SYMPOSIUM X

Frontiers of Materials Research

April 17 – 19, 2001

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* Invited paper

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.

SESSION X1:
Chairs: Nicholas E.B. Cowern, Tomas Diaz de la Rubia, Chad A. Mirkin and Cynthia A. Volkert
Tuesday Afternoon, April 17, 2001
Salon 7 (Marriott)

12:05 PM *X1.1
BIODETECTION. David R. Walt, Tufts University, Medford, MA.

As data transfer and communication become easier, we are increasing our demand for information. One of the most important types of information is the status of our health and environment. In this regard, the ability to detect biological species, such as specific DNA strands, cells, viral particles, and proteins, is essential for protecting us against potential pathogens or toxins. Such detection has applications in medical diagnostics, biotechnology, food and environmental protection, and biological weapons detection. The need for more sensitive detection, as well as simultaneous detection of multiple biological species, is increasing. In response to these needs, arrays of sensors or probes are being developed. In order to meet the sensitivity demand, new materials are being developed that possess both a recognition capability and allow such recognition to be coupled to a transduction signal. For multiplexing, there is a genuine need to pack more sensing elements into smaller spaces with a trend toward nanoscale features. This requirement poses a challenge to sensor and materials scientists to develop new strategies for preparing arrays using novel design principles and materials with reduced feature sizes. Scientists are beginning to exploit the sensing modalities employed by nature for new design principles. These principles are dramatically different from conventional sensor designs and will undoubtedly play an important role in future sensor design.

OUTSTANDING YOUNG INVESTIGATOR PRESENTATION

12:45 PM *X1.2
NEW DIRECTIONS IN PHOTOPOLYMERIZABLE MATERIALS. Kristi S. Anseth, University of Colorado, Boulder, CO.

Photopolymerization is one of the most rapidly expanding technologies for materials production with an array of applications from the printing of newspapers to the coating of optical fibers, and the potential is immense for future applications in medicine. From a biomaterials perspective, multifunctional monomers that can be photopolymerized to form degradable networks could provide numerous advantages. Photoinitiated polymerizations allow fast curing rates under physiological conditions, spatial and temporal control of the polymerization, and the ability to generate complex 3D structures in situ. Monomers that photopolymerize to form degradable networks circumvent the need for implant retrieval, avoid problems associated with permanent foreign bodies, and can be useful in applications ranging from controlled release of drugs to tissue engineering scaffolds. This talk will highlight our recent efforts and directions aimed at engineering photopolymerizable and degradable polymer networks for various medical applications including: 1) multifunctional anhydride monomers that photocrosslink to form high strength and surface eroding networks for fracture fixation applications, 2) encapulation of cells in photofabricated hydrogels that promote and/or guide tissue formation, and 3) transtissue photopolymerization of polymers to allow implantation without any surgical incision.

SESSION X2:
Chairs: Nicholas E.B. Cowern, Tomas Diaz de la Rubia, Chad A. Mirkin and Cynthia A. Volkert
Wednesday Afternoon, April 18, 2001
Salon 7 (Marriott)

12:05 PM *X2.1
MOLECULAR ELECTRONICS. Mark A. Ratner, Northwestern University, Evanston, IL.

Molecular species interacting with metallic interfaces can transduce both current and energy. These are crucial processes in molecular electronics and optoelectronics.
The talk will discuss the generalities of molecular-based devices and the prospects for understanding the simplest of them, molecular wire junctions and molecule-based optical devices. Particular emphasis will be placed on the different recognition mechanisms and molecular properties that separate molecule-based devices from those of most contemporary cmos structures.

12:45 PM *X2.2
MOLECULAR ELECTRONICS-A COMPLEMENT AND SUCCESSOR TO SILICON INTEGRATED CIRCUITS? R. Stanley Williams, Hewlett Packard Company, Palo Alto, CA.

The phenomena known popularly known as "Moore's Law", i.e. the exponentially increasing capability of electronic systems to store and process data, has had a tremendous impact on society in general and the economy in particular over the latter half of the twentieth century. This talk will present a brief review of some of the historical and economic issues with regard to the scaling of electronic devices, and then discuss both the physical and financial limitations imposed by silicon integrated circuits and opportunities/requirements for going well beyond the limits of silicon. A few of the potential successors to silicon integrated circuits will be introduced and discussed as well.

SESSION X3:
Chairs: Nicholas E.B. Cowern, Tomas Diaz de la Rubia, Chad A. Mirkin and Cynthia A. Volkert
Thursday Afternoon, April 19, 2001
Salon 7 (Marriott)

12:05 PM *X3.1
ANCIENT AND MODERN LAMINATED COMPOSITES - FROM THE GREAT PYRAMID OF GIZEH TO Y2K. Jeffrey Wadsworth, Lawrence Livermore National Laboratory, Livermore, CA.

Laminated metal composites have been cited in antiquity; for example, a steel laminate that may date as far back as 2750 B.C., was found in the Great Pyramid in Gizeh in 1837. A laminated shield containing bronze, tin, and gold layers, is described in detail by Homer. Well-known examples of steel laminates, such as an Adze blade, dating to 400 B.C.can be found in the literature. The Japanese sword is a laminated composite at several different levels and Merovingian blades were composed of laminated steels. Other examples are also available, including composites from China, Thailand, Indonesia, Germany, Britain, Belgium, France, and Persia. The concept of lamination to provide improved properties has also found expression in modern materials. Of particular interest is the development of laminates including high carbon and low carbon layers. These materials have unusual properties that are of engineering interest; they are similar to ancient welded Damascus steels. The manufacture of collectable knives, labeled "welded Damascus", has also been a focus of contemporary knifemakers. Additionally, in the Former Soviet Union, laminated composite designs have been used in engineering applications. Each of the above areas will be briefly reviewed, and some of the metallurgical principles will be described that underlie improvement in properties by lamination. Where appropriate, links are made between these property improvements and those that may have been present in ancient artifacts. The talk will also describe recent work to directly date iron and steel artefacts using carbon dating. Issues associated with obtaining samples of precious materials for carbon dating, such as the ancient iron plate from the Great Pyramid at Gizeh, will be discussed.

12:45 PM *X3.2
SCALING TRANSISTORS INTO THE NEXT DECADE: CHALLENGES IN MATERIAL SCIENCE. Paul A. Packan, Intel Corporation, Hillsboro, OR.

The scaling of the silicon transistor has continued unabated for more than 30 years. During this time, transistor performance has improved by more than 30% per year. This aggressive trend has required solutions to many difficult material science problems. This talk will discuss issues in fabricating state-of-the-art CMOS device technologies. Material issues related to dopant diffusion and activation to form shallow, low resistance profiles will be addressed. Issues related to the scaling of gate dielectrics including electrical performance and gate leakage trends will be included. The ability to define the extremely small dimensions required for future technologies as well as backend interconnect issues to improve performance and minimize parasitic effects will also be discussed.