

**SYMPOSIUM X**  
**Frontiers of Materials Research**

April 24 – 27, 2000

**Chairs**

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\* Invited paper

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This symposium is the Society's principal vehicle to maintain the interdisciplinary and integrative nature of its mission within the materials community with invited reviews presented over the lunch hour. Leaders in various specialties represented by the topical symposia present reviews designed for materials researchers who are **NOT** specialists in the reviewed field.

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SESSION X1:

Chairs: Anna C. Balazs, Robert Q. Hwang,  
Kevin S. Jones and Frances M. Ross  
Monday Afternoon, April 24, 2000  
Salon 7 (Marriott)

**12:05 PM \*X1.1**

**BIOTECHNOLOGY VERSUS CHEMICAL WARFARE: A BATTLE OF THE 21st CENTURY.** Alan Russell, University of Pittsburgh, Department of Chemical Engineering, Pittsburgh, PA.

Biocatalysis has emerged as a viable technique for the detoxification and/or detection of organophosphorus neurotoxins and their derivatives. Excellent specificity, mild operating conditions, and biocompatibility are all attributes of enzyme catalysis. However several shortcomings have limited the utility of enzymes in practical applications. Brief catalytic lifetimes, environmental sensitivity, and general applicability issues are among the perceived limitations of enzyme catalysis.

This presentation will describe our efforts to incorporate combinations of biocatalysts into a variety of environments that dramatically enhance their utility in real-life applications. The incorporation of multiple nerve agent hydrolyzing enzymes within a single polyurethane polymer during polymer synthesis will be discussed. These novel materials exhibit excellent specificity retention of each incorporated enzyme and represent, to our knowledge, the first biocatalytic materials with such broad-ranging utility. The enzymes, once covalently modified during polymerization, have excellent thermal stability and reduced sensitivity to environmental conditions such as pH or solution buffer capacity.

We have also devised an enzyme-based reusable sensor for the detection of nerve agents and the precursors that are used in the synthesis of the same. The sensor utilizes the aforementioned enzyme-polyurethane co-polymerization scheme, in which the resultant polymer is rendered sensitive to the presence of target compounds. An observable color change, or lack thereof, indicates not only the presence of organophosphorus neurotoxins but through the use of a novel fingerprinting approach, also indicates the type of agent present.

**12:45 PM \*X1.2**

**MATERIALS TO FIGHT COUNTERFEITING.** Christopher W. Lantman, Flex Products, Inc., A JDS Uniphase / OCLI Subsidiary, Santa Rosa, CA.

Today's global economy is supported by a vast amount of printed currency. Governments estimate that nearly a half trillion banknotes are currently in circulation and that number continues to grow. Materials can play an important role in protecting the world's increasing volume of money from counterfeiting. Modern security features include micropatterning, holography, and security pigments. The combination of thin film technology and interference optics now makes it possible to fabricate security pigments with carefully controlled morphologies. This paper provides the non-expert with an introduction to the world of paper currency, security features, and the use of materials science in money. Special emphasis will be given to interference pigments, the nanostructural control of color and the emerging need for new materials.

SESSION X2:

Chairs: Anna C. Balazs, Robert Q. Hwang,  
Kevin S. Jones and Frances M. Ross  
Tuesday Afternoon, April 25, 2000  
Salon 7 (Marriott)

**12:15 PM \*X2.1**

**MATERIALS MICROWORLD: A VEHICLE FOR TEACHING ELEMENTARY AND MIDDLE SCHOOL STUDENTS ABOUT MATERIALS.** Eric Werwa, Otterbein College, Department of Physics and Astronomy, Westerville, OH.

Materials MicroWorld is a traveling museum exhibit about the world of materials science to be created through collaboration between the Materials Research Society, museum professionals, and designers. It will give science museum visitors an appreciation for the concepts, processes, and trends in materials science through a combination of hands on exhibits, climb through environments, and educational programming. The primary target audience of the science centers to which MicroWorld will travel is the elementary and middle school student, and as such these museums are very popular with elementary and middle school groups and with families having children in this age group. In trying to bring materials science to younger children (a group that has proven difficult to reach on a widespread basis in the past), this route appears to be a very promising one. By involving members of MRS in exhibit creation and educational outreach, this project will establish a strong link between the worlds of materials research and informal science education. An array of educational materials and training videos will accompany the exhibit which can be used by teachers to develop programs to use with students in the classroom and by parents to continue these experimental activities with their children at home. A Materials MicroWorld link on the MRS web site will provide teachers and parents with additional resources about materials.

**12:30 PM \*X2.2**

**PHYSICS FIRST: IMPROVING HIGH SCHOOL SCIENCE EDUCATION IN THE U.S.** Leon M. Lederman, Resident Scholar, Illinois Mathematics and Science Academy, Aurora, IL.

Over 100 years ago, a prestigious Committee of Ten established a high school science curriculum, which mandated Biology (in ninth grade), followed by Chemistry (in 10<sup>th</sup> grade) and finally, Physics (11<sup>th</sup> or 12<sup>th</sup> grade). In the year 2000, 99% of all the high schools in the US are following the same sequence even though it is manifestly in the exact wrong order! Why this is so and data on the benefits of a coherent and logical sequence, are the substance of the talk. The awesome resistance of school systems to change is keenly illustrated by this story.

SESSION X3:

Chairs: Anna C. Balazs, Robert Q. Hwang,  
Kevin S. Jones and Frances M. Ross  
Wednesday Afternoon, April 26, 2000  
Salon 7 (Marriott)

**12:05 PM \*X3.1**

**METALLURGY OF THE RMS TITANIC.** T.P. Weihs, The Johns Hopkins University, Department of Materials Science & Engineering, Baltimore, MD; and T. Foecke, National Institute of Standards and Technology, Gaithersburg, MD.

The sinking of the RMS Titanic in 1912 was a classic disaster in that many unrelated factors contributed to a tragic loss of life. The ship was the largest manmade moving object of her time with a strong double bottom and water tight bulk heads that many thought made the ship unsinkable. Yet a glancing blow with an iceberg sent the ship to the ocean bottom, with more than 1500 passengers and crew members. One question that has been asked ever since her fateful maiden voyage is - What role did materials play in the disaster? Was the steel too brittle or were the wrought iron rivets too weak? With the discovery of the wreck in 1985 we now have an opportunity to study the actual steel and wrought iron that was used to build the RMS Titanic. This presentation will describe our initial findings. The talk will begin with a brief overview of the ship's construction and its maiden voyage. I will then describe a recent recovery operation in which steel plates and wrought iron rivets were retrieved from the ocean floor, some 13,000 feet below the water's surface. The remainder of the talk will then focus on our efforts to characterize the chemistry, the microstructure, and the mechanical properties of the steel and the wrought iron. Experimental data, still photographs, and video clips will be used to describe how the materials behave today, as well as how they behaved on the cold, clear night of April 14th, 1912.

**12:45 PM \*X3.2**

**RECYCLE AND REMEDIATE NATURE'S STRONGEST POLYMERS FROM WOOD!** Barbara Illman, USDA Forest Service, Forest Products Lab, University of Wisconsin, Madison, WI.

Lignocellulose from wood is one of the strongest polymers in nature. Produced by synthetic pathways in trees, this carbon-based polymer has strength properties that account for the long-term use of wood as a prime structural material. Wood is a renewable resource that has remarkably high strength per unit weight. Loss of structural integrity of wood is a natural phenomenon that results from degradation by decay fungi. Fungal enzymes and metabolites that degrade wood in service are also responsible for cycling carbon and other elements from biomass on the forest floor. In this talk we will review the structural

properties of wood and our research on fungal mechanisms that alter structural integrity. The focus will be on the use of synchrotron-based methods to detect element distribution and speciation as probes of decay chemistry or bioremediation of metal-treated wood and to image structural degradation with microtomography.

SESSION X4:

Chairs: Anna C. Balazs, Robert Q. Hwang,  
Kevin S. Jones and Frances M. Ross  
Thursday Afternoon, April 27, 2000  
Salon 7 (Marriott)

**12:05 PM \*X4.1**

**DID YOU EVER WATCH A CRYSTAL GROW?** Ruud M. Tromp,  
IBM T.J. Watson Research Center, Yorktown Heights, NY.

Compared to watching grass grow, watching a crystal grow is a surprisingly exciting activity! Crystal surfaces, of course, aren't perfectly flat. They are more like staircases, atomically flat terraces separated by atomic height steps. During growth, atoms land on the terraces, scurry around up and down the steps, until they stick at a step edge. Or until enough of them get together to start a new terrace on top of an existing one. When we watch a crystal grow we see the steps move along as more and more atoms stick to them, making them change shape, jiggle, run into each other, pile up, get messy. This lively scene is governed by a rather small number of simple 'rules'. In this talk I will show some videos of crystals growing (as seen with a Low Energy Electron Microscope), and discuss what these movies tell us about the rules. We will end up with an improved understanding of crystal growth in the world of semiconductor materials.