

## Interfacial and Processing Sciences News Notes

June 1999

### Environmental and Molecular Sciences Laboratory Pacific Northwest National Laboratory

*News Notes, established to help keep our Users and others who have had a connection with us up-to-date on activities, events, capabilities, and interesting results, including short summaries of the work of users.*

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This issue includes:

- **Users Meeting and Surface Tools tutorial update**
- **Recent Research Results**
- **Staff Member Receives Science Education Award**

#### **Users Meeting Symposia and Tutorial on Surface Analysis Methods - Update**

Registration forms and other information about the Users Meeting and a range of tutorials are now available on the EMSL web page <http://www.emsl.pnl.gov>. There is no charge for attending any of the tutorials, but a fee to cover breaks and meals associated with the symposia is being charged.

The one-day tutorial on Surface Analysis Methods is scheduled for **July 22, 1999**. This tutorial is being scheduled in conjunction with the Environmental Molecular Sciences Laboratory (EMSL) Users Meeting on **July 21 - 24, 1999**. I&PS has organized the Mini-Symposium on the **Physics and Chemistry of Oxide Surfaces**. Other symposia include a) **Environmental Chemistry and Transport**; b) **Computational Science: New Advances and Recent Applications**; and c) **Structural and Functional Proteomics**. The combined tutorial and Users Meeting provides an excellent way to learn about EMSL capabilities and to see some of the research being conducted.

For more information, contact Terry Law (509/376-2418), Don Baer ([don.baer@pnl.gov](mailto:don.baer@pnl.gov); 509/376-1609), or see the EMSL web page.

#### **Some Recent Research Results**

##### **New Method Used to Determine Surface Structure and Termination of Cerium Oxide**

The EMSL low-energy ion scattering/direct recoil spectroscopy (LEIS/DRS) system has recently been used by Greg S. Herman to determine the surface termination of CeO<sub>2</sub>(001) using angle-resolved mass-spectroscopy of recoiled ions (AR-MSRI). The high-mass resolution and inherent surface sensitivity available with the MSRI technique provides a unique and powerful new capability for learning details of surface structure, particularly for materials for which different atoms may occupy surface sites. Although there have been several advances of the MSRI technique, there has been no prior MSRI work performed in the area of surface structure determinations. Cerium oxide is used as an oxygen storage material in an automobile catalytic converter, and the structural information is helping to explain the oxidation and reduction properties of the material. A comparison of experimental and simulated angle-resolved MSRI

scans from a CeO<sub>2</sub>(001) surface indicate that the surface is terminated by an oxygen layer that has half a monolayer of oxygen missing.

#### **Fabrication of Noncommutative Superlattices**

I&PS scientists have successfully fabricated (by molecular beam epitaxy) and characterized epitaxial " -Cr<sub>2</sub>O<sub>3</sub>/" -Fe<sub>2</sub>O<sub>3</sub> superlattices on " -Al<sub>2</sub>O<sub>3</sub>(0001). Scott Chambers and Yong Liang have measured, among other properties, valence band discontinuities at the interface, and have found them to be noncommutative. This means that the band offset is not the same for Cr<sub>2</sub>O<sub>3</sub> on Fe<sub>2</sub>O<sub>3</sub> as it is for Fe<sub>2</sub>O<sub>3</sub> on Cr<sub>2</sub>O<sub>3</sub>. The values are  $0.3 \pm 0.1$  eV for Fe<sub>2</sub>O<sub>3</sub> on Cr<sub>2</sub>O<sub>3</sub> and  $0.7 \pm 0.1$  eV for Cr<sub>2</sub>O<sub>3</sub> on Fe<sub>2</sub>O<sub>3</sub>, and are highly reproducible. When combined with the fact that the conduction band offset in the Fe<sub>2</sub>O<sub>3</sub> layer is always lower in energy than that in the Cr<sub>2</sub>O<sub>3</sub> layer, noncommutativity means that the material has excellent potential for effective spatial separation of electrons and holes created by visible light in the Fe<sub>2</sub>O<sub>3</sub> layer. Such a materials system may ultimately be useful in applications ranging from photocatalysis to information storage. The reason(s) for the noncommutativity are currently being investigated. Possibilities include strain, quantum confinement, and growth-order-dependent interface dipoles.

#### **Staff Receive Laboratory Director's Award for Science Education Contributions**

I&PS science and engineering associate Glen Dunham received one of three Fitzner-Eberhardt Awards for Outstanding Contributions to Science and Engineering Education on June 1. The award is in memory of Battelle scientists Richard Fitzner and Les Eberhardt who died in a plane crash in 1992, cutting short their outstanding service and contribution to students, teachers and faculty. Fitzner and Eberhardt demonstrated commitment and dedication of their time and talents not only to their research, but also to the education and training of future scientists, engineers and technologists.

Glen has been involved in relating physics and materials science to students and teachers in many different ways. He has been involved with curriculum development and class room demonstrations/projects with students in the Richland, Kennewick and Pomeroy school districts and was recently appointed to the Technology Advisory Committee of the Tri-Cities Area Educational Cooperative. He is a frequent host and mentor to high school and college students in the laboratory (over 17 since 1992). He was the southeastern Washington organizer for the DOE sponsored Junior Solar Sprint competition (solar energy) from 1992-1996, served as a coach for Odyssey of the Mind teams (1995 and 1997) and has been involved with the Society of Technical Communication Student Technical Writing Contest for 14 years. This summer he starts a three-year cycle for an NSF funded program that involves hosting a Hanford High School teacher and developing a connection between laboratory research and a high school chemistry class. The current plan is to develop off-site control for the Kratos multi-technique surface analysis system so that students can collect XPS and AES data from the classroom.

#### **I&PS Contacts**

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