



Covestro is guided by a simple and powerful purpose: **to make the world a brighter place.** The company focuses on four topics: Alternative Raw Materials to reduce fossil fuels, Innovative Recycling using energy-efficient technologies to reuse and recycle products, Renewable Energy for cleaner energy to power the Circular Economy, and Joint Solutions, collaborating across industries to advance the initiatives.

With its materials and application solutions found in nearly every area of modern life, Covestro is among the leading suppliers of high-performance polymers. Covestro develops sustainable solutions to the greatest challenges of our age: climate change, resource depletion, urban expansion, and population growth. These concerns will inevitably lead to a higher demand for renewable energies, alternative resources, energy-efficient transportation, and sustainable, affordable housing.

Covestro aims to meet this demand with long-lasting, light, environmentally friendly and cost-effective materials, which in many cases are suitable replacements for conventional, less sustainable materials such as steel and glass. The main segments served are the automotive, electrical and electronics, construction, medical, sports, and leisure industries.

At the backbone of their organization's success are its 16,500 employees, who work at around 30 sites across the globe – from smaller technical centers and innovation hubs, to large-scale production plants. Covestro's activities are coordinated from its corporate headquarters in Leverkusen, Germany. More at [www.covestro.com](http://www.covestro.com).

#### Previous Stein-Covestro Speakers

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*Professor Timothy P. Lodge, 2019-2020*  
*Professor Paula T. Hammond, 2018-2019*  
*Professor Karen L. Wooley, 2017-2018*  
*Prof. Krzysztof Matyjaszewski, 2016-2017*  
*Professor Mitch Winnik, 2015-2016*  
*Professor David A. Tirrell, 2014-2015*  
*Professor Christopher Ober, 2013-2014*  
*Professor Frank S. Bates, 2012-2013*  
*Dr. Mohan Srinivasarao, 2011-2012*  
*Professor James Heath, 2010-2011*  
*Dr. Catherine Coleman, 2009-2010*

*Professor Edwin L. Thomas, 2008-2009*  
*Professor George Whitesides, 2007-2008*  
*Professor Julia Kornfield, 2006-2007*  
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*Professor Samuel Stupp, 2004-2005*  
*Dr. Craig J. Hawker, 2003-2004*  
*Dr. Richard Turner, 2002-2003*  
*Dr. Elsa Reichmanis, 2001-2002*  
*Dr. Robert Langer, 2000-2001*  
*Professor Robert H. Grubbs, 1999-2000*  
*Professor Herbert Morawetz, 1998-1999*  
*Dr. Robert L. Kruse, 1997-1998*

Richard Stein – Covestro

# Annives Kravonoy

in Polymer Chemistry

The Department of Chemistry, University of Massachusetts Amherst  
presents

## PROFESSOR ZHENAN BAO

Stanford University  
Department of Chemical Engineering

“Skin-Inspired Organic Electronics”

Thursday, October 14, 2021  
11:30 a.m., Zoom

# Zhenan Bao



**Z**HENAN BAO is Department Chair and K.K. Lee Professor of Chemical Engineering, and by courtesy, a Professor of Chemistry and a Professor of Material Science and Engineering at Stanford University. Bao founded the Stanford Wearable Electronics Initiative (eWEAR) in 2016 and serves as the faculty director.

Prior to joining Stanford in 2004, she was a Distinguished Member of Technical Staff in Bell Labs, Lucent Technologies from 1995-2004. She received her Ph.D in Chemistry from the University of Chicago in 1995. She has over 600 refereed publications and over 100 US patents with a Google Scholar H-Index >175.

Bao is a member of the National Academy of Engineering, the American Academy of Arts and Sciences and the National Academy of Inventors. She is a Fellow of MRS, ACS, AAAS, SPIE, ACS PMSE and ACS POLY.

Bao was selected as Nature's Ten people in 2015 as a "Master of Materials" for her work on artificial electronic skin. She was awarded the MRS Mid-Career Award in 2021, the inaugural ACS Central Science Disruptor and Innovator Prize in 2020, the Gibbs Medal by the Chicago session of ACS in 2020, the Wilhelm Exner Medal by Austrian Federal Minister of Science 2018, ACS Award on Applied Polymer Science 2017, the L'Oréal-UNESCO For Women in Science Award in the Physical Sciences 2017, the AIChE Andreas Acrivos Award for Professional Progress in Chemical Engineering in 2014, ACS Carl Marvel Creative Polymer Chemistry Award in 2013, ACS Cope Scholar Award in 2011, the Royal Society of Chemistry Beilby Medal and Prize in 2009, the IUPAC Creativity in Applied Polymer Science Prize in 2008.

Bao is a co-founder and on the Board of Directors for C3 Nano and PyrAmes, both are silicon-valley venture funded start-ups. She serves as an advising Partner for Fusion Venture Capital.

**ABSTRACT** Skin is the body's largest organ, and is responsible for the transduction of a vast amount of information. This conformable, stretchable, self-healable and biodegradable material simultaneously collects signals from external stimuli that translate into information such as pressure, pain, and temperature. The development of electronic materials, inspired by the complexity of this organ is a tremendous, unrealized materials challenge. However, the advent of organic-based electronic materials may offer a potential solution to this longstanding problem. Over the past decade, we have developed materials design concepts to add skin-like functions to organic electronic materials without compromising their electronic properties. These new materials and new devices enabled arrange of new applications in medical devices, robotics and wearable electronics. In this talk, I will discuss basic material design concepts for realizing stretchable, self-healable and biodegradable conductive or semiconductive materials. I will show our methods for scalable fabrication of stretchable electronic circuit blocks. Finally, I will show a few examples of applications we are pursuing uniquely enabled by skin-like organic electronics when interfacing with biological systems, such as low-voltage electrical stimulation, high-resolution large area electrophysiology, "morphing electronics" that grows with biological system and genetically targeted chemical assembly (GTCA).



Images of stretchable electronic skin. Image credit: Amir Foudeh, Sihong Liu of Bao Group, Stanford University

**R**ICHARD STEIN was born in Far Rockaway, New York in 1925. He was an undergraduate at Brooklyn Polytechnic, where he made some of the first light scattering studies of the dimensions of polymers in solution. He received his PhD from Princeton for work with Professor Tobolsky on using birefringence and X-ray diffraction to study polymer orientational relaxation. He then spent a postdoctoral year at Cambridge University to extend his studies using infrared dichroism. Stein joined the University of Massachusetts Chemistry faculty in 1950, where he began his pioneering studies into the development of rheo-optical techniques for studying orientation and phase transition phenomena in amorphous, crystalline and liquid crystalline polymers. Stein initiated the Polymer Science and Engineering Department and now serves as Emeritus Goessmann Professor in Chemistry. He has over 400 publications, and has been consulting for companies such as Monsanto and Bayer for over 45 years.

Dr. Stein's efforts have been recognized by awards from the American Chemical Society, the American Physical Society, the Society of Rheology, the Society of Plastics Engineers, the Society of Polymer Science in Japan, and the Plastics Hall of Fame. In 1999, the Materials Research Society conferred on him its highest honor, the Von Hippel Award. He received a Distinguished Alumni Award from Polytechnic University in Brooklyn, and has been awarded three honorary doctorates. Dr. Stein was named to the National Science and National Engineering Academies, as well as the American Academy of Arts and Sciences. He was a member of the first delegation in Chemistry to the People's Republic of China.

Professor Stein remained actively involved in research until his passing in the summer of 2021. He was a founder of the Pioneer Valley Biochar Initiative, a member of the Planning Committee for the North American Biochar Symposium in 2013, co-organizer of the UMass contribution to the National Teach-In for Global Warming Solutions, and of the New England Biochar Symposium, in 2009. He gives public lectures on the topic, and in 2011, he co-authored a book titled "The Energy Problem." In June of 2014, Prof. Stein was presented with a certificate of Congressional Recognition for his

outstanding service to UMass and to the community. In August of 2015, Senator Rosenberg presented Prof. Stein with an official Joint House Senate resolution recognizing his many accomplishments and contributions to the Commonwealth.

It was his desire to leave the world a better place, and all who knew him would agree that he did.



Richard Stein