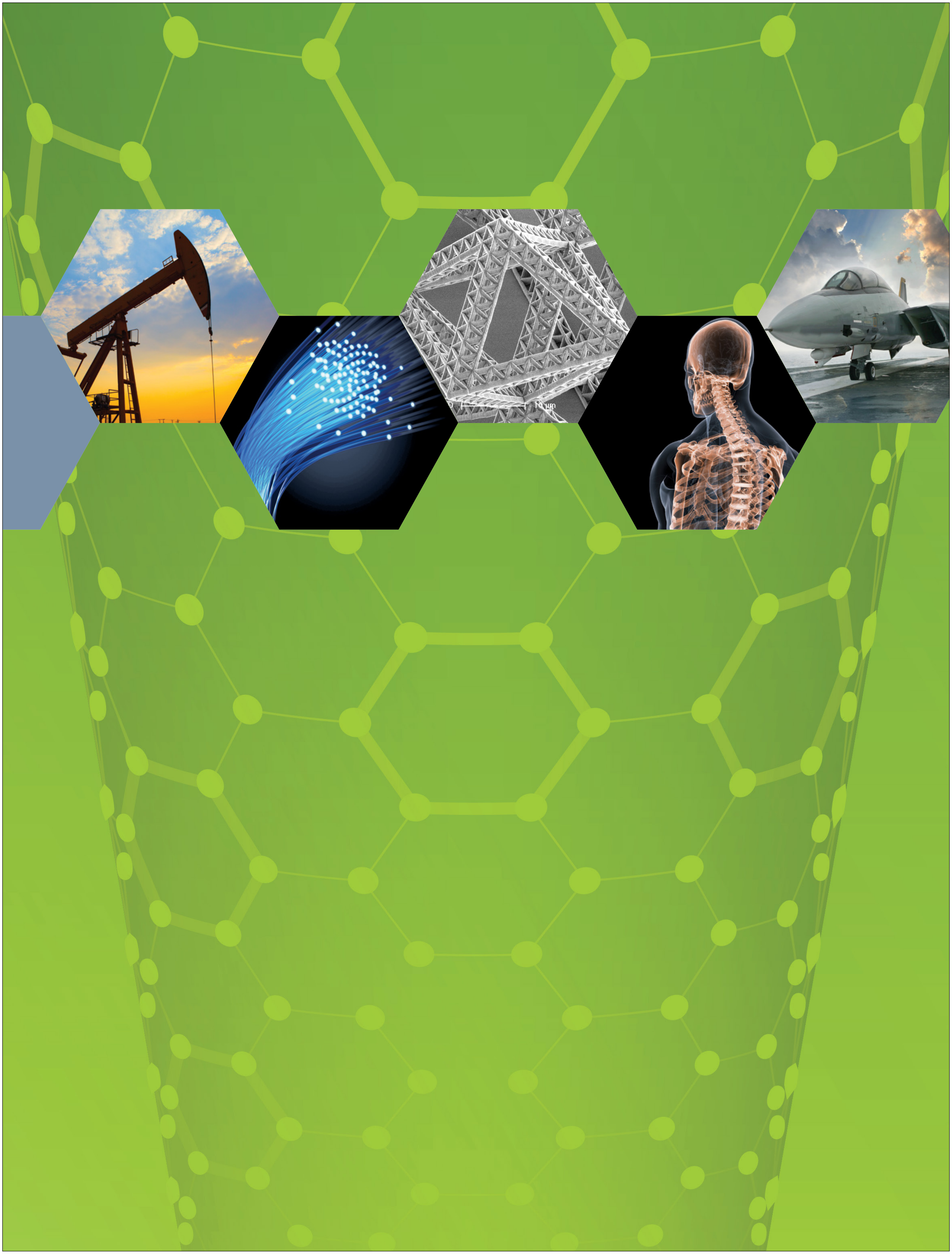
2016 Annual Conference

Materials for the 21st Century: Challenges and Opportunities

THE ACADEMY OF
MEDICINE, ENGINEERING & SCIENCE
OF TEXAS

#TAMEST2016



THE ACADEMY OF
MEDICINE, ENGINEERING & SCIENCE
OF TEXAS

On behalf of the TAMEST board of directors and program committee, welcome to the 2016 annual conference of The Academy of Medicine, Engineering and Science of Texas. This year's conference focuses on challenges and opportunities in materials science and engineering. In the 21st century, our state, nation, and world face enormous challenges in providing health care, a quality environment, economic well-being, security, and general quality of life to all of us. Developments in materials science and engineering are needed to provide the tools and products to address these challenges. The 2016 TAMEST Annual Conference will highlight recent advances in materials science and engineering that are, and will be, leading to qualitative changes in the production and performance of products, the way medicine is practiced, and the way energy is provided to our society.

In addition to the technical program, the Thursday lunch will feature a performance by conference speaker and concert pianist Julia R. Greer, Ph.D.

The 2016 Edith and Peter O'Donnell Award recipients will make their presentations on Thursday afternoon. This year also marks the 10th anniversary of the Edith and Peter O'Donnell Awards program. Established in 2006 to recognize the state's most promising young researchers, the O'Donnell Awards have honored a total of 44 individuals for their achievements in medicine, engineering, science and technology innovation. Thursday evening we will commemorate this important milestone with a special tribute at the O'Donnell Awards dinner where this year's recipients are honored.

Thank you for attending TAMEST's Annual Conference. Your continued support of TAMEST is much appreciated.

Sincerely,

Alan Needleman

Alan Needleman, Ph.D. (NAE)
2016 TAMEST Annual Conference Program Chair

AGENDA

WEDNESDAY, JANUARY 20

5:00–8:00PM	**Registration Open**	Dallas Foyer
6:00–8:00PM	**Opening Reception**	San Antonio II & San Antonio Foyer

THURSDAY, JANUARY 21

7:30AM–7:00PM	**Registration Open**	Dallas Foyer
8:00–8:30AM	**TAMEST Membership Meeting**	Dallas Ballroom II/III
8:30–8:45AM	BREAK (Protégés and special guests are invited to join the meeting.)	Dallas Foyer

MORNING SESSION

8:45–9:30AM	**Welcome and Remarks** **Kenneth E. Arnold, P.E.** (**NAE**), 2015 TAMEST Board President **C. D. Mote, Jr., Ph.D.**, President, National Academy of Engineering **Alan Needleman, Ph.D.** (**NAE**), 2016 TAMEST Annual Conference Program Chair	Dallas Ballroom II/III
9:30–10:15AM	*KEYNOTE SPEAKER:* ***Continuous Liquid Interface Production of 3D Objects*** **Joseph M. DeSimone, Ph.D.** (**NAE, NAM, NAS**), Chancellor's Eminent Professor of Chemistry; William R. Kenan, Jr. Distinguished Professor of Chemical Engineering University of North Carolina at Chapel Hill	Dallas Ballroom II/III
10:15–11:00AM	*KEYNOTE SPEAKER:* ***Materials by Design: Three-Dimensional Nano-Architected Metamaterials*** **Julia R. Greer, Ph.D.**, Professor of Materials Science, Mechanics and Medical Engineering California Institute of Technology	Dallas Ballroom II/III
11:00–11:20AM	BREAK	Dallas Foyer
11:20–11:50AM	***The Value and Limitations of Performing Material Science in Space*** **Al Sacco, Jr., Ph.D.**, Dean, Edward E. Whitacre Jr. College of Engineering Texas Tech University	Dallas Ballroom II/III
11:50AM–1:15PM	LUNCH ***Featuring a performance by conference speaker and concert pianist Julia R. Greer***	San Antonio Ballroom I/II

AFTERNOON SESSION

1:15–2:00PM	*KEYNOTE SPEAKER:* ***Materials for Sustainable Energy*** **Emily A. Carter, Ph.D. (NAS),** Founding Director, Andlinger Center for Energy and the Environment; Gerhard R. Andlinger Professor in Energy and the Environment; Professor of Mechanical and Aerospace Engineering & Applied and Computational Mathematics Princeton University	Dallas Ballroom II/III
2:00–2:30PM	***Materials Engineering Challenges in the Oil and Gas Industry*** **Douglas P. Fairchild, Ph.D.**, Sr. Metallurgical and Welding Consultant ExxonMobil Upstream Research Company	Dallas Ballroom II/III

AGENDA

THURSDAY, JANUARY 21 (CONTINUED)

2:30–3:15PM	*KEYNOTE SPEAKER:* ***Supramolecular Soft Matter in Future Energy and Biomedical Materials*** **Samuel I. Stupp, Ph.D. (NAE)**, Board of Trustees Professor of Materials Science, Chemistry and Medicine Northwestern University	Dallas Ballroom II/III
3:15–3:45PM	BREAK	
3:45–5:45PM	**Presentations by the 2016 Recipients of the Edith and Peter O'Donnell Awards**	Dallas Ballroom II/III
7:00–8:30PM	**O'Donnell Awards Dinner**	San Antonio Ballroom
8:30–10:00PM	**After-dinner Reception**	San Antonio Foyer

FRIDAY, JANUARY 22

7:30AM –12:00PM	**Registration Open**	Dallas Foyer
8:15–9:15AM	**Breakfast**	Dallas Ballroom I
9:15–9:45AM	***Intelligent Materials as Advanced Biomaterials in Drug Delivery and Biosensing*** **Nicholas A. Peppas, Sc.D. (NAE, NAM)**, Cockrell Family Regents Chair in Engineering No 6, Chemical Engineering, Biomedical Engineering and Pharmaceutics; Director of Institute for Biomaterials, Drug Delivery and Regenerative Medicine The University of Texas at Austin	Dallas Ballroom II/III
9:45–10:15AM	***Addressing Dirac's Challenge: Practical Quantum Mechanics for Predicting the Properties of Materials*** **Jim Chelikowsky, Ph.D.**, W.A. "Tex" Moncrief, Jr., Chair of Computational Materials; Professor in the Departments of Physics, Chemical Engineering, and Chemistry and Biochemistry; Director, Center for Computational Materials, Institute for Computational Engineering and Sciences The University of Texas at Austin	Dallas Ballroom II/III
10:15–10:45AM	BREAK	Dallas Foyer
10:45–11:15AM	***Biomaterials for Tissue Engineering*** **Antonios G. Mikos, Ph.D., (NAE, NAM)**, Louis Calder Professor of Bioengineering and Chemical and Biomolecular Engineering, Director of the Center for Excellence in Tissue Engineering Rice University	Dallas Ballroom II/III
11:15–11:45AM	***Mechanics and Materials of Bio-Integrated Electronics*** **Nanshu Lu, Ph.D.**, Assistant Professor, Department of Aerospace Engineering and Engineering Mechanics, and Department of Biomedical Engineering The University of Texas at Austin	Dallas Ballroom II/III
11:45AM–1:15PM	**Informal Networking Lunch**	San Antonio Ballroom
1:15PM	**Conference Concludes**	

C. D. Mote, Jr.

President
National Academy of Engineering

C. D. Mote, Jr. is president of the National Academy of Engineering and Regents' Professor on leave from the University of Maryland, College Park.
Dr. Mote is a native Californian who earned his BS, MS, and PhD degrees at the University of California, Berkeley in mechanical engineering between 1959 and 1963. After a postdoctoral year in England and three years as an assistant professor at the Carnegie Institute of Technology in Pittsburgh, he returned to Berkeley to join the faculty in mechanical engineering for the next 31 years. He and his students investigated the dynamics, stability, and control of high-speed rotating and translating continua (e.g., disks, webs, tapes, and cables) as well as biomechanical problems associated with snow skiing. He coined the area called "dynamics of axially moving materials" encompassing these systems. Fifty-eight PhD students earned their degrees under his mentorship.

He held an endowed chair in mechanical systems at Berkeley and chaired the Mechanical Engineering Department from 1987 to 1991, when the National Research Council (NRC) ranked its graduate program effectiveness highest nationally. Because of his success at raising funds for mechanical engineering, in 1991 he was appointed vice chancellor expressly to create and lead a $1 billion capital campaign, which raised $1.4 billion.

In 1998 Dr. Mote was recruited to the presidency of the University of Maryland, College Park, a position he held until 2010 when he was appointed Regents' Professor. His goal for the university was to elevate its self-expectation of achievement and its national and global position through proactive initiatives. During his tenure the number of Academy members on the faculty tripled, three Nobel laureates were recognized, and an accredited school of public health and a new department of bioengineering were created. He also founded a 130-acre research park next to the campus, faculty research funds increased by 150 percent, and partnerships with surrounding federal agencies and with international organizations expanded greatly. The number of students studying abroad tripled, and he created an annual open house day that attracts over 100,000 visitors, founded a charitable foundation for the campus whose board of trustees launched a successful $1 billion capital campaign, and took to lunch every student that wanted to go. The Academic Ranking of World Universities ranked the campus #36 in 2010 and its Engineering School #13.

The NAE elected him to membership in 1988 and to the positions of Councilor (2002–2008), Treasurer (2009–2013), and President for a six–year term beginning July 1, 2013. He has served on the NRC Governing Board Executive Committee since 2009. He chaired the NRC Committee on Global Science and Technology Strategies and Their Effects on US National Security (2009–2010), and co-chaired the National Academies Government-University-Industry Research Roundtable (2007–2013) and Committee on Science, Technology, Engineering, and Mathematics Workforce Needs for the US Department of Defense and the US Industrial Base (2011–2012). He was vice chair of the NRC Committee on the Department of Defense Basic Research (2004) and served on the NRC committee that authored the *Rising Above the Gathering Storm* reports of 2005 and 2010. He was also a founding member of the FBI's National Security Higher Education Advisory Board (2005–2010).

Dr. Mote's recognitions include the NAE Founders Award, the American Society of Mechanical Engineers Medal, and the Humboldt Prize of the Federal Republic of Germany. At the University of California, Berkeley, he was honored with the Distinguished Teaching Award, Distinguished Engineering Alumnus Award, Berkeley Citation, and Excellence in Achievement Award. He is an honorary fellow of the American Society of Mechanical Engineers, and fellow of the American Academy of Arts and Sciences, American Academy of Mechanics, Acoustical Society of America, and American Association for the Advancement of Science. He holds four honorary doctorates and two honorary professorships.

Joseph M. DeSimone, Ph.D. (NAE, NAM, NAS)

Chancellor's Eminent Professor of Chemistry
William R. Kenan, Jr. Distinguished Professor of Chemical Engineering
University of North Carolina at Chapel Hill

Continuous Liquid Interface Production of 3D Objects

"3D printing" is a misnomer: it is actually 2D printing over and over again. This presentation will include descriptions of a new advance in 3D additive manufacturing that is rapid, continuous, and no longer layer-by-layer that promises to advance industry beyond basic prototyping to 3D manufacturing. The new Continuous Liquid Interface Production technology (CLIP) harnesses light and oxygen to continuously grow objects from a pool of resin instead of printing them layer-by-layer. The technology was simultaneously introduced to the scientific community as the cover story in the journal *Science* and on the stages of TED2015. CLIP technology raises the state-of-the-art in 3D fabrication in three ways:

- Game-Changing Speed: 25–100 times faster than conventional 3D printing
- Commercial Quality: produces objects with consistent mechanical properties
- Material Choice: enables a broad range of polymeric materials
- Microfabrication: enables complex geometries to be fabricated in the tens of microns size scale

This presentation will introduce CLIP and will describe the opportunities associated with it, including the potential for designing new approaches to medical and drug delivery devices.

Julia R. Greer, Ph.D.

Professor of Materials Science, Mechanics and Medical Engineering
California Institute of Technology

Materials by Design: Three-Dimensional Architected Nanostructured Metamaterials

Creation of extremely strong yet ultra-light materials can be achieved by capitalizing on the hierarchical design of three dimensional nano-architectures. Such structural metamaterials exhibit superior thermomechanical properties at extremely low mass densities (lighter than aerogels), making these solid foams ideal for many scientific and technological applications. The dominant deformation mechanisms in such “metamaterials,” where individual constituent size (nanometers to microns) is comparable to the characteristic microstructural length scale of the constituent solid, are essentially unknown. To harness the lucrative properties of three dimensional hierarchical nanostructures, it is critical to assess mechanical properties at each relevant scale while capturing the overall structural complexity. During this presentation, these topics will be discussed: the fabrication of three dimensional nano-lattices whose constituents vary in size from several nanometers to tens of microns to millimeters; the deformation and mechanical properties of a range of nano-sized solids with different microstructures deformed in an *in-situ* nanomechanical instrument; and attention will also be focused on the interplay between the internal critical microstructural length scale of materials and their external limitations in revealing the physical mechanisms which govern the mechanical deformation, where competing material- and structure-induced size effects drive overall properties. Additional focus will include the deformation and failure in metallic, ceramic, and glassy nanostructures and discussion regarding size effects in nanomaterials in the framework of mechanics; physics of defects will also be covered. Specific discussion topics will also include: fabrication and characterization of hierarchical three dimensional architected metamaterials for applications in biomedical devices, ultra-lightweight batteries, and damage-tolerant cellular solids; nano-mechanical experiments; and flaw sensitivity in fracture of nanostructures.

Emily A. Carter, Ph.D. (NAS)

Founding Director, Andlinger Center for Energy and the Environment
Gerhard R. Andlinger Professor in Energy and the Environment
Professor of Mechanical and Aerospace Engineering & Applied and Computational Mathematics
Princeton University

Materials for Sustainable Energy

Efficient, clean, sustainable production of fuels and electricity is one of the great technological challenges of our time. Dr. Carter's research includes focus on developing and applying accurate first principles quantum mechanics techniques to help identify robust, efficient, and inexpensive materials that will enable sustainable energy generation. This presentation will highlight selected examples from Dr. Carter's research, ranging from photoelectrocatalysis to fuel cells to fusion, with brief descriptions of our unique theoretical methods used to extract insights into the relevant complex phenomena that will determine the efficacy of these technologies.

Samuel I. Stupp, Ph.D. (NAE)

Board of Trustees Professor of Materials Science, Chemistry and Medicine
Northwestern University

Supramolecular Soft Matter in Future Energy and Biomedical Materials

Supramolecular soft matter has the potential to mimic the structures and dynamics of biological systems, and it is therefore a rich platform for the development of bio-inspired materials. The interesting features of supramolecular soft materials include nanoscale control of dynamics, highly responsive behavior to external stimuli, capacity to self-heal defects, non-covalent co-localization of functional domains, and the use of self-assembly to optimize function, among many others. This presentation will first describe supramolecular soft materials that mimic the photosynthetic machinery in biological systems by integrating the necessary functions to generate solar fuels. Other energy relevant examples will be described in which supramolecular systems integrate electron donors and acceptors for photovoltaic behavior or ferroelectric response. As a third topic, the development of highly dynamic bioactive supramolecular materials for biomedical applications will be discussed. These materials mimic the architecture of extracellular matrices and have the capacity to promote regeneration of tissues by interacting with cells and triggering biological signaling pathways.

O'DONNELL AWARDS RECIPIENTS

MEDICINE

Joshua T. Mendell, M.D., Ph.D.

Investigator, Howard Hughes Medical Institute
Professor, Department of Molecular Biology
CPRIT Scholar in Cancer Research
The University of Texas Southwestern Medical Center

Regulation and Function of Non-coding RNAs in Physiology and Cancer

Gain- and loss-of-function of non-coding RNAs can potently influence cellular behavior in normal physiologic states and in diseases such as cancer. In particular, dysregulation of microRNA (miRNA) expression has been clearly shown to result in dramatic phenotypic consequences. The Mendell Lab previously demonstrated extensive control of miRNA expression by well-characterized oncogenic and tumor suppressor networks including the MYC, KRAS, and p53 pathways. Through the generation and analysis of novel mouse models, we have uncovered potent, and often unexpected, consequences of miRNA gain- and loss-of-function *in vivo*. Moreover, we have shown that modulation of miRNA activity has therapeutic efficacy in cancer models. More recently, we have applied these approaches to dissect mechanisms of long non-coding RNA (lncRNA) regulation and function in physiology and cancer. I will present our latest results related to the regulation and function of non-coding RNAs and how these findings may be exploited for the development of novel therapeutics.

ENGINEERING

Andrea Alù, Ph.D.

Associate Professor, David & Doris Lybarger Endowed Faculty Fellow in Engineering,
Department of Electrical and Computer Engineering
The University of Texas at Austin
Chief Technology Officer, *Silicon Audio RF Circulator*

From Cloaking to One-Way Propagation: The Fascinating Wave Interaction with Metamaterials

During this presentation, I will highlight recent research activity in electromagnetics, nano-optics and acoustics, showing how tailored meta-atoms and their suitable arrangements open exciting venues to manipulate and control waves in unprecedented ways. I will discuss our most recent theoretical and experimental results, including nanoclusters and metasurfaces to control wave propagation and radiation, large nonreciprocity for sound and light without magnetic bias, giant nonlinearities in properly tailored metamaterials and their applications, and parity-time symmetric meta-atoms and metasurfaces. Physical insights into these exotic phenomena, new engineering devices based on these concepts, and their impact on technology will be also be discussed.

EDITH AND PETER O'DONNELL AWARDS
10TH ANNIVERSARY

SCIENCE

Alessio Figalli, Ph.D.

Professor and R.L. Moore Chair, Department of Mathematics and ICES
The University of Texas at Austin

Optimal Transport: Theory and Applications

The optimal transport problem consists of finding the cheapest way to transport a distribution of mass from one place to another. This problem, whose origin dates back to Monge in 1781, is by now a very important and active subject of study in mathematics. Apart from its natural applications to economics, optimal transport theory has a wide variety of applications: these include applications to other areas of mathematics such as partial differential equations and geometry, as well as to other fields such as chemistry, meteorology, and biology.

This presentation will include discussion about this problem and explain some of the recent applications of this theory.

TECHNOLOGY INNOVATION

Van N. Truskett, Ph.D.

Director of Jetting Technology
Canon Nanotechnologies, Inc.

Inkjet for Jet & Flash Imprint Lithography

Jet and Flash* Imprint Lithography (J-FIL*) is an effective technique for replication of nanoscale features in developing sub-20nm devices. J-FIL uses field-by-field deposition and exposure of a low viscosity resist deposited by inkjet printing onto the substrate. The patterned mask is lowered into the fluid, where capillary action assists to flow the fluid into the relief patterns. Following the filling step, the resist is UV cured, the mask is removed, and a patterned resist is left on the substrate. The inkjet technology provides process improvements for throughput and defectivity. The drop volume and drop placement accuracy of the inkjet-printed resist is critical, allowing the volume to be distributed appropriately across the substrate surface to achieve a uniform target thickness and preventing non-filling of the relief patterns.

* *Jet and Flash Imprint Lithography and J-FIL are trademarks of Molecular Imprints Inc.*

EDITH AND PETER 10TH ANNIVERSARY O'DONNELL AWARDS

Al Sacco, Jr., Ph.D.

Dean, Edward E. Whitacre Jr. College of Engineering
Texas Tech University

The Value and Limitations of Performing Materials Science in Space

The free-fall environment of low earth orbit provides an unmatched laboratory to investigate and better understand the effect(s) of fluid motion on the nucleation and growth of crystalline materials. Fluid motion and the concomitant heat and mass transfer affect a material's structure, morphology, and often its properties. However, performing experiments in low earth orbit is not the same as performing those experiments in a normal gravity environment. Surface tension becomes a more dominant force in orbit. This results in bubbles/foam stabilization with the associated problems of numerous multiple phase interfaces, thermal and solutal capillary flows, difficulties in uniform heating, and difficulties with mixing fluids which have different surface tensions. Video illustrating some of these difficulties will be presented, along with data that shows that, if performed correctly, morphology, defect concentration and size can be positively affected. Finally, a case will be presented where space crystals/data helped verify the active catalytic site of an industrially-important reaction.

Douglas P. Fairchild

Sr. Metallurgical and Welding Consultant
ExxonMobil Upstream Research Company

Materials Engineering Challenges in the Oil and Gas Industry

By 2040, the global population is projected to increase from about 7 to 9 billion. 2.8 billion are expected to ascend into the middle class, and energy consumption is estimated to rise by 35%. The majority of the consumption increase (about 70%) will come from developing countries, nearly half from China and India. Energy needs will be partly addressed by efficiency gains; for example, hybrid car sales are predicted to increase from 1% of new cars in 2010 to about 50% by 2040. Energy sources will change as well. Solar capacity is expected to grow by more than 20 times. All factors considered, it is also projected that the oil and gas industry will be supplying a majority of the world's energy needs in 2040.

To meet global energy demands, the oil and gas industry drills wells miles below the earth's surface and sometimes in water depths of thousands of feet. Large infrastructure installations are needed and offshore structures that weigh 200,000 tons have been constructed. Such engineering achievements are enabled through the use of advanced materials. ExxonMobil maintains world-class research staff and laboratories and this presentation will provide examples of technology advancements in the area of materials engineering.

Nicholas A Peppas, Sc.D. (NAE, NAM)

Cockrell Family Regents Chair in Engineering No 6, Chemical Engineering, Biomedical Engineering and Pharmaceutics; Director of Institute for Biomaterials, Drug Delivery and Regenerative Medicine
The University of Texas at Austin

Intelligent Materials as Advanced Biomaterials in Drug Delivery and Biosensing

Engineering the molecular design of intelligent biomaterials by controlling structure, recognition and specificity is the first step in coordinating and duplicating complex biological and physiological processes. Recent developments in siRNA and protein delivery have been directed towards the preparation of targeted formulations for protein delivery to specific sites, use of environmentally-responsive polymers to achieve pH- or temperature-triggered delivery, usually in modulated mode, and improvement of the behavior of their mucoadhesive behavior and cell recognition. We address design and synthesis characteristics of novel crosslinked networks capable of protein release as well as artificial molecular structures capable of specific molecular recognition of biological molecules. Molecular imprinting and microimprinting techniques, which create stereo-specific three-dimensional binding cavities based on a biological compound of interest can lead to preparation of biomimetic materials for intelligent drug delivery, drug targeting, and tissue engineering. We have been successful in synthesizing novel glucose- and protein-binding molecules based on non-covalent directed interactions formed via molecular imprinting techniques within aqueous media. We have also developed structurally superior materials to serve as effective carriers for siRNA delivery to combat Crohn's disease and ulcerative colitis.

Jim Chelikowsky, Ph.D.

W.A. "Tex" Moncrief, Jr., Chair of Computational Materials; Professor in the Departments of Physics, Chemical Engineering, and Chemistry and Biochemistry; Director, Center for Computational Materials, Institute for Computational Engineering and Sciences
The University of Texas at Austin

Addressing Dirac's Challenge: Practical Quantum Mechanics for Predicting the Properties of Materials

After the advent of quantum mechanics, P. A. M. Dirac wrote: "The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known, and the difficulty is only that the exact application of these laws leads to equations much too complicated to be soluble. It therefore becomes desirable that approximate practical methods of applying quantum mechanics should be developed, which can lead to an explanation of the main features of complex atomic systems." Dirac's challenge to develop practical quantum methods has largely remained unanswered when applied to understanding materials properties. Although quantum concepts have led to simple explanations of everyday materials phenomena, methods for accurately predicting materials properties remain elusive. Capitalizing on new algorithms and access to high performance advanced computers, this presentation will include discussion of how we might address Dirac's challenge. In particular, examples of practical quantum methods to predict materials properties across all length scales will be reviewed.

Antonios G. Mikos, Ph.D. (NAE, NAM)

Louis Calder Professor of Bioengineering and Chemical and Biomolecular Engineering;
Director of Center for Excellence in Tissue Engineering
Rice University

Biomaterials for Tissue Engineering

Biomaterial-based strategies for tissue engineering span a vast spectrum, from the production of scaffolds tailored with appropriate mechanical properties and degradation kinetics to serve transiently as a bridge to tissue formation, to the leverage of biomaterials for the controlled delivery of biological signals to regenerate tissue in specific sites in the body. For example, our laboratory has developed a variety of biodegradable polymers for the controlled delivery of bioactive agents and/or stem cell populations to promote regeneration of tissues such as bone and cartilage. We have also applied engineered culture of cell populations on three-dimensional scaffolds toward the development of biologically active hybrid scaffold/extracellular matrix constructs for regenerative medicine applications as well as testing of anticancer drugs. This presentation will highlight recent examples of biomaterial-based approaches for the development of tissue engineering technologies to meet clinical needs.

Nanshu Lu, Ph.D.

Assistant Professor,
Department of Aerospace Engineering and Engineering Mechanics
Department of Biomedical Engineering
The University of Texas at Austin

Mechanics and Materials of Bio-Integrated Electronics

Bio-integrated electronics have demonstrated exciting applications in wearable health monitors, smart surgical tools, as well as human-machine interfaces. Strategies for bio-integrated electronics must overcome challenges associated with the mismatch between the hard, planar surfaces of brittle semiconductor wafers and the soft, curvilinear tissues of dynamic biological systems. Although soft, stretchable electronics have been developed by integrating inorganic functional materials strategically onto soft polymeric substrates, their manufacture and performance are usually limited by the failure of brittle and delicate electronic materials under large deformation. When stretchable electronics are integrated on soft and active bio-tissues, the interface mechanical, thermal, and biochemical interactions present new challenges but also open up new opportunities. During this presentation, I will discuss materials and processes developed for bio-integrated electronics and the fundamental mechanics in the manufacture, deformability, and bio-integration of stretchable, tissue-like electronics. The impact will be manifested by examples such as noninvasive tattoo-like epidermal electronics and sensors as well as *in vivo* 3D brain and heart monitors.

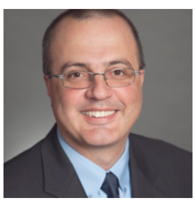
PROTÉGÉS

Protégés are invited to attend the conference as special guests of TAMEST Members.

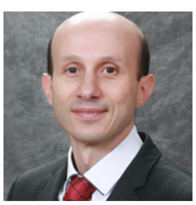
Erez Lieberman Aiden, Ph.D.
Assistant Professor, Molecular & Human Genetics
Baylor College of Medicine
James Lupski, M.D., Ph.D.

I. Yucel Akkutlu, Ph.D.
Associate Professor of Petroleum Engineering
Texas A&M University
Stephen A. Holditch, Ph.D.

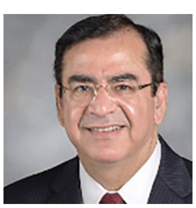
Roberto Ballarini, Ph.D., P.E., F.ASCE, F.EMI
Thomas and Laura Hsu Professor and Chair
University of Houston
Kaspar Willam, Ph.D.



Oguzhan Bayrak, Ph.D., P.E.
Professor, Department of Civil, Architectural and Environmental Engineering
The University of Texas at Austin
James O. Jirsa, Ph.D.

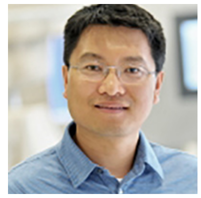


Amine Benzerga, Ph.D.
Associate Professor
Texas A&M University
Alan Needleman, Ph.D.



Kapil N. Bhalla, M.D.
Professor, Leukemia Department
The University of Texas MD Anderson Cancer Center
Neal Copeland, Ph.D.

Luciano Castillo, Ph.D.
Don-Kay-Clay Cash Distinguished Engineering Chair in Wind Energy
Texas Tech University
Kishor C. Mehta, Ph.D.

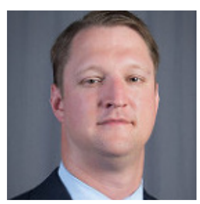


Rui Chen, Ph.D.
Associate Professor, Department of Molecular and Human Genetics
Baylor College of Medicine
Richard A. Gibbs, Ph.D.

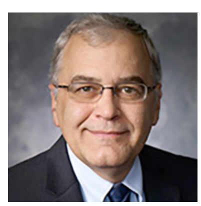
Clint Dawson, Ph.D.
John J. McKetta Centennial Energy Chair in Engineering and Professor of Aerospace Engineering and Engineering Mechanics
The University of Texas at Austin
J. Tinsley Oden, Ph.D.

Christopher J. Ellison, Ph.D.
Associate Professor and Frank A. Liddell, Jr. Centennial Fellow
The University of Texas at Austin
Nicholas A. Peppas, Sc.D.

Gregory Fiete, Ph.D.
Associate Professor of Physics
The University of Texas at Austin
Allan H. MacDonald, Ph.D.



John Foster, Ph.D.
Assistant Professor
Departments of Petroleum and Geosystems Engineering; Aerospace Engineering and Engineering Mechanics
The University of Texas at Austin
Larry W. Lake, Ph.D.



Bruce Gnade, Ph.D.
Vice President for Research
The University of Texas at Dallas
Don W. Shaw, Ph.D.

Nick V. Grishin, Ph.D.
Professor, Biophysics
The University of Texas Southwestern Medical Center
Johann Deisenhofer, Ph.D.

Teja Guda, Ph.D.
Assistant Professor, Biomedical Engineering
The University of Texas at San Antonio
Rena Bizios, Ph.D.

PROTÉGÉS

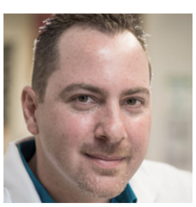
Ibrahim Karaman, Ph.D.
Head and Chevron Professor I of the Department of Materials Science & Engineering
Texas A&M University
Alan Needleman, Ph.D.

Dimitris C. Lagoudas, Ph.D.
Associate Vice Chancellor for Engineering Research,
The Texas A&M University System
University Distinguished Professor, Texas A&M University
Alan Needleman, Ph.D.

Charles Y. Lin, Ph.D.
Assistant Professor
Baylor College of Medicine
Brendan Lee, M.D., Ph.D.

Vassiliy Lubchenko, Ph.D.
Professor, Department of Chemistry
University of Houston
Peter G. Wolynes, Ph.D.

Jodie L. Lutkenhaus, Ph.D.
Associate Professor, William and Ruth Neely Faculty Fellow
Texas A&M University
M. Katherine Banks, Ph.D.



Angel A. Martí, Ph.D.
Associate Professor of Chemistry, Bioengineering and Materials Science & Nanoengineering
Rice University
Peter J. Rossky, Ph.D.

Efstathios E. (Stathis) Michaelides, Ph.D., P.E.
Professor and W.A. Tex Moncrief Chair of Engineering
Texas Christian University
Karl J. Springer

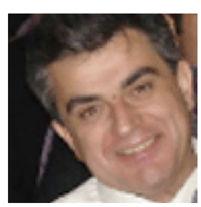
Richard Tyler Miller, M.D.
Professor of Medicine
The University of Texas Southwestern Medical Center
Scott Grundy, M.D., Ph.D.

Delia Milliron, Ph.D.
Associate Professor and Fellow of the Henry Beckman Professorship
The University of Texas at Austin
Robert M. Metcalfe, Ph.D.

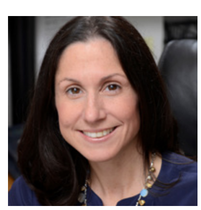
Robert D. Moser, Ph.D.
Professor
The University of Texas at Austin
Thomas J.R. Hughes, Ph.D.

Partha P. Mukherjee, Ph.D.
Assistant Professor, Mechanical Engineering
Texas A&M University
Akhil Datta-Gupta, Ph.D.

Chongzheng Na, Ph.D.
Associate Professor of Environmental Engineering
Texas Tech University
Danny D. Reible, Ph.D.



Michael Nikolaou, Ph.D.
Professor of Chemical and Biomolecular Engineering
University of Houston
Christine A. Ehlig-Economides, Ph.D.



Kathryn A. O'Donnell, Ph.D.
Assistant Professor of Molecular Biology
The University of Texas Southwestern Medical Center
Eric N. Olson, Ph.D.

PROTÉGÉS

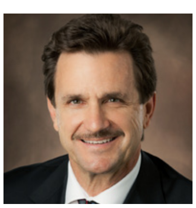
Matteo Pasquali, Ph.D.
Professor and Department Chair of Chemistry
Rice University
Peter J. Rossky, Ph.D.

Keshav K. Pingali, Sc.D.
Professor of Computer Science and W.A. "Tex" Moncrief Chair of Grid and Distributed Computing, Institute for Computational Engineering and Science
The University of Texas at Austin
J. Tinsley Oden, Ph.D.

John N. Randall, Ph.D.
President
Zyvex Labs
David E. Daniel, Ph.D.

Emilie Ringe, Ph.D.
Assistant Professor of Materials Science and NanoEngineering and Assistant Professor of Chemistry
Rice University
Edwin L. Thomas, Ph.D.

Andrew J. Schaefer, Ph.D.
Noah Harding Chair and Professor
Rice University
Richard A. Tapia, Ph.D.



Lawrence Schovanec, Ph.D.
Provost and Senior Vice President
Texas Tech University
Fazle Hussain, Ph.D.

Robert Skelton, Ph.D.
TEES Distinguished Professor, Aerospace Engineering
Texas A&M University
John L. Junkins, Ph.D.

Courtney A. Smith, M.D., F.A.A.P.
Chief Resident, Pediatric Residency Program
Baylor College of Medicine, San Antonio
Fernando A. Guerra, M.D.

Jeff Tabor, Ph.D.
Assistant Professor of Bioengineering
Rice University
Antonios G. Mikos, Ph.D.

Ben H. Thacker, Ph.D.
Director, Materials Engineering Department
Southwest Research Institute
H. Norman Abramson, Ph.D.

Angelique Whitehurst, Ph.D.
Assistant Professor
The University of Texas Southwestern Medical Center
Melanie H. Cobb, Ph.D.

Michael Wong, Ph.D.
Professor and Department Chair of Chemical and Biomolecular Engineering
Rice University
George J. Hirasaki, Ph.D.

Anvar Zakhidov, Ph.D.
Deputy Director, NanoTech Institute
The University of Texas at Dallas
Ray H. Baughman, Ph.D.

Janet Zoldan, Ph.D.
Associate Professor
The University of Texas at Austin
Nicholas A. Peppas, Sc.D.

2016 Board of Directors

David W. Russell, Ph.D., **President**
The University of Texas Southwestern Medical Center
NAS (2006)

The Honorable Gordon R. England, **Vice President**
V1 Analytical Solutions
NAE (2012)

Kenneth E. Arnold, P.E., **Treasurer and Past President**
WorleyParsons
NAE (2005)

Danny D. Reible, Ph.D., **Secretary**
Texas Tech University
NAE (2005)

C. Thomas Caskey, M.D., F.A.C.P., F.A.C.M.G., F.R.S.C.
Baylor College of Medicine
NAS (1993) NAM (1989)

Francisco G. Cigarroa, M.D.
The University of Texas Health Science Center at San Antonio
NAM (2006)

Brian Clark, Ph.D.
Schlumberger
NAE (2010)

Melanie H. Cobb, Ph.D.
The University of Texas Southwestern Medical Center
NAS (2006)

Naomi J. Halas, Ph.D., D.Sc.
Rice University
NAS (2013) NAE (2014)

Peter J. Hotez, M.D., Ph.D.
Baylor College of Medicine
NAM (2008)

Danny O. Jacobs, M.D., M.P.H.
The University of Texas Medical Branch at Galveston
NAM (2001)

Joanne R. Lupton, Ph.D.
Texas A&M University
NAM(2009)

David J. Meltzer, Ph.D.
Southern Methodist University
NAS (2009)

Robert M. Metcalfe, Ph.D.
The University of Texas at Austin
NAE (1997)

Roberta B. Ness, M.D., M.P.H.
The University of Texas Health Science Center at Houston
NAM (2009)

Peter G. Wolynes, Ph.D.
Rice University
NAS (1991)

Sharon L. Wood, Ph.D.
The University of Texas at Austin
NAE (2013)

TAMEST LEADERSHIP

Nobel Laureates of Texas

Bruce A. Beutler, M.D. (NAM, NAS)
Nobel Prize in Physiology or Medicine, 2011 | The University of Texas Southwestern Medical Center

Michael S. Brown, M.D. (NAM, NAS)
Nobel Prize in Physiology or Medicine, 1985 | The University of Texas Southwestern Medical Center | TAMEST Founding Co-Chair

Robert F. Curl, Ph.D. (NAS)
Nobel Prize in Chemistry, 1996 | Rice University

Johann Deisenhofer, Ph.D. (NAS)
Nobel Prize in Chemistry, 1988 | The University of Texas Southwestern Medical Center

Joseph L. Goldstein, M.D. (NAM NAS)
Nobel Prize in Physiology or Medicine, 1985 | The University of Texas Southwestern Medical Center

Dudley R. Herschbach, Ph.D. (NAS)
Nobel Prize in Chemistry, 1986 | Texas A&M University

Russell A. Hulse, Ph.D.
Nobel Prize in Physics, 1993 | The University of Texas at Dallas

David M. Lee, Ph.D. (NAS)
Nobel Prize in Physics, 1996 | Texas A&M University

Steven Weinberg, Ph.D. (NAS)
Nobel Prize in Physics, 1979 | The University of Texas at Austin

IN MEMORIAM
Norman E. Borlaug, Ph.D. (NAS)
Nobel Peace Prize, 1970

S. Malcolm Gillis, Ph.D.
Past President and University Professor
Rice University

Alfred G. Gilman, M.D., Ph.D. (NAM, NAS)
Nobel Prize in Physiology or Medicine 1994 | The University of Texas Southwestern Medical Center

Jack St. Clair Kilby (NAE)
Nobel Prize in Physics, 2000

Alan G. MacDiarmid, Ph.D. (NAE, NAS)
Nobel Prize in Chemistry, 2000

Richard E. Smalley, Ph.D. (NAS)
Nobel Prize in Chemistry, 1996 | TAMEST Founding Co-chair

Industry and Community Affiliates Committee

Chair

Sara N. Ortwein
President
ExxonMobil Upstream Research Company

Members

Ernest H. Cockrell
Chairman
Cockrell Interests, Inc.

Michael S. Dell
Chairman of the Board and CEO
Dell Inc.

Norbert Dittrich
President
The Welch Foundation

Robert R. Doering, Ph.D.
Senior Fellow | Research Manager
Texas Instruments, Inc.

Richard H. Edwards
Executive Vice President
Lockheed Martin Missiles and Fire Control

Thomas J. Engibous (NAE)
Retired Chairman
Texas Instruments, Inc.

Larry R. Faulkner, Ph.D.
President Emeritus
The University of Texas at Austin

Peter T. Flawn, Ph.D. (NAE)
President Emeritus
The University of Texas at Austin

John L. Garrison, Jr.
President and CEO
Bell Helicopter

Adam L. Hamilton, P.E.
President
Southwest Research Institute

Honorable William P. Hobby
Former Lt. Governor of Texas

Kenneth M. Jastrow II

Neal F. Lane, Ph.D.
Malcolm Gillis University Professor and Senior Fellow
James A. Baker III Institute for Public Policy
Rice University

Robert M. Metcalfe, Ph.D. (NAE)
Professor of Innovation and Murchison Fellow of Free Enterprise
The University of Texas at Austin

Paul B. Murphy
CEO
Cadence Bancorp, LLC

Peter O'Donnell, Jr.
Chairman of the Board
O'Donnell Foundation

Kurt Swogger, P.E.
Chief Executive Officer
Molecular Rebar Design, LLC

Charles W. Tate
Chairman and Founding Partner
Capital Royalty L.P.

James J. Truchard, Ph.D. (NAE)
President, CEO and Co-Founder
National Instruments

James R. Von Ehr II
CEO and Founder
Zyvex Labs, LLC

Pete Winstead
Founding Shareholder
Winstead PC

H. Bartell Zachry
Chairman of the Board
Zachry Group, Inc.

2016 CONFERENCE SPONSORS

PLATINUM

THE TEXAS A&M UNIVERSITY SYSTEM & TEXAS A&M UNIVERSITY

DIAMOND

ExxonMobil

THE Welch FOUNDATION
Advancing Chemistry. Improving Life.

SOUTHWESTERN MEDICAL FOUNDATION 75 YEARS EST. 1939 & UT Southwestern Medical Center

2016 CONFERENCE SPONSORS

GOLD

Bell Helicopter — A Textron Company

CRG

Lockheed Martin

Molecular Rebar Design

Texas — The University of Texas at Austin

UT Dallas — The University of Texas at Dallas

SILVER

Castleview Productions

Ernest H. Cockrell

Schlumberger

SwRI

St. David's HealthCare

Texas Instruments

Texas Tech University

Texas Tech University Health Sciences Center

University of Texas Arlington

UTHealth — The University of Texas Health Science Center at Houston

We Make Lives Better — UT Health Science Center San Antonio

University of Houston

Winstead Attorneys

OPENING RECEPTION SPONSOR

Bank of America

at the designation of Kay Bailey Hutchison

SAVE THE DATE

2017 ANNUAL CONFERENCE

A Sustainable Future for Texas

Program Chair: Stephen A. Holditch, Ph.D.

Texas A&M University

January 18–20, 2017

The Westin Riverwalk

San Antonio, Texas

TAMEST ENDOWMENT FUND DONORS

TAMEST honors members of the Founders of the Endowment and the Legacy Circle whose extraordinary commitment will ensure sustainable funds to build upon its success and continue the mission of promoting excellence in science and technology.

FOUNDERS OF THE ENDOWMENT

Anadarko Foundation

AT&T

BNSF Foundation

ConocoPhillips

Energy Future Holdings

Edith and Peter O'Donnell

Temple-Inland

The USAA Foundation

LEGACY CIRCLE

The Eugene McDermott Foundation

Connect with TAMEST

facebook

twitter
@TAMESTX

LinkedIn

THE ACADEMY OF
MEDICINE, ENGINEERING & SCIENCE
OF TEXAS

www.tamest.org