The National Academies of SCIENCES ENGINEERING MEDICINE

NATIONAL MATERIALS AND MANUFACTURING BOARD
BOARD ON PHYSICS AND ASTRONOMY
Division on Engineering and Physical Sciences

Frontier of Materials Research: A Decadal Survey
Meeting #3

Thursday, September 7, 2017
Intercontinental Hotel
Camelot Room
505 N. Michigan Avenue
Chicago, IL

Open SESSION

8:00 a.m. – 8:30 a.m.	**Working Breakfast (in the meeting room)**
8:30 a.m. – 8:45 a.m.	**Welcome** Study Co-chairs
8:45 a.m. – 9:25 a.m.	Materials for Bio-Integrated Electronics **John Rogers,** *Northwestern University*
9:25 a.m. – 10:05 a.m.	Engineering Materials for Quantum Information Processing **David Awschalom,** *University of Chicago*
10:05 a.m. – 10:20 a.m.	Break
10:20 a.m. – 11:00 p.m.	Materials Development and Aerospace Engineering **Robert Schafrik,** *GE, Retired*
11:00 a.m. – 11:40 a.m.	The Science of Granular Materials **Heinrich Jaeger,** *University of Chicago*
11:40 a.m. – 12:30 p.m.	Open discussion with the Speakers and the Committee *All*
12:30 p.m. – 1:15 p.m.	Lunch (45min)

Closed SESSION

1:15 p.m. – 5:00 p.m.	**Committee Closed session issues.** All Members (only)
6:00 p.m.	**Dinner** (TBD)

Friday, September 8, 2017
Intercontinental Hotel
Camelot Room
505 N. Michigan Avenue
Chicago, IL

Open SESSION

8:00 a.m. – 8:30 a.m.	**Working Breakfast (in the meeting room)**
8:30 a.m. – 8:45 a.m.	**Welcome** Study Co-chairs
8:45 a.m. – 9:25 a.m.	Active matter - a bridge between biology and materials science **Cristina Marchetti,** *Syracuse University*
9:25 a.m. – 10:05 a.m.	Materials Designed for Low Energy Growth **Mercouri Kanatzidis,** *Northwestern University*
10:05 a.m. – 10:20 a.m.	Break
10:20 a.m. – 11:00 p.m.	Batteries, Materials for Energy Storage **George Crabtree,** *U. of Illinois-Chicago and Argonne National Lab.*
11:00 a.m. – 12:00 p.m.	Open discussion with the Speakers and the Committee *All*
12:00 p.m. – 12:45 p.m.	Lunch (45min)

Closed SESSION

12:45 p.m. – 5:00 p.m.	**Committee Closed session issues.** All Members (only)
5:00 p.m.	Adjourn

BIOS

Cristina Marchetti (Syracuse)
William R. Kenan Distinguished Professor of Physics, Syracuse University
Email: mcmarche@syr.edu

Bio: Professor Marchetti is the William R. Kenan Professor of Physics at Syracuse University, where she has been a member of the faculty since 1987. She is a versatile theoretical physicist who has worked on a broad range of problems including supercooled fluids, glasses and superconductors. Currently, she is interested in understanding the emergent behavior of active materials, from suspensions of self-catalytic colloids to living tissues. She has recently co-organized a long program at the Kavli Institute for Theoretical Physics of UC Santa Barbara on Active Matter: Cytoskeleton, Cells, Tissues, and Flocks. Marchetti has held elected positions in the American Physical Society and was awarded a Rotschild-Mayent Fellowship at the Institut Curie and a Simons Fellowship in Theoretical Physics. At Syracuse University she has served as chair of the Department of Physics (2007-2010) and as associate director of the Syracuse Biomaterials Institute (2007-2017). She is a member of the American Academy of Arts and Sciences and a fellow of the American Association for the Advancement of Science and of the American Physical Society. She is co-editor of the Annual Reviews of Condensed Matter Physics and most recently she was appointed co-lead editor of Physical Review X, a highly selective, online open-access journal published by the American Physical Society.

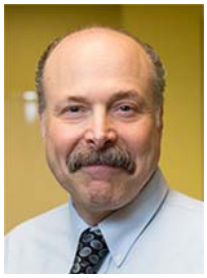
Robert Schafrik (GE)
Consultant and recently retired general manager of the Materials and Process Engineering Department at GE Aviation
Email: bobschafriksr@gmail.com

Bio: Dr. Schafrik is a consultant and recently retired general manager of the Materials and Process Engineering Department at GE Aviation. He received his Ph.D. in metallurgical engineering from Ohio State University in 1979, an M.S. in information systems from George Mason University in 1996, an M.S. in aerospace engineering from the Air Force Institute of Technology in 1974, and a B.S. in metallurgy from Case-Western Reserve University in 1967. As such he was responsible for developing advanced materials and processes used in GE's aeronautical turbine engines and their marine and industrial derivatives. He oversaw Materials Application Engineering activities supporting GE Aviation's global design engineering, manufacturing, and field support activities. He also operated a state-of-the-art in-house laboratory for advanced materials development, characterization, and failure analysis. Prior to joining GE in November 1997, he served in 2 concurrent positions within the National Research Council, which he joined in 1991: Staff Director, National Materials Advisory Board and Staff Director, Board on Manufacturing and Engineering Design. Under his direction, 33 final reports for studies were issued that addressed significant national issues in materials and manufacturing. Dr. Schafrik also served in the U.S. Air Force in a variety of R&D and system acquisition capacities; he retired as a Lieutenant Colonel, while recently he served as member of the Air Force Scientific Advisory Board, 2009-2013.

Mercouri Kanatzidis (NU)
Charles E. and Emma H. Morrison Professor of Chemistry at Northwestern University
Email: m-kanatzidis@northwestern.edu

Bio: Professor Kanatzidis received a B. Sc from Aristotle University in Greece and a Ph D. in chemistry from the University of Iowa in 1984. He was a post-doctoral research associate at the University of Michigan and Northwestern University from 1985 to 1987 and is currently the Charles E. and Emma H. Morrison Professor of Chemistry at Northwestern University. Professor Kanatzidis has developed synthesis new methodologies for the design and discovery of new chalcogenide materials and intermetallics. He is known for the elaboration of flux synthesis techniques which allow reactions to proceed at lower temperatures than otherwise would and can lead to new structures and compositions. From his research, metal sulfide ion-exchangers have been discovered. They are effective materials in heavy metal remediation of industrial waste waters. Kanatzidis promoted new ideas on nanostructured thermoelectrics which led to new design paradigms and performance breakthroughs in thermoelectric research. Mercouri also holds an appointment at Argonne National Laboratory and is the editor in chief of the Journal of Solid State Chemistry.

David Awschalom (UC)
Liew Family Professor in Spintronics and Quantum Information and Deputy Director at the Institute for Molecular Engineering at the University of Chicago.
Email: awsch@uchicago.edu



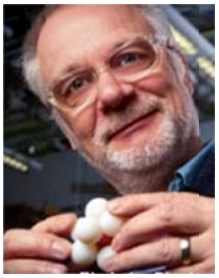
Bio: Professor Awschalom is the Liew Family Professor in Spintronics and Quantum Information and Deputy Director at the Institute for Molecular Engineering at the University of Chicago. He is one of the world's leading scientists in spintronics and quantum information engineering whose research involves understanding and controlling the spins of electrons, ions, and nuclei for fundamental studies of quantum systems, as well as potential applications in computing, imaging, and encryption. His group explores optical and magnetic interactions in semiconductor quantum structures, spin dynamics and coherence in condensed matter systems, macroscopic quantum phenomena in nanometer-scale magnets, and implementations of quantum information processing in the solid state. These measurements resulted in the discovery of robust electron spin coherence, transport of coherent states, and the spin Hall effect in semiconductors. Professor Awschalom received his BSc in physics from the University of Illinois at Urbana-Champaign, and his PhD in experimental physics from Cornell University. He was a Research Staff member and Manager of the Nonequilibrium Physics Department at the IBM Watson Research Center in Yorktown Heights, New York. In 1991 he joined the University of California-Santa Barbara as a Professor of Physics, and in 2001 was additionally appointed as a Professor of Electrical and Computer Engineering. During this period he served as the Peter J. Clarke Professor and Director of the California NanoSystems Institute, and Director of the Center for Spintronics and Quantum Computation. Professor Awschalom received the American Physical Society Oliver E. Buckley Prize and Julius Edgar Lilienfeld Prize, the European Physical Society Europhysics Prize, the Materials Research Society David Turnbull Award and Outstanding Investigator Prize, the AAAS Newcomb Cleveland Prize, the International Magnetism Prize and the Néel Medal from the International Union of Pure and Applied Physics, and an IBM Outstanding Innovation Award. He is a member of the American Academy of Arts and Sciences, the National Academy of Sciences, the National Academy of Engineering, and the European Academy of Sciences.

John Rogers

Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Neurological Surgery (and by courtesy Electrical Engineering and Computer Science, Mechanical Engineering and Chemistry)
Email: jrogers@northwestern.edu

Bio: Professor Rogers' research seeks to understand and exploit interesting characteristics of 'soft' materials, such as polymers, liquid crystals, and biological tissues as well as hybrid combinations of them with unusual classes of micro/nanomaterials, in the form of ribbons, wires, membranes, tubes or related. The aim is to control and induce novel electronic and photonic responses in these materials; and also develop new 'soft lithographic' and biomimetic approaches for patterning them and guiding their growth. This work combines fundamental studies with forward-looking engineering efforts in a way that promotes positive feedback between the two. Current research focuses on soft materials for conformal electronics, nanophotonic structures, microfluidic devices, and microelectromechanical systems, all lately with an emphasis on bio-inspired and bio-integrated technologies. These efforts are highly multidisciplinary, and combine expertise from nearly every traditional field of technical study. Professor Rogers obtained BA and BS degrees in chemistry and in physics from the University of Texas, Austin, in 1989. From MIT, he received SM degrees in physics and in chemistry in 1992 and the PhD degree in physical chemistry in 1995. From 1995 to 1997, Rogers was a Junior Fellow in the Harvard University Society of Fellows. During this time he also served as a founder and Director of Active Impulse Systems, a company that commercialized technologies developed during his PhD work. He joined Bell Laboratories as a Member of Technical Staff in the Condensed Matter Physics Research Department in 1997, and served as Director of this department from the end of 2000 to 2002. From 2003-2016, he was on the faculty at University of Illinois at Urbana/Champaign, where he held a Swanlund Chair, the highest chaired position at the university, with a primary appointment in the Department of Materials Science and Engineering, and joint appointments in the Departments of Chemistry, Bioengineering, Mechanical Science and Engineering, and Electrical and Computer Engineering. He served as the Director of a Nanoscale Science and Engineering Center on nanomanufacturing, funded by the National Science Foundation, from 2009-2012 and as Director of the Seitz Materials Research Laboratory from 2012 to 2016. In September of 2016, he joined Northwestern University as the Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering, Mechanical Engineering, Electrical Engineering and Computer Science, Chemistry and Neurological Surgery, where he is also the founding Director of the newly endowed Center on Bio-Integrated Electronics.

Heinrich Jaeger (UC)



William J. Friedman and Alicia Townsend Professor of Physics at the University of Chicago
Email: h-jaeger@uchicago.edu

Bio: Heinrich Jaeger is the William J. Friedman and Alicia Townsend Professor of Physics at the University of Chicago. He received his Ph.D. in physics in 1987, under Allen Goldman at the University of Minnesota, working on ultrathin superconducting films. After a postdoc at the University of Chicago 1987-89, Jaeger spent two years at the Centre for Submicron Technology of the University of Delft in The Netherlands. He has been on the faculty at Chicago since 1991, directing the Chicago Materials Research Center from 2001 – 2006, and the James Franck Institute from 2007-2010. Jaeger's current research focuses on investigations of self-assembled nanoparticle-based structures, on the rheology of dense suspensions, and on studies of the packing and flow of granular materials. Jaeger is the recipient of a David and Lucille Packard Fellowship for Science and Engineering, an Alfred P. Sloan Fellowship, and a Research Corporation Cottrell Scholarship. He received the University of Minnesota Outstanding Achievement Award and a Llewellyn John and Harriet Manchester Quantrell Award for Excellence in Undergraduate Teaching.

George Crabtree (UC)
Email: crabtree@uic.edu

Bio: George Crabtree is Director of the Joint Center for Energy Storage (JCESR) at Argonne National Laboratory, and a Distinguished Professor of Physics, Electrical, and Mechanical Engineering at University of Illinois-Chicago (UIC). He leads research on creating next-generation electricity storage technology beyond lithium-ion batteries. He has directed workshops for the Department of Energy on energy science and technology, is a member of the National Academy of Sciences and has testified before the U.S. Congress on the hydrogen economy, on meeting sustainable energy challenges, and on the prospects for next generation electrical energy storage.