

Chemical Engineering: Challenges and Opportunities in the 21st Century

Committee

Eric W. Kaler

Chair

Eric W. Kaler (Chair), NAE, is President of Case Western Reserve University. Previously, he was Professor of Chemical Engineering and Materials Science and President Emeritus at the University of Minnesota. He served on the faculty of the Department of Chemical Engineering at the University of Washington before moving to the Department of Chemical Engineering at the University of Delaware as an Associate Professor in 1989, later becoming Dean of the College of Engineering in 2000. Dr. Kaler's research interests focus on "complex fluids" containing surfactants, polymers, proteins or colloidal particles, either separately or in mixtures. Additionally, Dr. Kaler studies statistical mechanics and thermodynamics. Dr. Kaler received one of the first Presidential Young Investigator Awards from the National Science Foundation in 1984. He has received numerous other awards for his research and is a Fellow of several scientific societies. He has authored or co-authored over 200 peer-reviewed papers and holds ten U.S. patents. He was elected to the National Academy of Engineering in 2010 and named a Fellow of the American Academy of Arts and Sciences in 2014. Dr. Kaler earned a Ph.D. in Chemical Engineering from the University of Minnesota in 1982.

Monty M. Alger

Member

Monty M. Alger, NAE, is a Professor of Chemical Engineering at the Pennsylvania State University. His experience in the chemical and energy industries includes positions as Vice President and Chief Technology Officer at Air Products and Chemicals Inc., and as Senior Vice President of Research at Myriant. He spent 23 years at General Electric (GE), where he led technology development at the Global Research Center of GE Plastics and was the General Manager of Technology for the Advanced Materials business. Prior to GE, he was Director of the Massachusetts Institute of Technology (MIT) Chemical Engineering Practice School Station at GE Plastics. He serves on advisory boards for organizations including the Shenhua National Institute of Clean and Low Carbon Energy and PTT Global Chemical (Thailand). Dr. Alger is a senior member and 2020 President of the American Institute of Chemical Engineers. He is also a former member of the Council on Competitiveness Technology Leadership Strategy Initiative. He earned a Ph.D. from the University of Illinois at Urbana-Champaign in chemical engineering.

Gilda A. Barabino

Member

Gilda A. Barabino, NAE, NAM, is the second president of Olin College of Engineering, and Professor of Biomedical and Chemical Engineering. Previously, she was Dean and Daniel and Frances Berg Professor of Engineering at The City College of New York's Grove School of Engineering. Prior to this position, Dr. Barabino was a Professor and Associate Chair for Graduate Studies in the Department of Biomedical Engineering at Georgia Institute of Technology and Emory University. She served as the inaugural Vice Provost for Academic Diversity and is credited for establishing a legacy to strengthen diversity and inclusion at Georgia Tech. Prior to her appointments at Georgia Tech and Emory, she rose to the rank of full Professor of chemical engineering and served as Vice Provost for Undergraduate Education at Northeastern University. Her research interests include sickle cell disease, cellular and tissue engineering, and diversity in science and engineering. In addition to being an American Institute of Chemical Engineers (AIChE) Fellow, Dr. Barabino is a Fellow of the American Association for the Advancement of Science, the American Institute for Medical and Biological Engineering and the Biomedical Engineering Society. Dr. Barabino has an extensive record of leadership and service in the chemical and biomedical engineering communities and currently serves as the President of the Biomedical Engineering Society. She is a Sigma Xi Distinguished Lecturer for 2012-2014 and is the recipient of numerous awards including the BMES Diversity Award, the American Society for Engineering Education/Dow Outstanding Faculty Award, the AIChE Minority Affairs Committee (MAC) Distinguished Service Award, and the AIChE MAC Eminent Chemical Engineers Award. Dr. Barabino is a recognized innovator, researcher, and consultant on faculty development and on diversity in science and engineering. She has led a number of initiatives in these areas including serving as the founder and Executive Director of the National Institute for Faculty Equity. She received her BS degree in Chemistry from Xavier University of Louisiana and her PhD in Chemical Engineering from Rice University.

Gregg T. Beckham

Member

Gregg T. Beckham is a Senior Research Fellow and Group Leader at the National Renewable Energy Laboratory. He currently leads and works with an interdisciplinary team of biologists, chemists, and engineers on the development of green processes and products from biomass and waste plastics using the tools of chemistry and biology. Dr. Beckham served as a co-organizer for the National Academies Chemical Sciences Roundtable's workshop, Closing the Loop on the Plastics Dilemma, and received his PhD in Chemical Engineering at Massachusetts Institute of Technology in 2007.

Dimitris I. Collias

Member

Dimitris I. Collias is Research Fellow in the Corporate R&D Department of the Procter & Gamble (P&G) company leading the development of technologies in the Bio and Circular Economy space. Dr. Collias has 27 years of industrial experience in materials processing, properties, and delivery systems. He has technology development and management experience, has worked extensively with outside industrial partners and universities, and many of his technical developments have been commercialized in various P&G products. Dr. Collias co-authored the book *Polymer Processing – Principles and Design*, published more than 35 articles in journals and conference proceedings, and holds more than 90 issued US patents and numerous patent applications. He has earned many awards, such as the 2020 American Chemical Society's Affordable Green Chemistry Award, P&G's CTO Pathfinder Awards in 2019 and 2010, P&G's IP Strategy Award in 2018, Los Alamos National Laboratory's Recognition and Commendation in 2009, and P&G's Cost Innovation Award in 2007. He is a member of the American Institute of Chemical Engineers, American Chemical Society, Society of Rheology, Society of Plastics Engineers, and American Oil Chemist's Society. Dr. Collias earned his Ph.D. in Chemical Engineering from Princeton University.

Juan J. de Pablo

Member

Juan J. de Pablo, NAE, is the Liew Family Professor and Vice President for National Laboratories at the University of Chicago. He is also a senior scientist at Argonne National Laboratory. Dr. de Pablo is a leader in developing models and simulations of molecular and large-scale phenomena. He conducts supercomputer simulations to design and find applications for new materials including protein folding and aggregation, DNA folding and hybridization, glassy materials, block copolymers, liquid crystals, and development of advanced molecular simulation methods. He holds over 20 patents and has authored or coauthored approximately 500 publications. He has received the DuPont Medal for Excellence in Nutrition and Health Sciences, the Intel Patterning Science Award, and the Charles Stine Award from the American Institute of Chemical Engineers. He is also the founding editor of *Molecular Systems Designing and Engineering*. Dr. de Pablo currently chairs the Mathematical and Physical Sciences Advisory Committee of the National Science Foundation and the Committee on Condensed Matter and Materials Research at the National Academies. He is a fellow of the American Academy of Arts and Sciences and of the American Physical Society. Dr. de Pablo was elected as Foreign Correspondent Member of the Mexican Academy of Sciences in 2014. He is a member of the American Institute of Chemical Engineers and has served as the chair of the awards selection subcommittee. He earned his PhD in Chemical Engineering at the University of California, Berkeley.

Sharon C. Glotzer

Member

Sharon C. Glotzer, NAS, NAE, is the Anthony C. Lembke Department Chair of Chemical Engineering and Professor at the University of Michigan. Dr. Glotzer's research on computational assembly science and engineering aims toward predictive materials design of colloidal and soft matter. Among other notable findings, Dr. Glotzer invented the idea of "patchy particles," a conceptual approach to nanoparticle design. She is a Fellow of the American Physical Society, the American Association for the Advancement of Science, the American Institute of Chemical Engineers, and the Materials Research Society. Dr. Glotzer is the recipient of numerous awards, including the Nanoscale Science & Engineering Forum Award, the Charles M.A. Stine Award, the MRS Medal from the Materials Research Society, the Aneesur Rahman Prize in Computational Physics, and the Presidential Early Career Award for Scientists and Engineers. She has participated in many National Academies activities, and she currently serves on the Board on Chemical Sciences and Technology. Dr. Glotzer earned her Ph.D. in physics from Boston University.

Paula T. Hammond

Member

Paula Hammond, NAS, NAE, NAM, is the Insititute Professor, Department Head, and David H. Koch Professor and Head of the Chemical Engineering Department at the Massachusetts Institute of Technology (MIT) and a member of MIT's Koch Institute for Integrative Cancer Research, the MIT Energy Initiative, and a founding member of the MIT Institute for Soldier Nanotechnology. She previously served as the Executive Officer (Associate Chair) of the Chemical Engineering Department and is an Associate Editor for the journal ACS Nano. Dr. Hammond's research focuses on the self-assembly of polymeric nanomaterials, particularly the use of electrostatics and other complementary interactions to generate functional materials with highly controlled architectures, including the development of new biomaterials and electrochemical energy devices. She served on the National Academies Board on Chemical Sciences and Technology from 2006 to 2009. She was Chair of the American Institute of Chemical Engineers (AIChE) Materials Science and Engineering Division, has been involved for several years in Polymer programming, and in the past has served as faculty advisor for the AIChE MIT student chapter. She received the William Grimes Award, the Distinguished Scientist Award from Harvard University, and is a Fellow of the American Physical Society, the Polymer Division of the American Chemical Society, and the American Institute of Biological and Medical Engineers. Dr. Hammond earned her Ph.D. in Chemical Engineering from MIT.

Enrique Iglesia

Member

Enrique Iglesia, NAE, is the Theodore Vermeulen Chair in the Department of Chemical and Biomolecular Engineering at the University of California, Berkeley and a Faculty Senior Scientist in the E.O. Lawrence Berkeley National Laboratory. His research interests include the synthesis and the structural and mechanistic characterization of inorganic solids useful as catalysts for chemical reactions important in energy conversion, petrochemical synthesis, and environmental control. He is a Fellow of the American Chemical Society. Dr. Iglesia has received a Humboldt Senior Scientist Award from the Alexander von Humboldt Foundation and a Doctor Honoris Causa from the Universidad Politecnica de Valencia. In 2011, he was recognized with the Gabor A. Somorjai Award for Creative Research in Heterogeneous Catalysis of the American Chemical Society, the Alpha Chi Sigma Award for Excellence in Chemical Engineering Research of the American Institute of Chemical Engineers (AIChE) and the Francois Gault Lectureship Award of the European Federation of Catalysis Societies. Dr. Iglesia is the former Editor-in-Chief of Journal of Catalysis (1997-2010) and serves as President of the North American Catalysis Society. He has served as chairman of the Division of Petroleum Chemistry of the American Chemical Society, as a Director in the Division of Catalysis and Reaction Engineering in the AIChE, and on the Editorial Board of several leading journals in the catalysis field. Dr. Iglesia received his Ph.D. degree in Chemical Engineering from Stanford University.

Sangtae Kim

Member

Sangtae Kim, NAE, is Distinguished Professor of Chemical Engineering at Purdue University, where he was also the inaugural Donald W. Feddersen Distinguished Professor of Mechanical Engineering. His other professional experiences include Executive Director, Morgridge Institute for Research; (inaugural) Division Director, National Science Foundation Cyberinfrastructure Division; and Vice President of Research and Development Information Technology at pharmaceutical companies Eli Lilly and Warner Lambert. He started his career as a faculty member in chemical engineering at the University of Wisconsin where he engaged in mathematical and computational methods for microhydrodynamics and coauthored the 1991 book on this topic. Dr. Kim is a fellow of the American Institute of Medical and Biological Engineers and the American Institute of Chemical Engineers, and a Trustee of the American Institute of Chemical Engineers (AIChE) Foundation. His honors and awards include the 2013 Ho-Am Prize in Engineering, AIChE's George Lappin Award and Colburn Award, and the 1992 Award for Initiatives in Research from the National Academies. Dr. Kim received a PhD in chemical engineering from Princeton University.

Samir Mitragotri

Member

Samir Mitragotri, NAE, NAM, is Hiller Professor of Bioengineering and Hansjorg Wyss Professor of Biologically Inspired Engineering at Harvard University, John A. Paulson School of Engineering and Applied Sciences. His research focuses on transdermal, oral, and targeted drug delivery systems. Dr. Mitragotri has made groundbreaking contributions to the field of biological barriers and drug delivery. His research has advanced fundamental understanding of biological barriers and has led to the development of new materials as well as technologies for diagnosis and treatment of various ailments including diabetes, cardiovascular diseases, skin diseases, and infectious diseases. Dr. Mitragotri is an elected fellow of the National Academy of Inventors, American Association for the Advancement of Science, Biomedical Engineering Society, American Institute for Medical and Biological Engineering, and the American Association of Pharmaceutical Scientists. He is an author of over 300 publications, an inventor on over 170 patents/patent applications, a recipient of American Institute of Chemical Engineers' Colburn award and Acrivos Professional Progress award, and SFB's Clemson award. Dr. Mitragotri received his PhD in chemical engineering from Massachusetts Institute of Technology.

Babatunde A. Ogunnaike

Member

Babatunde A. Ogunnaike, NAE, is the William L. Friend Chaired Professor of Chemical Engineering at the University of Delaware. Prior to this role, Dr. Ogunnaike had a 13-year research career with DuPont. His research focuses on process control, modeling and simulation, systems biology, and applied statistics. He has made notable contributions to microhydrodynamics, protein dynamics, and drug discovery through the application of high-performance computing. Dr. Ogunnaike is the author or co-author of four books including a widely used textbook, Process Dynamics, Modeling and Control, and Random Phenomena: Fundamentals of Probability and Statistics for Engineers. He is an Associate Editor of the journal Industrial and Engineering Chemistry Research. Dr. Ogunnaike's awards include the American Institute of Chemical Engineers' (AIChE) CAST Computing Practice Award, the University of Delaware's College of Engineering Excellence in Teaching award, the ISA Eckman Award, and the American Association for Clinical Chemistry Control Engineering Practice award. He is a fellow of the American Institute of Chemical Engineers and of the Nigerian Academy of Engineering. He received his Ph.D. in Chemical Engineering from the University of Wisconsin-Madison.

Anne Robinson

Member

Anne Robinson is the Department Head for Chemical Engineering at Carnegie Mellon University. Previously, Dr. Robinson was the Catherine and Henry Boh Professor in Engineering and Chair of Chemical and Biomolecular Engineering at Tulane University. She has several patents and over 85 publications in the areas of protein (re)folding and aggregation, protein biophysics, and protein expression of therapeutically relevant protein molecules. From 2015-2017, she served on the Board of Directors of AIChE. She is on the advisory board of Biotechnology and Bioengineering and the editorial board of Biotechnology Journal, and has been an ad hoc reviewer for many National Institute of Health and National Science Foundation study sections. She is also a member of the Advisory Committee for Pharmaceutical Sciences of the Food and Drug Administration. Her honors include a DuPont Young Professor Award, a National Science Foundation Presidential Early Career Award for Science and Engineering (PECASE) Award, and she is a fellow of the American Institute for Medical and Biological Engineering and the American Institute of Chemical Engineers (AIChE). Dr. Robinson received her Ph.D. in Chemical Engineering from the University of Illinois at Urbana-Champaign.

Jose G. Santiesteban

Member

José G. Santiesteban, NAE, is a Strategy Manager for ExxonMobil Research and Engineering Company. During his approximately 30-year career at ExxonMobil, Dr. Santiesteban has served in a number of technical leadership and management assignments. His current responsibilities include leading a team for developing strategic technology direction, providing research guidance, and ensuring robustness of the R&D portfolio. His area of expertise is in heterogeneous catalysis, including design, synthesis, physical chemical characterization of novel catalytic materials and reaction mechanism/kinetics. He is the inventor or co-inventor on more than 85 U.S. patents, editor of two special catalysis journals, and coauthor of over 20 referenced publications. Dr. Santiesteban has led and made significant technical contributions to the discovery, development, and commercialization of more than 20 novel catalyst technologies for the production of high performing lubricants, clean fuels, and petrochemicals. Dr. Santiesteban was elected member of the National Academy of Engineering in 2016. In 2018, he was elected member of The Academy of Medicine, Engineering and Science of Texas (TAMEST). Dr. Santiesteban also received the Society of Hispanic Professional Engineers (SHPE) 2018 Innovator Award and the "Key to the City" of Parral from Chihuahua in 2016. He has received multiple technical and leadership awards within ExxonMobil Research and Engineering Company and Mobil Research and Development Company. He is a senior member of the American Institute of Chemical Engineers and has served on the advisory board of various academic and research institutions around the world. Dr. Santiesteban received his Ph.D. in Physical Chemistry from Lehigh University.

Rachel A. Segalman

Member

Rachel A. Segalman, NAE, is Department Chair and Edward Noble Kramer Professor at the University of California, Santa Barbara. Previously, she served as Acting Director at Lawrence Berkeley Laboratories in the Materials Science Division as well as Professor of Chemical Engineering at the University of California, Berkeley. Dr. Segalman's research focuses on molecular structure control over soft matter on molecular through nanoscopic lengthscales to optimize properties for applications ranging from energy to biomaterials. She is particularly interested in materials for energy applications such as photovoltaics, fuel cells, and thermoelectrics. She was named Massachusetts Institute of Technology Review's Top 35 Innovators under 35 years old, received the Early Career Award in Science and Engineering, and the Journal of Polymer Science Innovation Award. She has been elected to the American Academy of Arts and Sciences, the Materials Research Society, the American Physical Society, and is an elected senior member of the American Institute of Chemical Engineers. Dr. Segalman received her Ph.D. in Chemical Engineering from the University of California, Santa Barbara.

David Sholl

Member

David Sholl is the John F. Brock III School Chair of Chemical and Biomolecular Engineering at the Georgia Institute of Technology. His research uses computational materials modeling to accelerate development of new materials for energy-related applications, including generation and storage of gaseous and liquid fuels and carbon dioxide mitigation. Before his appointment at Georgia Tech, Dr. Sholl was on the faculty of Carnegie Mellon University for 10 years. He has published over 300 papers that have received over 13,000 citations. He has also written a textbook on density functional theory, a quantum-chemistry method that is widely applied through the physical sciences and engineering. Dr. Sholl served as a member on the National Academies' Committee on a Research Agenda for a New Era in Separations Science. He is a senior editor of the American Chemical Society journal *Langmuir*, and he was instrumental in the development of the Rapid Advancement in Process Intensification Deployment (RAPID) Institute, a \$70 million, U.S. Department of Energy—funded manufacturing institute focused on process intensification and run by the American Institute of Chemical Engineers. Dr. Sholl received a Ph.D. in applied mathematics from the University of Colorado, Boulder.

Kathleen J. Stebe

Member

Kathleen J. Stebe, NAE, is Goodwin Professor in the School Engineering and Applied Sciences at the University of Pennsylvania. Her research focuses on directed assembly in soft matter and at fluid interfaces, with an emphasis on confinement, geometry, and emergent structures for novel functional materials. Previously, she spent a post-doctoral year in Compiègne, France under the guidance of Dominique Barthes-Biesel. After, she joined the Department of Chemical Engineering at Johns Hopkins University, where she became Professor and served as the Department Chair. She later joined the University of Pennsylvania, where she served as department chair prior to serving as Deputy Dean. She is an Associate Editor of the journal *Soft Matter*, and has been recognized by the Johns Hopkins Society of Scholars, as a Fellow of the American Physical Society and of the Radcliffe Institute. Dr. Stebe received her Ph.D. in Chemical Engineering at the Levich Institute.

Maggie Walser

Staff Officer

Maggie L. Walser is a Senior Program Officer with the Board on Chemical Sciences and Technology and has been with the National Academies of Sciences, Engineering, and Medicine since 2010. Prior to this role, she served as the Director of Education & Capacity Building for the Gulf Research Program where she contributed to strategic planning for the program and oversaw education and training activities and fellowship programs that support early-career scientists. From 2010 to 2014, Dr. Walser served as a Program Officer with the Board on Atmospheric Sciences and Climate and worked on topics such as climate science, weather research and policy, climate change and water security, and Arctic research priorities. Before joining the staff of the National Academies, she was the AGU/AAAS Congressional Science Fellow and worked on water and energy policy and legislation with the U.S. Senate Committee on Energy and Natural Resources. Prior to her time on the Hill, Dr. Walser was a Postdoctoral Fellow with the National Council for Science and the Environment. She completed her Ph.D. in Chemistry with the Aerosol Photochemistry Group at the University of California, Irvine in 2007. Her research focused on the composition and photochemistry of secondary organic aerosol, as well as biogenic emissions of atmospherically relevant trace gases. She also holds B.S. degrees in Chemistry and Chemical Engineering from the University of California, Irvine.