SYMPOSIUM X

Frontiers of Materials Research

November 29 – December 2, 1999

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* Invited paper

SESSION X1:
Chairs: Paul D. Bristowe, David G. Grier,
Fernando A. Ponce and Ellen D. Williams
Monday Afternoon, November 29, 1999
Room 208 (H)

12:05 PM *X1.1
PROSPECTS FOR MOLECULAR SCALE ELECTRONICS.
M.A. Reed, Yale University, Departments of Electrical Engineering and Applied Physics, New Haven, CT.

The recent state-of-the-art of electronic molecular-scale device systems utilizing self-assembled oligomers as the key fabrication strategy will be discussed. A variety of devices have been demonstrated, including switches with inherent mechanisms significantly different from conventional solid state devices.

12:45 PM *X1.2

MRS MEDAL AWARD TALK PRESENTATION

SCIENCE AND TECHNOLOGY AT THE NANOMETER SCALE USING VACUUM DEPOSITED ORGANIC THIN FILMS.
S.R. Forrest, Princeton University, Princeton Materials Institute and the Department of Electrical Engineering, Princeton, NJ.

Organic semiconductors have fascinated scientists worldwide for at least the last 50 years. The potential to tune molecular compositions and their crystalline structures almost "at will" has been the source of this interest, with the hopes that eventually organic semiconductor thin films would result in a new generation of electronic and optical devices. However, in the early years of research, the purity of the materials led to poor reproducibility of their properties, the materials were typically unstable to environmental exposure or were subject to rapid photophysical degradation, and disordered structures resulted in poor electrical conductivity. While many of these problems persist, many have also been solved. Indeed, today, color displays for car stereos consisting of organic light emitting devices are on the market. Several advances have lead to this change. Among the advances, high purity and often highly ordered thin films of organic molecules can now be routinely deposited in vacuum. Such films, often only a few monolayers in thickness, can exhibit flatness to the molecular scale, with long range order extending over entire macroscopic substrate surfaces. In this talk, I will discuss the advances in organic thin film deposition using high and ultrahigh vacuum techniques, and the properties of such films. Furthermore, some recent exciting device developments which have resulted from our increased understanding of the fundamental properties of vacuum deposited molecular organic semiconductors will be discussed, including organic light emitting devices, thin film transistors, and solar cells.

SESSION X2:
Chairs: Paul D. Bristowe, David G. Grier,
Fernando A. Ponce and Ellen D. Williams
Tuesday Afternoon, November 30, 1999
Room 208 (H)

12:05 PM *X2.1
CONTROLLING THE INTERACTIONS OF CELLS WITH MATERIALS. M. Mrksich, University of Chicago, Dept of Chemistry, Chicago, IL.

(ABSTRACT NOT AVAILABLE)

12:45 PM *X2.2
THE MATERIALS SCIENCE OF FOOD. Richard A.L. Jones, University of Sheffield, Dept of Physics and Astronomy, Sheffield, UNITED KINGDOM.

The study of food is not normally thought of as the province of materials scientists, but it turns out that many of the concepts of materials physics may be directly applied to food systems. I will discuss three examples. The first is the surprisingly direct applicability of the Cahn-Hilliard theory of spinodal decomposition and its refinements to the study of mixtures of biopolymers. Such mixtures are found in desserts, confectionary and low fat spreads; here if the mechanisms by which structure is formed are understood manufacturers should be able to design processing routes to achieve the desired texture. The second is the importance of the glass transition in low water starch systems such as biscuits and wafers. This plays a large role in determining how water gets into these materials, which is a big factor in governing shelf-life. The third is the way in which the conformation of protein molecules at interfaces influences their role in stabilising food colloids. This problem finds application in substances as diverse as mayonnaise and beer foam, but it also raises fascinating fundamental issues about the influence of interfaces on protein folding, which may have much wider importance in cell biology.
Apart from the intellectual satisfaction of understanding the behaviour of materials that are so familiar in everyday life, a major motivation for studying food from a materials physics point of view is the huge scale of the modern food industry, which means that incremental improvements in processes and products can lead to large impacts on profits. But our success in applying relatively simple models to these complex systems of biological origin emphasises just how widely applicable materials science concepts can be.

SESSION X3:
Chairs: Paul D. Bristowe, David G. Grier,
Fernando A. Ponce and Ellen D. Williams
Wednesday Afternoon, December 1, 1999
Room 208 (H)

12:05 PM *X3.1
TWO-PHOTON ABSORBING MATERIALS AND APPLICATIONS IN 3D TECHNOLOGIES. J.W. Perry, University of Arizona, Dept of Chemistry, Tucson, AZ.

(ABSTRACT NOT AVAILABLE)

12:45 PM *X3.2

MRS MEDAL AWARD TALK PRESENTATION

VISIBLE LIGHT EMITTING DIODES (LED'S): PAST, PRESENT, AND VERY BRIGHT FUTURE. M.G. Craford, Hewlett-Packard, San Jose, CA.

The presentation will give an overview of the technology and application of visible LED's. Visible LED's have for many years been the dominant compound semiconductor device in terms of numbers of devices produced and revenue generated. Their applications, limited by brightness, were generally in the indoor display and indicator area. More than an order of magnitude improvement that has been achieved in the past decade for AlInGaP (red, orange, amber) and AlInGaN (green, blue) LED's. The best results to date are 55% quantum efficiency for red (650nm) and 100 lm/w for orange (610nm)AlInGaP devices. The recent LED advances have enabled new outdoor applications such as traffic signals, automotive exteriors, and large area signs. With further improvements LED's can be expected to challenge other light sources for some types of illumination applications.

SESSION X4:
Chairs: Paul D. Bristowe, David G. Grier,
Fernando A. Ponce and Ellen D. Williams
Thursday Afternoon, December 2, 1999
Room 208 (H)

12:05 PM *X4.1
SUPERPLASTICITY: CURRENT STATUS AND FUTURE POTENTIAL. T. Sakuma, University of Tokyo, Dept of Materials Science, Tokyo, JAPAN.

The following definition of "superplasticity" was accepted at the 1991 International Conference on Superplasticity in Advanced Materials (ICSAM-91) held in Osaka, Japan:
"Superplasticity is the ability of a polycrystalline material to exhibit, in a generally isotropic manner, very high tensile elongation prior to failure."
This definition is related to the past advancement of superplasticity research for more than 30 years. Superplasticity research was originally developed in the field of metallurgy, and then extended in other materials such as ceramics. The present talk aims to introduce briefly the superplastic flow behavior in materials and the research advancement for nonspecialists. As for the fundamental research on superplasticity, it is crucial to develop very microscopic or atomistic analysis on grain booundary sliding or grain boundary failure as well as past mesoscopic analysis of flow stress against strain rate relationship to keep our potential in the future. Engineering application of superplastic forming or joining processes is limited mainly in Al alloys at present. Another key for more general application in the future must depend on sound collaboration between scientists and industrialists.

12:45 PM *X4.2
SINGLE MOLECULE BIOMECHANICS AND ITS IMPLICATIONS FOR MATERIALS RESEARCH. Paul K. Hansma, University of California-Santa Barbara, Department of Physics, Santa Barbara, CA.

It is now possible to measure the activity, the elasticity and even the motion of some individual protein molecules with scanning probe microscopes in particular the Atomic Force Microscope, AFM. After a brief overview of AFM development, featuring special emphasis on small cantilevers, this talk will review the progress to date modular proteins and on enzymes such as lysozyme and RNA polymerase. The modular proteins provide effective energy absorption and appear to be the real key to understanding the impressive fracture resistance of many biological composite materials. The elegant trick that makes this possible has been revealed by unfolding studies with the AFM. And, it is becoming possible, again with AFMs, to learn how some enzymes, natures nanomachines, do their exquisite materials synthesis and processing. Since the AFMs of today are very far from fundamental limits, this is only the beginning.