This course is now available on-line, following up on our earlier successful use of combined classroom and on-line instruction in our senior/graduate level solid state chemistry course. This transition to on-line courses allows students not in commuting distance to participate. We have found that such students perform just as well as students "in-class". This is particularly important for the continuing education of employed chemists as up to 30% find themselves working in materials positions with no background in the area. Examples of some of our experiences in this area will be discussed, as well as future plans for a MS in Materials Science through the SUNY Learning Network (SLN).
[1] M.S. Whittingham, MRS Bulletin, p. 40-45, August 1990.
[2] W. Gloffke, T. Kotch and M.S. Whittingham, ASEE Proc. pp. 897-900, June 1990.

2:15 PM GG6.4
AN INTEGRATED EDUCATION PROGRAM ON THERMO-DYNAMICS, KINETICS, AND MATERIALS DESIGN. Zikui Liu, Long-Qing Chen, Karl E. Spear, Penn State University, Dept. of MS&E, University Park, PA; Carlee Allison, Department of Educational & School Psychology & Special Education, University Park, PA.

Computer-intensive graduate courses in materials science and engineering are under development at Penn State with support from the National Science Foundation. The main objective of this project is to improve the student's learning and educator's teaching experiences in two of the core components in the curriculum, i.e. Thermodynamics of Materials, and Kinetics, by integrating fundamental principles and advanced computational approaches in the classroom. A new Materials Design course will follow these two core courses. Computer-based education tools will help students connect abstract thermodynamic concepts with the properties of real world materials, and mathematical kinetics with practical materials processing procedures, and thus remove the common stereotype perception among university students that thermodynamics and kinetics are abstract to learn and difficult if not impossible to apply in the real world. In this presentation, the goals and infrastructure of the project will be briefly discussed. Progress during the first nine months of the project will be reported, including examples of student's projects in the courses as well as the assessment of the program effectiveness from past and present students who have taken the core courses.

2:30 PM GG6.5
TEACHING MATERIALS CHARACTERIZATION TECHNIQUES: AN INTERDISCIPLINARY APPROACH TO DEVELOP INTERACTIVE WEB-BASED MULTIMEDIA TEACHING/ LEARNING SOFTWARE. Karin Pruessner*, Klaus Pingel**, Horst-Peter Dressel*, Christof Reiner***, Marc Schlosser***, Jens Becker**, and Hans-Jürgen Christ*. *Institute for Materials Technology, University of Siegen, GERMANY. **Institute of Physics, University of Siegen, GERMANY. ***Institute of Inorganic Chemistry, University of Siegen, GERMANY.

Many disciplines, like materials science, mineralogy, geology, physics, chemistry, biology, or medicine, use analytical techniques such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD) or optical microscopy to study different aspects of natural and artificial materials. The approach to teach these techniques and the background in crystallography, electron/material interaction, diffraction etc. is different. While in some departments teaching materials characterization techniques is part of the normal curriculum in the undergraduate programs, others only teach material characterization when students start working on research projects. Since this leaves many students on their own when learning about materials characterization techniques, we want in our project to develop an interactive web-based multimedia teaching/learning software that can be used to complement existing lectures or to stand alone and assist students in learning these techniques and the basic principles behind them. In a first step, we have developed a module on scanning electron microscopy to be mainly used in a mechanical engineering department. The interdisciplinary nature and almost universal applicability of materials characterization techniques suggests an interdisciplinary approach to teaching. Therefore, the Institute for Materials Technology, the Institute of Physics and the Institut of Chemistry collaborate in this project. The fact that the same basic principles of physics are needed in several techniques suggests a modular structure of the software package. Additional modules on transmission electron microscopy and X-ray diffraction are anticipated for the future. The fairly complicated concepts that need to be understood in order to use materials characterization techniques effectively, make the use of animations to visualize abstract concepts, and the use of interactive simulations to practice theory and application, particularly useful.

3:15 PM *GG6.6
THE POLYMER MODULE IN THE MATERIALS WORLD MODULE SERIES: A DESIGN-ORIENTED APPROACH TO INCORPORATING POLYMER CHEMISTRY IN THE GENERAL SCIENCE CURRICULUM OF GRADES 9-12. SonBinh T. Nguyen, Robert P.H. Chang, Jennifer K. Cocson, Carol L. Colby, Keith E. Miller, Northwestern University, Dept. of Chemistry and the Materials Research Center, Evanston, IL.

The Materials World Modules (MWM), funded by the National Science Foundation, is a series of nine short texts that introduce science and scientific concepts to high school students through guided investigations of the materials that surrounds us in the modern world. Designed to be flexible, these modules can be incorporated into a high school science curriculum as a learning-by-exploring addition to the main science text. Depending on the time that the teacher has, each module can be covered in between 8 to 15 class periods. Using an inquiry method of learning, the modules prompt the students to generate questions about a subject and find experimental approaches which will lead them to the answers. The modules encourage the students to learn by carrying out simple experiments using readily available materials. The Polymer Module of the MWM series aims at introducing the concepts of polymer chem. and polymeric materials to an audience that has had some exposure to general chemistry. It asks the students to investigate their surroundings to find polymer-based objects and to infer the properties of those objects from knowing the structures of the monomeric building blocks. It introduces the relation between polymer properties and structures and that between polymer properties and molecular weight by suggesting experiments that students can do with polyvinyl alcohols and polyvinyl acetate films. Finally, it encourages the students to use what they have learned to design simple devices using polymeric materials. Example of such a device is a humidity sensor that is fabricated from thin polymer films.

3:45 PM GG6.7
Abstract Withdrawn.

4:00 PM GG6.8
NON-LINEAR FORCE CURVES WITH THE FORCE MACROSCOPE. Claudio Guerra-Vela, University of Puerto Rico, Humacao, PR; Fredy R. Zypman, Yeshiva University, New York, NY.

The Force *Macroscope* (FM) was introduced last year (A HOME-MADE INCH-SCALE SCANNING FORCE "MICROSCOPE", Claudio Guerra-Vela, Fredy R. Zypman, MRS HH8.2, 1, 2000) as a laboratory teaching tool to introduce students to general concepts of Scanning Force Microscopy (SFM). It is a macroscopic version of the SFM, where the cantilever is a 10"-long aluminum bar. The FM pedagogical advantage (over the SFM) is its size: all students relate to the FM, but very few grasp at once the concepts for the 100 μm-long SFM cantilever. In this work we will show how we take advantage of the FMs large size to teach concepts of force reconstruction. In SFM, F-s curves (where F is the force at tip-sample separation s) are measured indirectly from direct information about the motion of the cantilever. In the simplest algorithm, F is obtained by multiplying the cantilever's displacement times an effective spring constant. Other, more realistic algorithms, take into account inertia, and the extended and continuous nature of the cantilever. Regardless of the degree of sophistication of the data reconstruction program, SFM cannot gauge its accuracy *because the microscopic forces cannot be measured directly.* For the FM, the situation is completely different: any load at its free end (magnets, in our case) that simulates the tip-sample interaction forces, and that can significantly perturb the kinematics of the aluminum bar can be measured directly by other means. Thus concretely, in this work we use the FM to reconstruct non-linear F-s curves using standard SFM algorithms. Subsequently, we compare these curves with those obtained by *direct* measurement of the F-s curve by means of a dynamometer.
Work supported by National Cancer Institute CA77796-01, NSF DMR-9872689 and Yeshiva University.

4:15 PM GG6.9
WEB MODULES LINKING MECHANICS AND MATERIALS SCIENCE. David Roylance, Dept. of MS&E, MIT, Cambridge, MA.

In 1996, the MIT subject 3.11 Mechanics of Materials in the Department of Materials Science and Engineering began using an experimental new textbook approach, written with a strongly increased emphasis on the materials aspects of the subject. It also included several topics such as finite element methods, fracture mechanics, and statistics that are not included in most traditional Mechanics of Materials texts. These nontraditional aspects were designed to fit the curriculum in Materials Science and Engineering, but do not always fit the needs of instructors in other departments and schools. Further, a number of topics are of general interest in other educational curricula and industrial practice. One approach to increasing the flexibility and adaptability of this materials-oriented text is to make discrete and coherent portions of it available as stand-alone, web-available modules. Instructors could then pick and choose among topics, and assemble a subject offering in whatever way they choose. It would also be possible for instructors of specialty engineering subjects, for instance bridge or aircraft design, to add modules on mechanics of materials aimed at their own needs. A series of such modules are now being developed under a National Science Foundation Course, Curriculum and Laboratory Improvement (CCLI) grant aimed at strengthening the links in the engineering curriculum between materials and mechanics. Each module is intended to be capable of standing alone, so that it will usually be unnecessary to work through other modules in order to use any particular one. This approach will be outlined and demonstrated, both as an approach to the specific topic of a mechanics-materials linkage, and as a possibility for more general implementation in distance learning.

4:30 PM GG6.10
INCORPORATING INFORMATION COMPETENCE INTO CLASSES. Katherine C. Chen, Materials Engineering Dept., California Polytechnic State University, San Luis Obispo, CA.

Enabling students to become independent learners is a desirable goal for many educators. However, the task is not always easily addressed with the long lists of concrete, technical objectives that must usually be covered in classes. As a result, information often follows a one-way path from the instructor to the student, and students can develop a reliance on "packaged" knowledge and answers from only teachers and textbooks. In efforts to engage students in the learning process and to encourage the self-directed exploration of knowledge, "information competence" has been incorporated into an upper-level materials course. Using current topics in materials science and engineering, students formulate questions to address specific issues and then locate pertinent information. A variety of resources, such as newspapers, web sites, and scholarly journals, are explored and evaluated. The instructor acts a facilitator that assists with search strategies and evaluation of the information. Students develop the ability to process and reorganize the information into useful forms (e.g., reports, oral presentations). Providing the tools and instructions to function effectively in this Information Age will hopefully promote lifelong learning in today's students.

4:45 PM GG6.11
INTERACTIVE INFORMATION TECHNOLOGIES FOR MSE EDUCATORS. B.N. Kodess , Pl&P. Kodess, G. Glasunov, Dept. of Crystal Metrology, VNIIMS, Moscow, Dept. of Materials Science, ICS&E at Denver, CO; F.A. Sidorenko, Technical and Physics Dept., Ural Technical University, Ekaterinburg, RUSSIA.

Introduction of new conceptions and pedagogical methods shall be accompanied with additional support to educators, taking into account their psychological features. An approach to creation of interactive teaching modules intended for support of the MSE instructor/teacher activity is submitted. This modules ease the process of conversion from image formation to usage of this knowledge by different channels of perception, which provides for better understanding of information essence, its acceptance and mastering. In the given example of a lectures, computer graphical animation is used to create auspicious emotional atmosphere for students and open up more channels of perception. The time is used more intensively during these classes. Two essential aspects of implementation - technological, connected with specificity of new methods and technique use, and personal are being discussed based on results of observations (more than 50 educators). Personal part of new information saturated method amplifies the effect, which can be caused by technological approach implemented in it, and allows an instructor, a teacher and a principal to influence efficiency of mastering. Submitted approach and modules prepare the students to estimation of their success "by the results". It provides for more conscious decision-making and in more "uncertain" problem situations, when the educators puts forward questions considerably more often and thus raises activity and responsibility of the students for process of training. The usage of such lectures is the advantageous in distant and team studies process also.