

SYMPOSIUM X
Frontiers of Materials Research

Authoritative Reviews for Nonspecialist

November 28 - December 1, 2005

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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.

* Invited paper

SESSION X1

Chairs: Yang-Tse Cheng, David S. Ginley, Kathryn E. Uhrich and Ralf B. Wehrspohn
Monday Afternoon, November 28, 2005
Grand Ballroom (Sheraton)

12:05 PM *X1.1

The Self-Organizing Dynamics of a Knowledge-Based Economy. Loet Leydesdorff, Amsterdam School of Communications Research (ASCoR), Amsterdam, Netherlands.

Dr. Leydesdorff is Senior Lecturer at the Amsterdam School of Communications Research. He has published in the philosophy of science, social network analysis, scientometrics, and the sociology of innovation. His studies of communication in science, technology, and innovation have enabled him to specify theory and methods for understanding the self-organizing dynamics of the knowledge base of social systems. In 2003, he received the Derek de Solla Price Award for the quantitative study of scientific communication. He has been visiting professor in Paris (1990), Calgary (1995), Tokyo (1998), and Lausanne (2005). His first degree was a Masters in biochemistry from the University of Amsterdam in 1973. During his studies, he became increasingly interested in the changing relations between science and society. He obtained a Masters in the philosophy of science and social philosophy in 1977. In 1984, he obtained his PhD in the sociology of labour and organization on the basis of a book entitled *Employees and the Process of Technological Innovation*. In this study he tried to explain in empirical terms how the dynamics of knowledge upset the economic dynamics of exchanges on the market and institutional control mechanisms. The specification of the dynamics of knowledge production and control, and the latter's interaction with economic exchange and normative control has remained a central focus of his work. When these three coordination mechanisms of the social system interact, the generation of a complex dynamics can be expected. How can economic wealth generation, technological innovation, and institutional retention be (re)-combined in a triple helix of university-industry-government relations? In the 1980s, he first had the opportunity to help organize the interfaculty department of Science & Technology Dynamics as a unit at the University of Amsterdam. In this context, he focused primarily on developing methodologies for studying scientific communication and knowledge-based systems. How are human communication systems which generate, communicate, and codify meaning, different from (e.g., biological) information-processing systems? During the 1990s, he returned to the subject of innovation. Unlike scientific communications which are mainly text-based technologies and innovations are shaped at interfaces, for example, between the sciences and relevant markets. New theories about self-organizing systems (Maturana) and systems which communicate in terms of meaning (Luhmann) can be recombined with the more rigorous apparatus of entropy statistics. The theory of anticipatory systems (Rosen) has to be appreciated in order to understand how time can be considered as a variate which adds to the dynamics of meaning-processing. Meaning is provided from the perspective of hindsight and knowledge can recursively be considered as a meaning which makes a difference. The focus of Dr. Leydesdorff's lecture will be on the modelling, the measurement, and the simulation of knowledge-based systems.

12:45 PM *X1.2

Self-Assembly Codes for Soft Materials. Samuel I. Stupp, Materials Science, Northwestern University, Evanston, Illinois.

Professor Samuel Stupp earned his B.S. in chemistry from the University of California at Los Angeles in 1972, and his Ph.D. in materials science and engineering from Northwestern University in 1977. He joined the faculty at Northwestern in 1977 as professor of biological materials, and in 1980 moved to the University of Illinois at Urbana-Champaign where he was professor of materials science and engineering, chemistry and bioengineering until January 1999. While at the University of Illinois, he was named Swanlund Professor of Materials Science and Engineering, Chemistry, and Bioengineering in 1996, being one of the first seven faculty members to be recognized by the University of Illinois with this endowed chair. He also served as chairman of the Polymer Division in the Department of Materials

Science and Engineering, and was a member of the Beckman Institute for Advanced Science and Technology from its founding in 1989. In January 1999, Professor Stupp returned to Northwestern University as a Board of Trustees professor of Materials Science, Chemistry, and Medicine, and in 2000, was appointed to direct the Institute for BioNanotechnology in Medicine at Northwestern. In 1985, Professor Stupp received the Xerox Faculty Award for Excellence in Engineering Research. In 1991, he received the Department of Energy Prize for Outstanding Achievement in Materials Chemistry. That same year he was elected fellow of the American Physical Society. In 1997, he was awarded a Humboldt Senior Prize from the Humboldt Foundation. Also in 1997, he was Joliot Curie Professor in Paris at the Ecole Supérieure de Physique et de Chimie Industrielles. Professor Stupp became an elected member of the American Academy of Arts and Sciences in 1998, and in 1999 was elected as a fellow of the American Association for the Advancement of Science. In 2000, he was awarded the Materials Research Society's Medal Award, and in 2002 a Paris Sciences Medal. Professor Stupp was elected as a Fellow of the World Technology Network in 2003. In 2004, he was elected as a Fellow of the Biomaterials Science and Engineering, World Biomaterials Congress, and was awarded the Merck-Karl Pfister Visiting Professorship in Organic Chemistry, Department of Chemistry, Massachusetts Institute of Technology, and was hosted by Professor Jean-Marie Lehn as a visiting professor at the Institut de Science et d'Ingénierie Supramoléculaires, Université Louis Pasteur, Strasbourg, France. Additionally, Professor Stupp was awarded in 2005 a Sir Edward Youde Memorial Fund Visiting Professorship in Chemistry at Hong Kong University of Science and Technology. In March of 2005, he received the American Chemical Society Award in Polymer Chemistry. Professor Stupp has served as a member of the Department of Energy's Basic Energy Sciences Advisory Committee since 1999. In 2001, at the request of the White House Professor Stupp served as the chair of the committee to review the National Nanotechnology Initiative. In this capacity he has briefed and testified at the US Senate and on two occasions the Presidents Council of Advisors on Science and Technology. In 2003, Professor Stupp began service as a member of the Nanotechnology Technical Advisory Group of the Presidents Council of Advisors on Science and Technology. His areas of research include molecular self-assembly, supramolecular organic nanostructures, electronic and photonic properties of organic materials, biomolecular mineralization, templating chemistry of inorganic nanostructures, and biomaterials for regenerative medicine, including the central nervous system, organ cell transplantation, bone, and cartilage.

SESSION X2

Chairs: Yang-Tse Cheng, David S. Ginley, Kathryn E. Uhrich and Ralf B. Wehrspohn
Tuesday Afternoon, November 29, 2005
Grand Ballroom (Sheraton)

12:05 PM *X2.1

Smart Clothes. Alex (Sandy) Pentland, Human Dynamics, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Prof. Alex (Sandy) Pentland is a pioneer in wearable computers, health systems, smart environments, and technology for developing countries. He is one of the most-cited computer scientists in the world. He is a co-founder of the Wearable Computing research community, the Autonomous Mental Development research community, the Center for Future Health, the international Digital Nations Consortium, and was the founding director of the Media Lab Asia. He was formerly the Academic Head of the MIT Media Laboratory, and is the Toshiba Professor of Media Arts and Sciences. He has won numerous international awards in the Arts, Sciences and Engineering. He was chosen by Newsweek as one of the 100 Americans most likely to shape the next century. He currently directs the Human Dynamics research group at the MIT Media Lab.

12:45 PM *X2.2

Nanotechnology in Textile Finishing – State of the Art and Future Prospects. Jan Beringer, Textile Research Center, Hohensteiner Institute, Boennigheim, Germany.

Studied chemistry at the University of Stuttgart, Germany. Did diploma work and received doctoral thesis from the Institute of Textile- and Fiber Chemistry at University of Stuttgart, in the research group of Prof. Dr. K. Bredereck. Thesis "Pulp from wheat straw..." (ISBN-No: 3832507973). Publications: Beringer, J., Hoefler, D., Nanotechnology and its application, *Melliand International* 10 (2004), 295-296. Beringer, J., Hoefler, D., Nanotechnologie und Anwendung, *Melliand Textilberichte* 10 (2004), 698-699. Hoefler, D., Beringer, J., Vermeidung von Hautirritationen durch Textilien, *Melliand Textilberichte* 5 (2005), 377-379.

SESSION X3

Chairs: Yang-Tse Cheng, David S. Ginley, Kathryn E. Uhrich and Ralf B. Wehrspohn
Wednesday Afternoon, November 30, 2005
Grand Ballroom (Sheraton)

12:05 PM *X3.1

Flexible Displays: Would They Ever be Real? Ghassan Jabbour, Department of Chemical and Materials Engineering and Flexible Display Center, University of Arizona, Tempe, Arizona.

A Professor of Chemical and Materials Engineering, and the Director of Research and Development in the area of Optoelectronic Materials and Devices at the Flexible Display Center (FDC) at Arizona State University. He is also the Technical Advisory Board Leader on Optoelectronic Materials, Devices and Encapsulation at FDC. Professor Jabbour is an Associate Editor of the Journal of the Society for Information Displays (JSID) and a Consultant for MRS Bulletin. He was the Track Chair of the Nanotechnology Program for the SPIE Annual Meeting (2001-2004), and the Secretary General for the Materials Secretariat of the American Chemical Society (2001). Professor Jabbour is a guest editor for the MRS Bulletin issue on Organic Photovoltaics, January 2005. Professor Jabbour is the chair and/or co-chair and on the committees of over 60 conferences related to photonic and electronic properties of organic and nano-organic materials and their applications in displays and lighting, transistors and solar cells, hybrid photosensitive materials, and hybrid integration of semiconducting materials. Professor Jabbour attended Northern Arizona University, the Massachusetts Institute of Technology (MIT), and the University of Arizona where he got his Ph. D. in 1994. Prof Jabbour's recent research projects include work on flexible nano and mega electronics and photonics; Photovoltaic materials and devices; Optimization of OLEDs performance and integration; Printed and patterned optical, electronic and optoelectronic materials and devices; Optics and materials science of thin films and nanostructures; Combinatorial techniques in photonic and electronic materials discovery; Photosensitive materials for optoelectronic applications; Chemical and biological sensors; and Smart fabrics. Prof. Jabbour has more than 350 publications, invited talks, seminars, and conference proceedings. He edited several books related to nanotechnology, organic and functional optoelectronics areas. He has been selected to the Asahi Shimbun 100 New Leaders of the USA and he received the Presidential Award for Excellence from the Hariri Foundation in 1997. Prof. Jabbour is an SPIE fellow.

12:45 PM *X3.2

Polymer Electronics for Sensors. Timothy M. Swager, Chemistry, MIT, Cambridge, Massachusetts.

Timothy M. Swager is a Professor of Chemistry and Head of the Department of Chemistry at MIT. A native of Montana, he received a BS from Montana State University in 1983, and a Ph.D. from the California Institute of Technology in 1988. After a postdoctoral appointment at MIT, he was on the chemistry faculty at the University of Pennsylvania as an Assistant Professor 1990-1996 and as a Professor 1996. He moved to MIT in July of 1996 as a Professor of chemistry. The author of over 180 peer reviewed publications, Swager's research interests are in design, synthesis, and study of organic-based electronic, sensory, and liquid crystalline materials. Swager's research in electronic polymers has been primarily directed at the demonstration of new conceptual approaches to the construction of sensory materials. In particular, he has developed conjugated polymer sensory transduction schemes that translate molecular recognition events into readily measured signals. The fundamental tenet of this research is that the cooperative nature of these materials produces enhancements in observable signals relative to monomeric analogs. Swager has shown this application to be general and applicable to any signal, which is dependent upon the transport properties of the system. Materials and methods from the Swager laboratory are the enabling technology for the explosive detectors that have become the flagship products of Nomadics incorporated (www.Nomadics.com). These systems have demonstrated unprecedented sensitivities for the detection of chemical weapons, toxic industrial chemicals, and biological molecules.

SESSION X4

Chairs: Yang-Tse Cheng, David S. Ginley, Kathryn E. Uhrich and Ralf B. Wehrspohn
Thursday Afternoon, December 1, 2005
Grand Ballroom (Sheraton)

12:05 PM *X4.1

Size Matters! Smaller is Stronger: Strength and Plasticity at the Nanoscale. William D. Nix, Department of Materials Science and Engineering, Stanford University, Stanford, California.

Professor Nix obtained his B.S. degree in Metallurgical Engineering from San Jose State College, and his M.S. and Ph.D. degrees in Metallurgical Engineering and Materials Science, respectively, from Stanford University. He joined the faculty at Stanford in 1963 and was appointed Professor in 1972. He was named the Lee Otterson Professor of Engineering at Stanford University in 1989 and served as Chairman of the Department of Materials Science and Engineering from 1991 to 1996. He became Professor Emeritus in 2003. In 2001 he was awarded an Honorary Doctor of Engineering Degree by the Colorado School of Mines. In 1964 Professor Nix received the Western Electric Fund Award for Excellence in Engineering Instruction, and in 1970, the Bradley Stoughton Teaching Award of ASM. He received the 1979 Champion Herbert Mathewson Award and in 1988 was the Institute of Metals Lecturer and recipient of the Robert Franklin Mehl Award of the Metallurgical Society (TMS). In 1995 he received the Educator Award from TMS. He was selected by ASM International to give the 1989 Edward DeMille Campbell Memorial Lecture and in 1998 received the ASM Gold Medal. He gave the Alpha Sigma Mu Lecture to ASM in 2000 and received the Albert Easton White Distinguished Teacher Award in 2002 and the Albert Sauveur Achievement Award in 2003, both from ASM. He also received a Distinguished Alumnus Award from San Jose State University in 1980. In 1993 he received the Acta Metallurgica Gold Medal and in 2001 he received the Nadai Medal from the American Society of Mechanical Engineers. He was elected Fellow of the American Society for Metals in 1978 and elected Fellow of the Metallurgical Society of AIME in 1988. In 1987 he was elected to the National Academy of Engineering and in 2002 was elected as a Fellow of the American Academy of Arts and Sciences. Prof. Nix was elected to the National Academy of Sciences in 2003. In 1966 he participated in Ford Foundation's "Residence in Engineering Practice" program as Assistant to the Director of Technology at the Stellite Division of Union Carbide Corporation. From 1968 to 1970 Professor Nix was Director of Stanford's Center for Materials Research. Professor Nix is engaged in research on the mechanical properties of solids. He is principally concerned with the relation between structure and mechanical properties of materials in both thin film and bulk form. He is co-author of more than 400 publications in these and related fields and he has trained 73 Ph.D. students in these subjects in his years at Stanford. Professor Nix teaches courses on dislocation theory and mechanical properties of materials. He is co-author of "The Principles of Engineering Materials", published in 1973 by Prentice-Hall, Incorporated.

12:45 PM *X4.2

Flaw Tolerant Nanoscale and Hierarchical Structures in Biological Materials. Huajian Gao, Max Planck Institute for Metals Research, Stuttgart, Germany.

Huajian Gao received his B.S. degree from Xian Jiaotong University of China in 1982, and his M.S. and Ph.D. degrees in Engineering Science from Harvard University in 1984 and 1988, respectively. He served on the faculty of Stanford University between 1988 and 2002, where he was promoted to Associate Professor with tenure in 1994 and to full Professor in 2000. He joined the Max Planck Society in 2001. At present, he is Director and Professor at the Max Planck Institute for Metals Research in Stuttgart, Germany. Professor Gao has a background in engineering science and applied mechanics. His research interests include stress and diffusion processes in various thin films and nanocrystalline materials, size-dependent plastic deformation at micron and submicron length scales and dynamic fracture in brittle solids. Since joining the Max Planck Society, he has also expanded his research toward mechanics of biological materials. He has nearly 20 years of research experience with more than 150 publications. He has broad collaborations with scientists in the United States, Europe and China. Professor Gao is a recipient of numerous academic awards including ASME Best Achievement Award for Young Investigators in Applied Mechanics, SES Young Investigator Award, the Humboldt Research Fellowship Award, the Presidential Young Investigator Award, the Guggenheim Memorial Fellowship, the IBM Faculty Development Award, and the Alcoa Science Award. He is a Fellow of the American Society of Mechanical Engineers and a Fellow of the Institute of Physics.