The Welch Foundation
Advancing Chemistry, Improving Life

Living in a Material World

66th Conference on Chemical Research

Catherine J. Murphy, Program Chair

October 23-24, 2023
Houston, Texas

THE ROBERT A. WELCH FOUNDATION
66TH CONFERENCE ON CHEMICAL RESEARCH
LIVING IN A MATERIAL WORLD

October 23-24, 2023

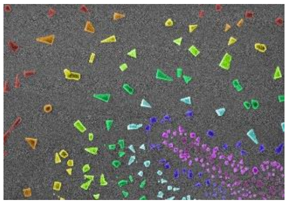
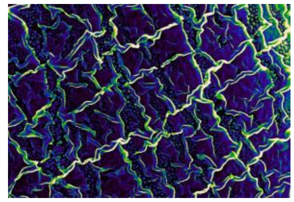
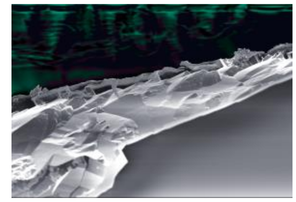
The Welch Foundation is a legacy to the world from Robert Alonzo Welch, a self-made man with a strong sense of responsibility to humankind, an enthusiastic respect for chemistry and a deep love for his adopted state of Texas. Mr. Welch came to Houston as a youth and later made his fortune in oil and minerals. Over the course of his career and life he became convinced of the importance of chemistry for the betterment of the world. He had a belief in science and the role it would play in the future. In his will, Mr. Welch stated, "I have long been impressed with the great possibilities for the betterment of Mankind that lay in the field of research in the domain of chemistry." Mr. Welch left a generous portion of his estate to his employees and their families. The balance began what is now The Welch Foundation.

The Welch Foundation, based in Houston, Texas, is one of the United States' oldest and largest private funding sources for fundamental chemical research at universities, col- leges and other educational institutions in Texas. Since its founding in 1954, the organization has contributed to the advancement of chemistry through research grants, departmental programs, endowed chairs, and other special projects at educational institutions in Texas. The Foundation presents the Welch Award in Chemistry for chemical research contributions which have had a significant positive influence on humankind. The Foundation also bestows the Norman Hackerman Award in Chemical Research, an award that recognizes the work of young researchers in Texas.

Each year since 1957, The Robert A. Welch Foundation hosts a conference which draws leading scientists from around the world to explore state-of-the-art research in various areas of chemistry. The Foundation sponsors these annual conferences in order to support increased fundamental research in chemistry.

This year's two-day conference will be held on October 23-24, 2023, at The Post Oak Hotel at Uptown Houston. The title of the 66th annual Welch Conference in Chemical Research is: Living in a Material World. Presiding over the conference will be Welch Scientific Advisory Board Chair, Dr. Catherine J. Murphy, Larry R. Faulkner Endowed Chair in Chemistry, University of Illinois at Urbana-Champaign.

LIVING IN A MATERIAL WORLD

Much of the progress in our standard of living can be traced to improvements in materials science and materials chemistry over the past 100 years. Advances in the crystal growth and thin film deposition of both inorganic and organic materials has led to today's semiconductor manufacturing industry, which in turn has enabled worldwide access to computers and smart phones. Continual improvements in solar, wind, and battery technologies rely on evolving materials chemistry and materials processing. Medical diagnostics and therapeutics take advantage of new nanoscale imaging agents and biodegradable materials.

This conference brings together the thought leaders across many sectors of fundamental materials chemistry. The first session focuses on materials for energy and sustainability, and includes new discoveries that underly solar energy conversion and smart windows. Featured keynote speaker Steven Chu, former U.S. Secretary of Energy, will discuss how materials chemistry will help reduce greenhouse gas emissions. The second session focuses on building materials in a controlled, hierarchical manner, to produce complex structures by design at the near-atomic level. The third session covers plastics of the future, ranging from bio-based materials to materials that can be intentionally degraded. The fourth session showcases advancements in materials chemistry to promote human wellness, from drug delivery to wearable sensors.

PROGRAM

"LIVING IN A MATERIAL WORLD"

Monday, October 23, 2023

8:30 **DOUGLAS L. FOSHEE**, Chair of the Board of Directors
8:45 **CATHERINE J. MURPHY**, University of Illinois at Urbana-Champaign, Program Chair

SESSION I – MATERIALS FOR ENERGY AND SUSTAINABILITY

8:50 **TOMCE RUNCEVSKI**, Southern Methodist University, *Session Leader*

9:00 **CHAD A. MIRKIN**, Northwestern University
"Repurposing the Blueprint of Life Through Colloidal Crystal Engineering with DNA"

9:35 Discussion

9:45 **MICHAEL GRAETZEL**, Swiss Federal Institute of Technology Lausanne
"Molecular Photovoltaics and the Rise of Perovskite Solar Cells"

10:20 Discussion

10:30 Break

10:40 **DAVID S. GINGER**, University of Washington
"Picturing Perovskite Photovoltaics"

11:15 Discussion

11:25 Individual Poster Session Discussions

11:40 LUNCH

2023 Keynote Speaker

12:00 **STEVEN CHU,** Stanford University
"Materials as an Enabling Technology in Getting to Net-Zero GHG Emissions"

SESSION II – HIERARCHICAL AND MULTIFUNCTIONAL MATERIALS

1:00 **ZACHARIAH A. PAGE**, The University of Texas at Austin, *Session Leader*

1:10 **JOANNA AIZENBERG**, Harvard University
"Multifunctional Materials with Self-Regulation"

1:45 Discussion

1:55 **SHARON C. GLOTZER**, University of Michigan
"Assembly Engineering for Matter-On-Demand"

2:30 Discussion

2:40 Break

2:50 **PEIDONG YANG**, University of California, Berkeley
"Semiconductor Nanowires: From Nanolasers to Photochemical Diodes"

3:25 Discussion

3:35 Individual Poster Session Discussions

4:15 Adjourn

PROGRAM

"LIVING IN A MATERIAL WORLD"

Tuesday, October 24, 2023

SESSION III – "PLASTICS" OF THE FUTURE

8:30 **KRISTIN M. HUTCHINS**, University of Missouri, *Session Leader*

8:40 **CRAIG J. HAWKER**, University of California, Santa Barbara
"Pushing the Limits of Polymer Synthesis through Controlled Polymerization, Click Chemistry and Sustainable Building Blocks"

9:15 Discussion

9:25 **JEFFREY S. MOORE**, University of Illinois
"The Mechanophore Hypothesis"

10:00 Discussion

10:10 Break

10:20 **KAREN L. WOOLEY**, Texas A&M University
"Sugar Plastics as Designer Next-Gen Sustainable Materials"

10:55 Discussion

2023 Welch Awardee Lecture

11:05 **JACQUELINE K. BARTON**, California Institute of Technology
"Signaling through DNA"

11:40 LUNCH

SESSION IV – MATERIALS SYSTEMS FOR HUMAN WELLNESS

1:00 **JEREMIAH J. GASSENSMITH**, The University of Texas at Dallas, *Session Leader*

1:10 **CHAD A. MIRKIN**, Northwestern University
"Foundational Tools, Techniques and Materials as Outputs of the Modern Age of Nanotechnology"

1:45 Discussion

1:55 **JOHN A. ROGERS**, Northwestern University
"Electronic Materials and Analytical Devices for the Human Body"

2:30 Discussion

2:40 Break

2:50 **PAULA T. HAMMOND**, Massachusetts Institute of Technology
"Polyelectrolyte Nanocarriers to Target Cells and Tissues"

3:25 Discussion

3:35 Adjourn

Douglas L. Foshee

Sallyport Investments, LLC
Welch Foundation Board of Directors, Chair

Douglas L. Foshee has spent over thirty years in the Energy Industry and is founder and owner of Sallyport Investments, LLC. Foshee is former chairman, president, and chief executive officer of El Paso Corporation, which owned North America's largest natural gas pipeline system and one of North America's largest natural gas producers prior to its merger with Kinder Morgan, Inc. in 2012, one of the largest mergers in Energy Industry history. Prior to joining El Paso in 2003, Foshee served as executive vice president and chief operating officer for Halliburton. He joined Halliburton in 2001 as executive vice president and chief financial officer. Prior to that, Foshee was president, chief executive officer, and chairman of the board at Nuevo Energy Company. From 1993 to 1997, Foshee served Torch Energy Advisors Inc. in various capacities, including chief operating officer and chief executive officer. He held various positions in finance and new business ventures with ARCO International Oil and Gas Company and spent seven years as an energy lender. Foshee earned a Master of Business Administration degree from the Jesse H. Jones School at Rice University in 1992 and a Bachelor of Business Administration degree from Southwest Texas State University in 1982. He is also a graduate of the Southwestern Graduate School of Banking at Southern Methodist University. Foshee has been actively involved in civic and philanthropic endeavors for many years. He co-founded NextOp Vets, a non-profit organization that provides job placement assistance, mentorship, support, and education for Veterans. Additionally, he founded Houstonians for Great Public Schools, a non- profit that seeks to increase public understanding of the roles and responsibilities of school board members and to hold members accountable for high performance. He served on the board of Small Steps Nurturing Center, a faith- based preschool for underprivileged children for over a decade. Foshee and his family have founded and continue to support scholarship programs at Rice University, separately at the Jones School at Rice University, at Baylor University, at Texas State University and at the Texas Business Hall of Fame, primarily but not exclusively for underprivileged students and military veterans.

Catherine J. Murphy

University of Illinois at Urbana-Champaign
Welch Foundation Scientific Advisory Board, Chair

Catherine J. Murphy holds the Larry R. Faulkner Endowed Chair in Chemistry at the University of Illinois at Urbana-Champaign. She earned two B.S. degrees from Illinois (chemistry and biochemistry) in 1986, and her Ph.D. from Wisconsin in 1990. After postdoctoral fellowships at Caltech, Murphy began her independent career as an assistant professor of chemistry at the University of South Carolina in 1993. After promotions to associate and full professorships at South Carolina, she was recruited back to Urbana-Champaign in 2009. Her laboratory has pioneered the colloidal synthesis of shape-controlled gold and silver nanoparticles in aqueous solution. In the 5-100 nm range, gold and silver exhibit brilliant shape-dependent optical properties that enable applications in chemical sensing, biological, imaging, mechanically improved polymer nanocomposites, and photothermal therapy for the ablation of pathogenic cells. She has coauthored over 260 peer-reviewed papers that have been cited 40,000 times and has delivered more than 400 invited lectures. Murphy's honors include the ACS Award in Inorganic Chemistry (2020), the Linus Pauling Medal (2019), the TREE (Transformational Research and Educational Excellence) Award from the Research Corporation for Science Advancement (2015), the Carol Tyler Award of the International Precious Metals Institute (2013), and ACS Division of Inorganic Chemistry's Inorganic Nanoscience Award (2011) and numerous young investigator awards. She is a Fellow of the American Chemical Society, the Materials Research Society, the Royal Society of Chemistry, and the American Association for the Advancement of Science. She was ranked #32 in Thomson Reuters Science watch List of "Top 100 Chemists for the Decade 2000-2010" and #10 on their list of "Top 100 Materials Scientists of the Decade 2000-2010." In 2015, she was elected to the U.S. National Academy of Sciences. In 2019, she was elected to the American Academy of Arts and Sciences.

Tomče Runčevski

Southern Methodist University
Monday, October 23, 2023; 8:40 AM

Tomče Runčevski is an Assistant Professor of Chemistry at Southern Methodist University, where he leads a research group focused on physical and materials chemistry of organic materials. Their research explores the relationships between innate equilibrium, structure, and properties in crystalline, amorphous, and glassy molecular materials. Their current focus is on organic minerals on Saturn's Titan, crystal engineering, and high-pressure reactivity. Dr. Runčevski received his Ph.D. in Materials Chemistry in 2014 from the Max Planck Institute for Solid State Research in Stuttgart, Germany. For his work done during his graduate studies, he was honored with the Otto Hahn Medal of the Max Planck Society. After completing a one-year postdoctoral stay at the Max Planck Institute, he joined UC Berkeley and Lawrence Berkeley National Laboratory in 2015 as a postdoctoral researcher, where he worked on the characterization and design of porous materials for gas capture and storage. In 2018, Dr. Runčevski started his independent career at Southern Methodist University. He is a topic editor for the ACS journal Crystal Growth and Design. He has received numerous awards for his research, including the NSF CAREER award in 2021 and the ACS PRF award in 2021.

Michael Graetzel

Swiss Federal Institute of Technology Lausanne (EPFL)
Monday, October 23, 2023; 9:35 AM

Michael Graetzel is a Professor at EPFL where he develops systems for the generation of electricity and chemical fuels from sunlight. Michael graduated from the Technical University Berlin and was a postdoctoral fellow at the University of Notre Dame before joining the EPFL faculty as a professor of physical chemistry. There, he started his groundbreaking investigations on colloidal semiconductors, which generated several new research fronts worldwide. Michael is worldwide renowned for the breakthrough development of a new type of molecular photovoltaic cell, mimicking the light reaction in photosynthesis. Its unique mesoscopic structure enables it to efficiently transform sunlight into electric energy. Graetzel played a pivotal role in the recent development of perovskite solar cells that directly emerged from his dye-sensitized photosystems. Their meteoric rise to reach a solar to electric power conversion efficiency of 25.7% in 2020 has stunned the PV-community and attracted enormous research interest with over 20'000 papers being published on the subject over the last 10 years. He applied his mesoscopic design concept also to enhance the power of lithium-ion batteries and to create photoelectrochemical cells that realize efficient generation of chemical fuels from sunlight mimicking solar energy conversion by natural photosynthesis. This opened up a new path to provide future sources of renewable energy that is stored in chemical bonds. His group achieved high conversion efficiencies for the solar light driven decomposition of water into hydrogen and oxygen and the reduction of carbon dioxide to carbon monoxide or ethylene. Michael's over 1800 publications have received some 466'000 citations and his H-index is 293 (Google May 2023). A recent ranking issued by Stanford University places Michael in the first position on a list of 100,000 top scientists across all fields of science. According to the Web of Science (2022), he is currently the most highly cited chemist in the world. The excellency of Michael's career was recognized by a number of prestigious awards, including the Rank Prize, BBVA Foundation Frontiers of Knowledge Award in Basic Science, Millenium Technology Prize, Global Energy Prize, Marcel Benoist Prize, Paul Karrer Gold Medal, Balzan Prize, King Feisal International Science Prize, Harvey Prize and the Calveras Award for Leapfrog Photovoltaics. He is a member of several learned societies and received 12 honorary doctor degrees from European and Asian Universities. His over 1800 publications had a major impact on the photovoltaic field. A recent bibliometric ranking by Stanford University places Michael first amongst 100'000 world-wide leading scientists across all areas of science.

Abstract: Molecular Photovoltaics and the Rise of Perovskite Solar Cells

Photovoltaic cells using molecular dyes, semiconductor quantum dots or perovskite pigments as light harvesters have emerged as credible contenders to conventional devices. Dye sensitized solar cells (DSCs) use a three-dimensional nanostructured junction for photovoltaic electricity production and reach currently a power conversion efficiency (PCE) of 15.2 % in full sunlight and over 30 % in ambient light. They possess unique practical advantages in particular highly effective electricity production from ambient light, ease of manufacturing, flexibility and transparency, bifacial light harvesting, and aesthetic appeal, which have fostered large scale industrial production and commercial applications. They served as a launch pad for perovskite solar cells (PSCs) which are presently being intensively investigated as one of the most promising future PV technologies, the PCE of solution processed laboratory cells having currently reached 25.7%. Present research focusses on their scale up to as well as ascertaining their long-term operational stability. My lecture will cover our most recent findings in these revolutionary photovoltaic domains.

David Ginger

University of Washington

Monday, October 23, 2023; 10:30 AM

David S. Ginger is the B. Seymour Rabinovitch Endowed Chair in Chemistry, and Washington Research Foundation Distinguished Scholar in Clean Energy at the University of Washington, where he also serves at the Chief Scientist for the Washington Clean Energy Institute. He earned dual B.S. degrees in chemistry and physics at Indiana University with departmental honors and highest distinction, performing undergraduate research in nuclear chemistry with Victor E. Viola. He received a British Marshall Scholarship and an NSF Graduate Fellowship and completed his Ph.D. in physics with Neil C. Greenham in the Optoelectronics group at the University of Cambridge (UK). Prior to joining UW, he held a joint NIH and DuPont Postdoctoral Fellowship at Northwestern University in Chad Mirkin's lab. He holds a dual appointment as a Senior Scientist and Lab Fellow at Pacific Northwest National Lab (PNNL), and is the founding director of the NSF Science and Technology Center for the Integration of Modern Optoelectronic Materials on Demand (IMOD). He is a Fellow of the Materials Research Society, an elected member of the Washington State Academy of Sciences, a Fellow of the AAAS (American Association for the Advancement of Science) and has been named a Research Corporation Cottrell Scholar, a Research Corporation Scialog Fellow in solar energy conversion, an Alfred P. Sloan Foundation Research Fellow, a Camille Dreyfus Teacher-Scholar. He received the Presidential Early Career Award for Scientists and Engineers, and the ACS Unilever Award in Colloid and Surfactant Science. He has received the Burton Medal of the Microscopy Society of America and was honored as a Finalist for the Blavatnik National Awards for Young Scientists in 2016.

Abstract: Picturing Perovskite Photovoltaics

Halide perovskite semiconductors have emerged as promising materials for applications ranging from solar photovoltaics (PV) and light emitting diodes (LEDs), to radiation detectors, and even as sources of quantum light. While perovskite semiconductors are often described as remarkably defect tolerant, they are not defect free. As these materials race towards commercialization for solar energy harvesting, it is imperative to understand how different processing methods lead to semiconductor films with different levels of efficiency and stability. In this talk we will discuss our understanding of defects and heterogeneity, and our ability to control them from the molecular to macroscopic scale. We show how controlled molecular passivation of perovskite surfaces enables the additive manufacturing of semiconductors with performance parameters that can rival the purest III-V semiconductors. By combining optical microscopy with advances in electron microscopy we reveal the true grain structure of halide perovskite films on the nanometer to micron scale and relate this grain structure directly to non-radiative recombination losses in the films. Using widefield imaging and hyperspectral microscopy, we show how processing additives can undergo unexpected chemical reactions that alter the growth processes in perovskite films, leading to improved uniformity with processing over large areas. Finally, we discuss how these advances are improving the prospects for high-efficiency perovskite multijunction solar cells, either as perovskite-on-silicon tandems, or perovskite-on-perovskite tandem.

Steven Chu

Stanford University

Monday, October 23, 2023; 12:00 PM

Steven Chu is the William R. Kenan, Jr. Professor of Physics, of Molecular and Cellular Physiology, and of Energy Science and Engineering at Stanford University. He received an A.B. and B.S. degrees in physics and mathematics from the University of Rochester, and a Ph.D. in physics from the University of California, Berkeley. From January 2009 to April 2013, Dr. Chu served as U.S. Secretary of Energy under President Barack Obama. During his tenure, he began several initiatives, including ARPA-E (Advanced Research Projects Agency – Energy), the Energy Innovation Hubs, and as the first scientist Cabinet member, recruited dozens outstanding scientists. Previously, he was the director of the Lawrence Berkeley National Laboratory, Professor of Physics and of Molecular and Cell Biology at Berkeley, and the Geballe Professor of Physics and Applied Physics at Stanford University where he helped start Bio-X. His scientific contributions include the introduction of laser cooling and optical trapping of atoms and particles, atomic fountain clocks and atom interferometers, the optical tweezers of biomolecules, and single molecule FRET of biomolecules tethered to surfaces. His current research is in biophysics, molecular and cellular physiology, medical imaging, nanoparticle synthesis, battery research and carbon capture. He has received numerous awards including the 1997 Nobel Prize for laser cooling and optical trapping of atoms. He is a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, National Academy of Inventors, and a foreign member of the Royal Society, 6 other foreign academies and has 35 honorary degrees.

Abstract: Materials as an Enabling Technology in Getting to Net-Zero GHG Emissions

Throughout human history, the ability to create new materials such as metal, glass and ceramics, fertilizers and other chemicals, and plastics have played a pivot role in the development of civilization. The ability to extract and manipulate Earth's resources and use them to create materials has enabled multiple industrial and agricultural revolutions that have profoundly transformed the world. However, the unintended consequence of these revolutions is that the greenhouse gas emissions are changing the climate of Earth. Most of the materials we use to today result in large greenhouse gas emissions. For example, most of our energy sources, the industrial and agricultural chemicals, and building materials and are fossil-fuel based, and many of the processes we use to create these materials demand industrial heat. The challenges how to provide clean energy, water, air, food in a world of over 8 billion people and likely to grow to 11 billion by 2100 are formidable. I will discuss how new material approaches will be needed to achieve net-zero greenhouse emissions and a more sustainable and prosperous future where there is no Planet B.

Zachariah A. Page

The University of Texas at Austin

Monday, October 23, 2023; 1:00 PM

Zachariah A. Page is an Assistant Professor in the Chemistry Department at The University of Texas (UT) at Austin, where his research program develops light-driven approaches to make and manipulate plastics for applications in soft robotics and wearable electronics. Dr. Page earned a B.S. in Chemistry at Juniata College, and a Ph.D. in Polymer Science and Engineering at the University of Massachusetts, Amherst with Prof. Todd Emrick, studying novel pi-conjugated polymers as charge transporters for organic solar cells. Dr. Page trained as a postdoctoral scholar with Prof. Craig Hawker at the University of California Santa Barbara, studying photochemical transformations in the areas of organic electronics and 3D printing, before joining UT Austin in 2018. He currently directs an active research program centered around fundamental science in photoredox catalysis, preparation of novel polymers via radical, ionic, and metathetic chemistries, and additive manufacturing. Dr. Page is an active member of the American Chemical Society (ACS) in both the Polymeric Materials: Science and Engineering (PMSE) Division and Division of Polymer Chemistry. He has been recognized by numerous awards, including the Camille Dreyfus Teacher-Scholar Award (2023), ACS PMSE Young Investigator Award (2022), Cottrell Scholar Award (2022), DoD AFOSR Young Investigator Award (2021), and NSF CAREER Award (2021).

Joanna Aizenberg

Harvard University

Monday, October 23, 2023; 1:10 PM

Joanna Aizenberg is the Amy Smith Berylson Professor of Materials Science and Professor of Chemistry and Chemical Biology at Harvard University. She received the B.S. degree in Chemistry from Moscow State University, and the Ph.D. degree in Structural Biology from the Weizmann Institute of Science. She was a postdoctoral fellow at Harvard and worked nearly a decade at Bell Labs, prior to joining Harvard. The Aizenberg lab's research is aimed at understanding some of the basic principles of biological architecture and the economy with which nature solves complex problems in the design of multifunctional, adaptive materials. These biological principles are then used as guidance in developing new, bio-inspired synthetic routes and nanofabrication strategies that would lead to advanced materials and devices, with broad implications in fields ranging from architecture to energy efficiency to medicine. Research topics of interest include biomimetics, smart materials, wetting phenomena, bio-nano interfaces, self-assembly, surface chemistry, structural color, metamaterials and catalysis. Aizenberg is elected to the National Academy of Sciences, National Academy of Engineering, American Academy of Arts and Sciences, American Philosophical Society, American Association for the Advancement of Science; and she is a Fellow of the American Physical Society, Materials Research Society and External Member of the Max Planck Society. Dr. Aizenberg's select awards include: MRS Medal; ACS National Award in Colloid Chemistry; Kavli Innovations in Chemistry Leader Award, ACS; Fred Kavli Distinguished Lectureship in Nanoscience, MRS; Ronald Breslow Award for the Achievement in Biomimetic Chemistry, ACS; and Harvard's Ledlie Prize for the most valuable contribution to science. She has >300 publications, >90 issued patents, and is a Founder of four start-up companies.

Abstract: Synthetic Multifunctional Materials with Self-Regulation

Dynamic structures that respond reversibly to changes in their environment are central to self-regulating thermal and lighting systems, targeted drug delivery, sensors, and self-propelled locomotion. Since an adaptive change requires energy input, an ideal strategy would be to synthesize materials that harvest energy directly from the environment and use it to drive an appropriate response. This lecture will present the design of a novel class of reconfigurable materials that use 'hairy' surfaces bearing arrays of nanostructures put in motion by environment-responsive gels. Their unique hybrid architecture, and chemical and mechanical properties can be optimized to confer a wide range of adaptive behaviors. Using both experimental and modeling approaches, we are developing these hydrogel-actuated integrated responsive systems (HAIRS) as new materials with reversible optical and wetting properties, as a multifunctional platform for controlling cell differentiation and function, and as a first homeostatic system with autonomous self-regulation. The extension of these principles to the synthesis of unique liquid crystal elastomer microstructures capable of a broad range of hierarchical, even mechanically unfavored deformation behaviors with applications in switchable adhesion, information encryption, autonomous antennae, energy harvesting, soft robotics, and smart buildings will be discussed.

Sharon C. Glotzer

University of Michigan
Monday, October 23, 2023; 1:55 PM

Sharon C. Glotzer is the John W. Cahn Distinguished University Professor of Engineering and the Stuart W. Churchill Collegiate Professor of Chemical Engineering and Professor of Materials Science and Engineering at the University of Michigan, Ann Arbor, and also holds faculty appointments in Physics, Applied Physics, and Macromolecular Science and Engineering. Since July 2017 she is the Anthony C. Lembke Department Chair of Chemical Engineering at the University of Michigan. Her research on computational assembly science and engineering aims toward predictive materials design of colloidal and soft matter. Using computation, geometrical concepts, and statistical mechanics, her research group seeks to understand complex behavior emerging from simple rules and forces, and to use that knowledge to design new materials. Glotzer's group also develops and disseminates powerful open-source software including the particle simulation toolkit, HOOMD-blue, which allows for fast molecular simulation of materials on graphics processors, the *signac* framework for data and workflow management, and *freud* for analysis and visualization. She has authored over 320 publications and has presented over 400 invited talks. Glotzer received her Bachelor of Science degree in Physics from UCLA, and her PhD in Physics from Boston University. She is a member of the National Academy of Sciences, the National Academy of Engineering, and the American Academy of Arts and Sciences. Glotzer is the recipient of numerous awards and honors, including the Aneesur Rahman Prize for Computational Physics from the American Physical Society, the Nanoscale Science and Engineering Forum and the Alpha Chi Sigma Awards both from the American Institute of Chemical Engineers, and the Fred Kavli Distinguished Lectureship in Materials Science and MRS Medal from the Materials Research Society. She is a two-time recipient of the Vannevar Bush Faculty Fellowship from the DoD and was a Simons Foundation Investigator from 2012-2022.

Abstract: Assembly Engineering for Matter-On-Demand

From the Stone Age to the Silicon Age, the materials available to humankind have defined the world we live in. Tomorrow, our world will be shaped not by the discovery of a single material that enables a host of new technologies, but by the design and integration of a host of material building blocks dictated by the conception of new technologies. In the coming Age, matter will be realized on demand – what, where and when we need it -- by engineering the assembly of multifunctional collections of building blocks into materials with precision, programmability and personalization. One important route to matter-on-demand is through nanoparticles designed and synthesized as multi-material "atoms" with the valency needed to assemble into complex target structures. Unlike electronic valency governing the assembly of atoms through chemical bonding, nanoparticle valency arises from particle shape and physical interparticle interactions. Remarkably, even in the absence of explicit interactions, and due solely to entropy, particle shape alone can create the valency needed for particles to assemble into crystal structures of extraordinary complexity. What sort of "bonding" describes these interactions, which emerge as the particles become crowded, and how do we exploit it for matter-on-demand? We discuss these questions and present a new theory of entropic bonding that has important analogies with chemical bonding theory. With entropic bonding theory, we can predict colloidal crystal structures from nanoparticle ***shape*** in the same way that chemical bonding theory predicts atomic crystal structures from ***electronic valence***.

Peidong Yang

University of California, Berkeley
Monday, October 23, 2023; 2:50 PM

Peidong Yang is a Chemistry professor, S. K. and Angela Chan Distinguished Chair Professor in Energy at the University of California, Berkeley. He is a senior faculty scientist at Materials and Chemical Sciences Division, Lawrence Berkeley National Laboratory. He is a member of both the National Academy of Sciences and the American Academy of Arts and Sciences. Prof. Yang is known particularly for his work on semiconductor nanowires and their photonic and energy applications including artificial photosynthesis. He is the director for California Research Alliance by BASF and the Kavli Energy Nanoscience Institute at Berkeley. He is an Executive Editor for Journal of the American Chemical Society. Dr. Yang received his B.A. in Chemistry from the University of Science and Technology in China in 1993. He then received his Ph.D. in Chemistry from Harvard University in 1997 and did his postdoctoral fellowship at the University of California, Santa Barbara. Soon after, he joined the faculty at the University of California, Berkeley. He is the recipient of Global Energy Prize, MacArthur Fellowship, E. O. Lawrence Award, Alan T. Waterman Award, ACS Nanoscience Award, MRS Medal, ACS Baekeland Medal, Julius Springer Prize for Applied Physics, Alfred P. Sloan research fellowship, the Arnold and Mabel Beckman Young Investigator Award, National Science Foundation Young Investigator Award, MRS Young Investigator Award, ACS Pure Chemistry Award. He is the 2014 Thomas Reuters Citation Laureate for Physics.

Abstract: Semiconductor Nanowires: From Nanolasers to Photochemical Diodes

Wires of different forms are an integral part of our human society for centuries. Electricity is being delivered through powerlines to every household; information is routinely transmitted through optical fibers and bridge-building requires the use of mechanically robust cables. In the past 30 years, scientists have fundamentally discovered a new process of making nanoscopic wires, 1000 times thinner than human hairs, enabling a new generation of computing, integrated photonics, and energy and biomedical technologies. After several decades of research, semiconductor nanowires with predictable and controlled electrical properties can be synthesized, thus providing optoelectronically-tunable nanoscale building blocks for device assembly for the first time, including nanoscopic lasers, solar cells, nanofluidic transistors, intracellular optical and electrical probes, thermoelectrics and (bio)photochemical diodes. Nanowire represents an important class of nanostructure building blocks for photovoltaics as well as direct solar-to-fuel conversion because of their high surface area, tunable bandgap, and efficient charge transport and collection. In this talk, I will present a brief history of nanowire research for the past 30 years and highlight the synthesis of nanowires using well-defined chemistry. I will summarize the research progress in the area of nanowire photonics, and thermoelectrics. In addition, these semiconductor nanowires, with their unique photoelectrochemistry, are used for artificial photosynthesis based on (bio)photochemical diode system design, where solar energy is converted and stored in chemical bonds in a solar-driven CO_2 fixation process.

Kristin M. Hutchins

University of Missouri
Tuesday, October 24, 2023; 8:30 AM

Kristin Hutchins is an Associate Professor of Chemistry at the University of Missouri where her research group investigates solid-state motion, thermal expansion, improving properties of pharmaceuticals, and design of materials that capture rare-earth elements. Dr. Hutchins earned her B.S. in Chemistry from the University of Iowa in 2010. She stayed at the University of Iowa for graduate school and worked with Leonard MacGillivray in the areas of crystal engineering and solid-state reactivity and received her Ph.D. in 2015. She went to the University of Illinois at Urbana-Champaign to conduct postdoctoral work with Jeffrey Moore on polymer colloids for self-healing applications. In 2017, she started as an Assistant Professor at Texas Tech University and was promoted to Associate Professor with tenure in 2022. By controlling the self-assembly of molecules into solid-state structures, her group has developed materials with tunable properties that are most relevant to electronics and pharmaceutics. Kristin is an advisory board member for the Women in Supramolecular Chemistry Network (WISC) – an international organization dedicated to promoting career progression of women in chemistry. She is also an editorial advisory board member for *CrystEngComm*. Kristin was named an Emerging Investigator by *Crystal Growth & Design* in 2019 and received the Texas Tech Alumni Association New Faculty Award in 2020. She received the Texas Tech Mortar Board Apple Polishing Award in 2020, 2021, and 2022, as well as the Eta Omicron Nu Faculty Appreciation Award in 2021, and both awards recognize excellence in teaching at the undergraduate level. Kristin is a recipient of the *NSF CAREER* award and *ACS PRF Doctoral New Investigator* grants. She was named the inaugural Emerging Inventor of the Year for Texas Tech University in 2022 and is the 2023 recipient of the Margaret C. Etter Early Career Award from the American Crystallographic Association.

Craig J. Hawker

University of California, Santa Barbara
Tuesday, October 24, 2023; 8:40 AM

Professor Craig J. Hawker is Clarke Professor and holds the Alan and Ruth Heeger Chair of Interdisciplinary Science at UCSB where he co-directs the California NanoSystems Institute and the Dow Materials Institute. He came to UCSB in 2004 after eleven years as a Research Staff Member at the IBM Almaden Research Center in San Jose, CA. Professor Hawker's work has led to over 600 peer-reviewed papers and 80 patents with Professor Hawker helping to establish a range of start-up companies including Symyx, Intermolecular, Ilypsa, Relypsa and Olaplex. For his pioneering studies at the interface of polymer synthesis, material science and organic chemistry, Professor Hawker's honors include the Kathryn C. Hach Award for Entrepreneurial Success from the American Chemical Society, the Charles Overberger International Prize, the ACS Award in Polymer Chemistry, Arthur C. Cope Scholarship and the Centenary Prize from the Royal Society of Chemistry. Professor Hawker has been honored with election to the Royal Society as well as being named a Fellow of the National Academy of Inventors, American Association for the Advancement of Science, the American Academy of Arts and Sciences, the National Academy of Engineering and the National Academy of Sciences.

Abstract: Pushing the Limits of Polymer Synthesis through Controlled Polymerization, Click Chemistry and Sustainable Building Blocks

The coupling of controlled polymerizations with orthogonal functionalization are critical design elements for the synthesis of well-defined macromolecular architectures and crosslinked networks for applications ranging from bio-adhesives to structural composites. In synthesizing these functional materials, the development of user-friendly approaches to the preparation of polymeric libraries and the discovery of sustainable monomers and building blocks are key to obtaining materials with exceptional properties while introducing desirable features such as degradability.

Jeffrey S. Moore

University of Illinois

Tuesday, October 24, 2023; 9:25 AM

Jeffrey Moore received his B.S. in chemistry (1984) and Ph.D. in materials science and engineering with Samuel Stupp (1989), both from the University of Illinois. He then went to Caltech as a National Science Foundation Postdoctoral Fellow working with Robert Grubbs. In 1990, he joined the faculty at the University of Michigan in Ann Arbor and in 1993 returned to the University of Illinois, where he was Professor of Chemistry, as well as a Professor of Materials Science & Engineering until 2022 and was also selected as the Stanley O. Ikenberry Endowed Chair in 2018. Jeff currently holds the titles of Stanley O. Ikenberry Research Professor of Chemistry, Stanley O. Ikenberry Endowed Chair Emeritus and Professor Emeritus of Chemistry. Jeff is a member of the National Academy of Sciences and a fellow of the American Academy of Arts & Sciences, the American Association for the Advancement of Science and the American Chemical Society (ACS); he has received the Campus Award for Excellence in Undergraduate Teaching and has been recognized as a "Faculty Ranked Excellent by their Students." For 14 years he served as an associate editor for the *Journal of American Chemical Society*. In 2014, he was selected as a Howard Hughes Medical Institute Professor and in 2016 was chosen as the recipient for the ACS Edward Leete Award in Organic Chemistry. He received the Royal Society of Chemistry's Materials Chemistry Division 2018 Stephanie L. Kwolek Award and was part of a team that was honored with the Secretary of Energy Honor Award, Achievement Award the same year. Jeff was also awarded the 2019 National Award in Polymer Chemistry by the American Chemical Society. He has published over 400 articles covering topics from technology in the classroom to self-healing polymers, mechanoresponsive materials and shape-persistent macrocycles. He served as the Director of the Beckman Institute for Advanced Science and Technology at the University of Illinois from 2017-2022. In this role, he received the 2021 Executive Officer Distinguished Leadership Award from the UIUC Campus.

Abstract: The Mechanophore Hypothesis

This talk will discuss the development of the mechanophore concept which grew out of the hypothesis that certain molecules selectively undergo force-induced covalent bond transformations. I will discuss the mechanisms of mechanical activation; these include force-modified potential energy surfaces and force-imparted chemical dynamics. Evidence for flyby reaction trajectories will be discussed which reflects the biased time course of a force-generated reactive intermediate leading to product distributions that depart from those predicted from the force-modified potential energy surface alone. New examples of mechanophores will be presented along with their use for the development of mechanoresponsive materials.

Karen L. Wooley

Texas A&M University

Tuesday, October 24, 2023; 10:20 AM

Karen Wooley holds the W. T. Doherty-Welch Chair in Chemistry and is a University Distinguished Professor at Texas A&M University, with appointments in the Departments of Chemistry, Chemical Engineering and Materials Science & Engineering. She also serves as Director of the Laboratory for Synthetic-Biologic Interactions. Her academic training included undergraduate study at Oregon State University (B.S., 1988) and graduate study under the direction of Jean M. J. Fréchet at Cornell University (Ph.D., 1993). She began an academic career as an Assistant Professor of Chemistry at Washington University in St. Louis, Missouri in 1993, was promoted in 1999 to Full Professor with tenure, and was installed in 2006 as a James S. McDonnell Distinguished University Professor in Arts & Sciences. Karen relocated to Texas A&M University in July 2009. In addition to her academic positions, she is the co-founder and President of Sugar Plastics, LLC, and Chief Technology Officer of Teysha Technologies, Ltd. Research interests include the synthesis and characterization of degradable polymers derived from natural products, unique macromolecular architectures, complex polymer assemblies, and well-defined nanostructured materials. She has designed synthetic strategies to harness the rich compositional, regiochemical and stereochemical complexity of natural products for the construction of hydrolytically-degradable polymers, which have impact toward sustainability, reduction of reliance on petrochemicals, and production of biologically-beneficial and environmentally-benign natural products upon degradation – these materials are expected to impact the global issue of plastic pollution and address challenges resulting from climate change. Recent awards include election as a Fellow of the American Academy of Arts and Sciences (2015), National Academy of Inventors (2019), American Association for the Advancement of Science (2020), American Institute for Medical and Biological Engineering (2020), and National Academy of Sciences (2020); she was also named as the 2021 Southeastern Conference (SEC) Professor of the Year.

Abstract: Sugar Plastics as Designer Next-gen Sustainable Materials

A primary interest in the Wooley laboratory is the production of functional polymers from renewable sources that are capable of reverting to those natural products once their purpose has been served. A long-standing focus has been the development of synthetic methodologies that transform sugars, amino acids and other natural products into well-defined polymer structures, while creating mechanisms for breakdown after their useful lifetime is complete, and providing for biological and environmental resorption of the degradation products. The overall process impacts the need to address the increasing accumulation and associated hazards of plastic pollution from the environmental persistence of non-degradable, petrochemically-sourced polymer systems. Moreover, inherent diversities of natural products provide opportunities to expand the scopes, complexities and properties of polymers, by utilizing fundamental organic chemistry approaches. This presentation will highlight the development of synthetic methodologies that take advantage of the diversity and complexities of carbohydrates as building blocks and invoke *in-situ* structural metamorphoses during the polymerization processes to produce next-generation sustainable, degradable polymers of diverse compositions, regio- and stereochemistries, and that can be made to exhibit a range of properties. Academically, we've made significant fundamental advances, and through partnership with Teysha Technologies, Ltd., advances are also being made toward commercial translation of carbohydrate-derived degradable plastics that are expected to become of great environmental benefit and societal impact. As scaled-up production of biomass-based biodegradable polymers continues to grow, we've recognized a need to avoid competition with resources that are important to food, fuel, construction and other societal demands. Therefore, we're turning to unique supply chains, including harvesting of naturally-derived building blocks from black soldier flies, which are being farmed for rapidly growing agricultural feed and food crop industries. Target materials are designed for potential applications in diverse areas, from energy, to medicine, to the environment. Examples will highlight contributions that polymer chemistry can make toward technological materials that are capable of impacting global needs, such as water-food-energy-health, and the grand challenges that must be solved in the coming decade.

Jacqueline K. Barton

California Institute of Technology

Tuesday, October 24, 2023; 11:05 AM

Dr. Jacqueline K. Barton is the John G. Kirkwood and Arthur A. Noyes Professor of Chemistry, Emerita at the California Institute of Technology. Barton was awarded the A.B. at Barnard College in 1974 and a Ph.D. in Inorganic Chemistry at Columbia University in 1978. After a postdoctoral fellowship at Bell Laboratories and Yale University, she became an assistant professor at Hunter College, City University of New York. Soon after, she returned to Columbia University, becoming a professor of chemistry in 1986. In 1989, she joined the faculty at Caltech, and from 2009-2019, she served as Chair of the Division of Chemistry and Chemical Engineering. Professor Barton has pioneered the application of transition metal complexes to probe recognition and reactions of double helical DNA. In particular, she has carried out studies to elucidate electron transfer chemistry mediated by the DNA double helix, a basis for understanding long range DNA-mediated signaling in DNA damage, repair, and replication. Through this research, Barton has trained more than 100 graduate students and postdoctoral students. Barton has also served the chemistry community through her service on government and industrial boards. She served as a Director of the Dow Chemical Company for over twenty years and currently serves as a Director of Gilead Sciences. Barton has received many awards. These include the NSF Waterman Award, the American Chemical Society (ACS) Award in Pure Chemistry, a MacArthur Foundation fellowship, and the National Academy of Sciences (NAS) Award in the Chemical Sciences. She has been elected to the American Academy of Arts and Sciences, the American Philosophical Society, the NAS, the National Academy of Medicine, and fellowship in the Royal Society of Chemistry. Barton received the 2010 National Medal of Science from President Obama, and in 2015, she received the ACS Priestley Medal, the highest award of the ACS.

Abstract: Signaling through DNA

Research in my laboratory has focused on probing recognition and reactions of DNA using transition metal complexes. In particular, we have explored electron transfer chemistry through DNA. Double helical DNA provides a medium for efficient redox chemistry over very long molecular distances. Significantly, this redox chemistry depends sensitively upon DNA base pair stacking; any perturbation in DNA stacking, such as occurs with base mismatches, lesions, and protein binding, turns off the efficient electron transfer chemistry through the base pair stack. Thus this DNA charge transport chemistry depends sensitively upon the integrity of the DNA duplex, and we have used DNA electrochemistry to prepare sensors for mismatches, lesions, and protein binding. We have also been exploring how this chemistry may be used within the cell. Increasingly, iron-sulfur clusters have been found in DNA-binding proteins involved in genome maintenance. These metal clusters, common redox cofactors, are associated not only with DNA repair proteins but also proteins involved in DNA replication, including our DNA polymerases. We have found that the metal clusters in these DNA-binding proteins are redox-active. Moreover, this chemistry leads to a redox switch to control DNA binding. This redox chemistry at a distance, mediated by the DNA helix, thus offers a route for long range signaling and coordination of DNA-processing proteins across the genome.

Jeremiah Gassensmith

The University of Texas at Dallas

Tuesday, October 24, 2023; 1:00 PM

Jeremiah Gassensmith is an associate professor in the Department of Chemistry and Biochemistry at the University of Texas at Dallas. He also holds a secondary appointment in Biomedical Engineering and Imaging at UT Southwestern Medical Center. Dr. Gassensmith received his B.Sc. degree in Chemistry from Indiana University under the guidance of Professor Joseph Gajewski. Later, he earned his Ph.D. from the University of Notre Dame where he specialized in the study of photophysical properties of sterically shielded near-infrared luminescent dyes under the supervision of Professor Bradley D Smith. He then went on to learn from Professor Sir J. Fraser Stoddart, the 2016 Nobel laureate in Chemistry, at Northwestern University. Dr. Gassensmith's research focuses on developing innovative needleless delivery methods for biotherapeutics. His group has pioneered new techniques for creating slow-release depots of biomacromolecular therapeutics using biodegradable layers of metal-organic frameworks. His team is also dedicated to advancing imaging technology and incorporating stimuli-responsive behavior into viral nanoparticles. Dr. Gassensmith is an associate editor for *Chemical Engineering Journal* and serves on the editorial advisory board of several journals, including *Chemical Science*. Dr. Gassensmith's work in the field has earned him several distinguished awards, including an NSF CAREER Award in 2017 and election as a Fellow of the Royal Society of Chemistry in 2022.

Chad A. Mirkin

Northwestern University

Tuesday, October 24, 2023; 1:55 PM

Dr. Chad A. Mirkin is the Director of the International Institute for Nanotechnology and the George B. Rathmann Professor of Chemistry, Chemical & Biological Engineering, Biomedical Engineering, Materials Science & Engineering, and Medicine at Northwestern University. He is a chemist and a world-renowned nanoscience expert, who is known for his discovery and development of spherical nucleic acids (SNAs) and SNA-based biodetection and therapeutic schemes and Dip-Pen Nanolithography (DPN) and related cantilever-free nanopatterning and materials discovery methodologies, and contributions to supramolecular chemistry and nanoparticle synthesis. Mirkin received his B.S. degree from Dickinson College (1986) and a Ph.D. degree from the Penn State University (1989). He was an NSF Postdoctoral Fellow at the MIT prior to becoming a professor at Northwestern University in 1991. He has authored over 850 manuscripts and over 1,200 patent applications worldwide (over 400 issued) and founded ten companies. Mirkin has been recognized with over 240 national and international awards, including the Kabiller Prize in Nanoscience and Nanomedicine, the SCI Perkin Medal, the Wilhelm Exner Medal, the Dan David Prize, the National Academy of Sciences Sackler Prize in Convergence Research, and the King Faisal Prize from the Kingdom of Saudi Arabia. He served for eight years on the President's Council of Advisors on Science & Technology, and he is one of very few scientists to be elected to all three US National Academies. Mirkin has served on the Editorial Advisory Boards of over 30 scholarly journals, and he is the founding editor of the journal *Small*. He was an Associate Editor of *J. Am. Chem. Soc.* and is a *Proc. Natl. Acad. Sci. USA* Editorial Board Member. He has given over 870 invited lectures and educated over 300 graduate students and postdoctoral fellows, of whom over 130 are now faculty members at top institutions around the world.

Abstract: Foundational Tools, Techniques, and Materials as Outputs of the Modern Age of Nanotechnology

The tools, techniques, and materials we use in our everyday lives have evolved over time. For instance, the progression from the stone materials used by early humans to the complex, polyelemental materials used today has enabled us to live safer, healthier, and more engaging lives. However, this transition to the modern age has arguably been slow, occurring over the course of hundreds of thousands of years. Nanotechnology has emerged as an interdisciplinary, transformative field that is hastening the pace of our discovery and development of foundational tools, techniques, and materials that are driving what is possible in society. We have gained access to materials with size, shape, and composition dependent chemical and physical properties that are permitting us to revolutionize aspects of medicine, energy and the environment, advanced manufacturing, and many other areas. This presentation will highlight my group's role over the last 30 years in shifting paradigms in these areas, especially with respect to 1) immunotherapy and vaccine design and development based on spherical nucleic acids (SNAs), 2) high-throughput materials discovery through nanocombinatoric chemistry and the concept of megalibrary and AI, and 3) stereolithography and additive manufacturing based on high-area rapid printing (HARP). All these advances have increased our understanding of modern Chemistry and Materials Science and significantly impacted society through their translation and commercialization.

John A. Rogers

Northwestern University

Tuesday, October 24, 2023; 2:50 PM

Professor John A. 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. 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. He then spent thirteen years on the faculty at University of Illinois, most recently as the Swanlund Chair Professor and Director of the Seitz Materials Research Laboratory. In the Fall of 2016, he joined Northwestern University as the Louis Simpson and Kimberly Querrey Professor of Materials Science and Engineering, Biomedical Engineering and Medicine, with affiliate appointments in Mechanical Engineering, Electrical and Computer Engineering and Chemistry, where he is also Director of the Querrey-Simpson Institute for Bioelectronics. He has co-authored more than 850 papers and he is a co-inventor on more than 100 patents, more than 70 of which are in active use by large companies or startups that he has co-founded. His research has been recognized by many awards, including a MacArthur Fellowship (2009), the Lemelson-MIT Prize (2011), the Smithsonian Award for American Ingenuity in the Physical Sciences (2013), the Benjamin Franklin Medal from the Franklin Institute (2019), a Guggenheim Fellowship (2021) and the James Prize in Science & Technology Integration from the National Academy of Sciences (2022). He is a member of the National Academy of Engineering, the National Academy of Sciences, the National Academy of Medicine, the National Academy of Inventors and the American Academy of Arts and Sciences.

Abstract: Electronic Materials and Analytical Devices for the Human Body

The skin is mechanically soft and curved; modern electronic and microfluidic technologies are rigid and planar. Eliminating this profound mismatch in physical properties will create vast opportunities in man-made systems that can naturally integrate with the epidermis, for diagnostic, therapeutic or sensory function with important, unique capabilities relevant to fitness/wellness, sports performance, clinical healthcare and virtual reality environments. Over the last decade, a convergence of new concepts in materials chemistry, mechanical engineering, electrical engineering and advanced manufacturing has led to the emergence of diverse, novel classes of 'biocompatible' electronic and microfluidic systems with skin-like physical properties. This talk describes the key ideas and presents some of the most recent device examples, including (1) wireless, battery-free electronic 'tattoos', with applications in continuous monitoring of vital signs in maternal, neonatal and pediatric populations, including active deployments in the most advanced hospitals in the US and clinics in multiple countries in Africa, (2) microfluidic platforms that can capture, manipulate and perform biomarker analysis on microliter volumes of sweat, with applications in cystic fibrosis management and nutritional monitoring.

Paula T. Hammond

Massachusetts Institute of Technology
Tuesday, October 24, 2023; 1:10 PM

Professor Paula T. Hammond is an Institute Professor at the Massachusetts Institute of Technology, Head of the Department of Chemical Engineering and a member of MIT's Koch Institute for Integrative Cancer Research. Her research in nanomedicine encompasses the development of new biomaterials to enable drug delivery from surfaces with spatio-temporal control. She investigates novel responsive polymer architectures for targeted nanoparticle drug and gene delivery, and is known for her work on nanoparticles to target cancer, and thin film coatings to release factors that regenerate bone and assist in wound healing. More recently, she has worked on nanomaterials systems to treat osteoarthritis and staged release systems for the delivery of vaccines. Professor Paula Hammond was elected into the National Academy of Science in 2019, the National Academy of Engineering in 2017, the National Academy of Medicine in 2016, and the 2013 Class of the American Academy of Arts and Sciences. She is also a member of the National Academy of Inventors. She received the American Institute of Chemical Engineers (AIChE) Margaret H. Rousseau Pioneer Award for Lifetime Achievement by a Woman Chemical Engineer in 2019 and gave the Materials Research Society (MRS) David Turnbull Lectureship, 2019. Professor Hammond has published over 330 papers, and over 20 patent applications. She is the co-founder and member of the Scientific Advisory Board of LayerBio, Inc., a member of the Scientific Advisory Board of Moderna Therapeutics and a member of the Board of Alector Therapeutics and the Board of Senda Biosciences, a Flagship company. In 2021, Professor Hammond was selected to become a member of the President's Council of Advisors on Science and Technology (PCAST). In terms of educational background, Prof. Hammond is from Detroit, Michigan, and received her B.S. in Chemical Engineering from MIT, then worked for two years in industry, moved to Atlanta to get an M.S. in Chemical Engineering at Georgia Tech, before returning to MIT for her PhD. She held the Ford Foundation Dissertation Fellowship, and on completing her PhD, was an NSF Postdoctoral Fellow at the Harvard University Chemistry Department before returning to MIT as a faculty member.

Abstract: Polyelectrolyte Nano Carriers to Target Cells and Tissues

Noncovalent interactions, including electrostatic interactions, hydrogen bonding and other non-specific interactions drive biological functions. By combining electrostatic interactions – the use of the opposites attract rules – in conjunction with chemistries that enable directed targeting, we can assemble nanoparticles that direct drugs and biological cargoes such as RNA, DNA and proteins to specific parts of the body. Furthermore, we are learning new mechanisms that drive the targeting of certain cells as well as how nanoparticles are engaged by cells, and leveraging that knowledge to deliver therapies to improve human health. Ultimately, we seek to explore and exploit these interactions to target nanoparticles to a range of different cell types. We can use high throughput sampling of nanoparticle-cell interactions using massively parallel pooled screens of large libraries of cells and nanoparticles to better understand nanoparticle-cell interactions and enhance cell uptake. Cancer, osteoarthritis, and other disease states can be addressed using an electrostatic toolset to modify nanoparticle systems in simple but elegant ways, with powerful outcomes.

The Welch Foundation
Advancing Chemistry, Improving Life

Notes