American Chemical Society

National Awards Nomination Packet

ACS Award in Polymer Chemistry:2018
for: Kristi Anseth

Received: 10/31/2016 *Cycle Year: 1*

"For outstanding accomplishments in the design and implementation of polymer chemistry as a tool in the formation of rationally designed, smart, active biomaterials."

NOMINATOR:

Daniel Schwartz
Univ of Colorado
424 University of Colorado
Boulder, CO 80309-0424
UNITED STATES

Tel: (303)492-7471
Email: daniel.schwartz@colorado.eduXXX

- Have you discussed this award nomination with the nominee? *Yes*

NOMINEE:

Kristi Anseth
Univ of Colorado
3415 Colorado Ave
Jscbb Ucb 596
Boulder, CO 80303-1904
UNITED STATES

Tel: (303)530-1029
Fax: (303)735-0095
Email: kristi.anseth@colorado.eduXXX

ACS Current Member: Yes
Years of Service: 25
Date of birth: 01/01/1968
Present Position: Distinguished Professor
Industry: Academia

CODE OF CONDUCT:

- To the best of my knowledge, including past and present circumstances, the nominee:
  1. Employs and requires good safety protocols and practices in his/her laboratory and/or work environment;
  2. Upholds the highest ethical standards in his/her laboratory and/or work environment; and
  3. Otherwise engages in conduct that is consistent with both the objects of the American Chemical Society as stated in Article II Section 1 of its Constitution and the Chemical Professional Code of Conduct.

Code of Conduct Answer: *Yes*

- Prior Recipient ? *Yes*
- Reason? Nominee has won at least one award in the past 5 C. Cope Mid Career Scholars Award:2016 in 2016
- Work Differs: The work cited here focuses on advances in funda opposed to organic chemistry, and represents con over the entire career of the nominee.

SUPPORTER 1

Robert Langer
MIT
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UNITED STATES

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Email: langeroffice@mit.eduXXX

SUPPORTER 2

David Tirrell
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UNITED STATES

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University of Colorado **Boulder**
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Daniel K. Schwartz
Associate Department Chair
Glenn L. Murphy Professor of Engineering
daniel.schwartz@colorado.edu
(303) 735-0240

October 31, 2016

Dear Selection Committee,

I am honored to nominate Kristi Anseth for the **2016 ACS Award in Polymer Chemistry**. Prof. Anseth is the world's leading researcher in the design and implementation of polymer chemistry as a tool in the formation of rationally designed, smart, active biomaterials. Through manipulation of polymer chemistry and structure and character, she has achieved spatiotemporal control of the chemical, biological, and physical properties of biomaterials as enabling tools to probe fundamental cell biology questions, and applied this understanding towards targeted applications in tissue regeneration, cancer treatment, and drug delivery. She synthesizes polymers with defined structures that enable her to learn about and influence the molecular dynamics of processes at the cell-biomaterial interface. Her seminal work on the mechanisms of extracellular cue transmission, and her innovative approaches for biomolecule presentation in polymer matrices, have revolutionized the field. Her contributions have been translated into medical products including *in situ* forming polymers for bone regeneration (Abbott and Bioplant), hydrogels for chondrocyte delivery (Advanced Tissue Sciences, Smith & Nephew, and Cartilix), and polymers that promote wound healing (Mosaic Biosciences). She ranked 3rd among all US bioengineers in highly cited papers in the fields of “Biomaterials and Tissue Engineering” (33 highly cited papers) and “Hydrogels” (with 50 highly cited papers) during the period of 1998-2014.

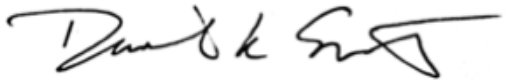
Prof. Anseth has pioneered the synthesis of polymeric biomaterials that *promote* or *suppress* targeted cell functions with the goal of engineering tissues through manipulation of the time-dependent polymer chemistry. She was the first to demonstrate the abiilty to use a photoinitiated polymerization to encapsulate chondroctyes and successfully regenerate cartilaginous tissue. While these PEG gels provided a *permissive* environment for cell encapsulation, Anseth's group has brilliantly exploited controlled photopolymerization mechanisms (i.e., click, thiol-ene) to create protein and peptide functionalized gels. She has synthesized functional, active polymer networks with spatiotemporal control of biochemical structure to controlthe differentiation of human mesenchymal stem cells, increasing survival and insulin secretion of islets, understanding tumor cell biology, facilitating enzyme-responsive drug delivery, and influencing process extension of neural cells – all through control of the polymer structure and functionality.

Prof. Anseth is also decisively answering questions about how the local presentation of biological signals, both context and concentration, influences cell phenotype and tissue evolution. Using sophisticated and elegant synthetic methods and the inclusion of orthogonal, photoresponsive moieties in the polymer architecture, she has synthesized polymeric biomaterial environments that promote information exchange between cell and material. Anseth has developed sophisticated polymer synthesis approaches, using a veritable toolbox of photochemical reactions, to exert spatiotemporal control on the cell’s microenvironment.

Prof. Anseth’s research group has published 315 publications in peer-reviewed journals, and her work has been cited more than 29,000 times with an H-index of 96 (Google Scholar). Prof. Anseth has mentored 55 PhD students, 32 postdoctoral associates, and over 150

undergraduate research assistants. Her students have been recognized with numerous ACS Awards in polymer chemistry (e.g., one ACS Flory Fellowship, two ACS ICI Student Finalists, one ACS DSM Outstanding Graduate Research Award). She has received numerous awards (more than 65) and represents the pinnacle of researchers in her field. She was the youngest individual to be selected among "one of the 100 [chemical] engineers of the modern era" (AIChE). In terms of translating fundamental advances into practical clinical benefits, she was *the* first engineer ever named a Howard Hughes Medical Institute (HHMI) Investigator. Given HHMI's focus on achieving practical advances and developments in the medical field, her unique selection is direct recognition of her ability to couple fundamental polymer chemistry with practical implementation. Notably, she received the 2004 Alan T. Waterman Award, the highest award of the NSF for demonstrated exceptional individual achievement in scientific or engineering research. Her innovative work in the field was recognized by recent election into the National Academy of Inventors, the Arthur C. Cope Scholar Award from the American Chemical Society, James Bailey Award from the Society for Biological Engineering, the mid-Career Award from the Materials Research Society (the first ever award of this type given by the MRS), and singular national awards from AIChE (3 different awards!), the Society for Biomaterials, and the Packard Foundation to name only a few. Prof. Anseth is an elected member of the National Academies of Engineering, Medicine, and Sciences, of which there are fewer than 20 people in history to be elected to all three of these National Academies.

Sincerely,



Daniel K. Schwartz, Ph.D.
Associate Chair, Department of Chemical and Biological Engineering
Glenn L. Murphy Professor of Engineering

KRISTI S. ANSETH
Department of Chemical and Biological Engineering, the Howard Hughes Medical Institute, and the BioFrontiers Institute, University of Colorado, Boulder, Colorado 80303-0596
phone: (303) 492-3147, e-mail: kristi.anseth@colorado.edu Web site: www.Colorado.EDU/ansethgroup/

EDUCATION

Ph.D. in Chemical Engineering, University of Colorado, December 1994.
B.S. in Chemical Engineering (with Highest Distinction), Purdue University, May 1992.

PROFESSIONAL EXPERIENCE

Distinguished Professor. Chemical and Biological Engineering, CU-Boulder, Jan. 2008 to present
Howard Hughes Medical Institute Investigator. Sept. 2005 to August 2017
Tisone Professor. Chemical and Biological Engineering, CU-Boulder, Sept. 2003 to present
Associate Faculty Director. BioFrontiers Institute, CU-Boulder, Nov. 2003 to present
Professor (by courtesy). Chemistry and Biochemistry, CU-Boulder, Mar. 2004 to present
Professor (by courtesy). Molecular, Cellular Developmental Biology, CU-Boulder, Mar. 2004 to present
Professor. Chemical Engineering, CU-Boulder. Aug. 2002 to Aug. 2003
Patten Associate Professor. Chemical Engineering, CU-Boulder. Aug. 1999 to July 2002
Howard Hughes Medical Institute Assistant Investigator. Aug. 2000 to Aug. 2005
Associate Professor. Surgery, University of Colorado Health Sciences Center, Denver. Aug. 2000 to present
Patten Assistant Professor. Chemical Engineering, CU-Boulder. Sept. 1998 to July 1999
Assistant Professor. Chemical Engineering, CU-Boulder. Aug. 1996 to 1998
Research Fellow. Dr. Robert Langer, mentor. MIT, Cambridge, MA. Sept. 1995 to July 1996

SELECTED HONORS AND AWARDS

2016 Wilhelm Lecturer, Princeton University
2016 Honorary Doctorate, Purdue University
2016 Elected to the National Academy of Inventors
2015 American Chemical Society, Arthur C. Cope Scholar Award
2015 Society for Biomaterials, Fellow
2015 Bonfils Stanton Foundation Science and Medicine Prize
2015 Bayer Distinguished Lecture, University of Pittsburgh
2015 Two Genes Memorial Lecture, Northwestern University
2015 Bayer Distinguished Lecture, University of Pittsburgh
2014 Food, Pharmaceutical & Bioengineering Division Award, American Institute of Chemical Engineers
2014 The Alumni Distinguished Lectures in Chemical Engineering, University of Massachusetts at Amherst
2014 Alexander M. Cruickshank Gordon Research Conference Lecturer at the Signal Transduction by Engineered Extracellular Matrices
2014 Ralph Peck Lecture, Illinois Institute of Technology
2014 Katz Lectureship, University of Michigan
2014 Cornelius Pings Lecture, University of Southern California
2013 James E. Bailey Award, Society for Biological Engineering
2013 Elected to the National Academy of Sciences
2013 Hazel Barnes Award, University of Colorado
2013 Visiting Lecturer, National Science Council, Taiwan.
2013 Weinbaum Lecture, Biomedical Engineering, Rensselaer Polytechnic Institute
2012 Mid-Career Research Award, Materials Research Society
2012 Kewaunee Lecture, Duke University
2012 Distinguished Engineering Alumni Award, Purdue University
2012 Colorado Women's Hall of Fame Inductee
2012 University of Colorado's Technology Transfer Office Pinnacle Award
2011 Basore Lecture, Auburn University
2011 Distinguished Research Lecturer, University of Colorado
2010 Wohl Lecture, University of Delaware
2010 Eminent Scholar Lecture, Medical University of South Carolina

2010 Pearson Lecture, University of California at Santa Barbara
2010 Lumpkin Memorial Lecture, University of Maryland Baltimore County
2010 Distinguished Lecture, University of Pittsburgh, McGowan Institute for Regenerative Medicine
2009 Elected to the National Academy of Engineering
2009 Professional Progress Award, American Institute of Chemical Engineers
2009 Fellow, Materials Research Society
2008 Named as one of the 'Brilliant 10' Scientists, *Popular Science*
2008 Ashland Distinguished Lecture Series, University of Kentucky
2008 Named one of the "One Hundred Chemical Engineers of the Modern Era", AIChE
2008 Distinguished Engineering Alumni Award, Research and Teaching, University of Colorado
2008 Zane Staebler Memorial Lecture in Transplant Biology, UCLA
2008 Clemson Award for Basic Research, Society for Biomaterials
2008 Lindsay Lecture Series Distinguished Speaker, Texas A&M University
2007 Britton Chance Distinguished Lecture, University of Pennsylvania
2007 McCabe Lecture, North Carolina State University
2006 Fellow, American Association for the Advancement of Science
2005 Elizabeth Gee Award, University of Colorado
2005 Bayer Distinguished Lectureship, University of Southern Mississippi
2005 Alan S. Michaels Distinguished Lecture in Medical and Biological Engineering, MIT
2004 Alan T. Waterman Award, National Science Foundation
2003 Allan P. Colburn Award, American Institute of Chemical Engineers
2003 Curtis W. McGraw Award, American Society for Engineering Education
2001 American Institute for Medical and Biological Engineering, Fellow
2001 Outstanding Young Investigator Award, Materials Research Society
2000 Camille Dreyfus Teacher-Scholar Award, Dreyfus Foundation
2000 Teaching Excellence Award, Boulder Faculty Assembly
1999 Selected to the Technology Review 100
1999 Dow Outstanding New Faculty Award, American Society for Engineering Education
1998 John and Mercedes Peebles Teaching Innovation Award, College of Engineering
1997 David and Lucile Packard Fellowship for Science and Engineering
1996 Camille and Henry Dreyfus New Faculty Award
1996 Unilever Award, Best PhD Thesis in Polymer Research, American Chemical Society

SELECTED EDITORIAL BOARDS

2015-pres. *Regenerative Engineering and Translational Medicine*, Editorial Board Member
2014-pres. *PNAS*, Editorial Board
2012-pres. *Annual Review of Chemical and Biomolecular Engineering,* Editorial Board
2011-pres. *Progress in Material Science*, Associate Editor
2011-pres. *Acta Materialia*, Governor-at-large
2010-pres. *Biomacromolecules*, Associate Editor
2010-pres. *Biotechnology & Bioengineering,* Associate Editor
2010-pres. *Journal of Heart Valve Disease*, Editorial Board
2007-pres. *Journal of Biomedical Materials Research — Part A (JBMR)*, Editorial Board
2004-2010 *Science,* Board of Reviewing Editors
2004-pres. *Acta Biomaterialia*, Editorial Board

>275 INVITED LECTURES

>340 PRESENTATIONS AT NATIONAL AND INTERNATIONAL MEETINGS

15 ISSUED US PATENTS

> 315 REFEREED PUBLICATIONS

> 29,000 CITATIONS AND AN H-INDEX OF 96 ACCORDING TO GOOGLE SCHOLAR

20 SIGNIFICANT PUBLICATIONS (out of >315 publications cited >29,000 times)

A.M. Rosales and **K.S. Anseth**, "Tuning biology by switching chemistry: capturing extracellular matrix dynamics with reversible hydrogels," *Nature Materials Reviews*, 1, 15012-19 (2016). (Cited 11 times)

K.S. Schultz, K.A. Kyburz and **K.S. Anseth**, "Measuring dynamic cell materials interactions and remodeling during 3D hMSC migration in hydrogels," *PNAS*, 112, E3757-64 (2015). (Cited 18 times)

C. Yang, M.W. Tibbitt, L. Basta and **K.S. Anseth**, "Mechanical memory and dosing influence stem cell fate," *Nature Materials*, 13, 645-652 (2014). (Cited 171 times).

S. Wang, L.A. Leinwand and **K.S. Anseth**, "The cells and their matrix microenvironment in cardiac valves," *Nature Reviews Cardiology*, 11, 715-27 (2014) (Cited 11 times)

M.A. Azagarsamy and **K.S. Anseth**, "Wavelength controlled photo-cleavage of multiple proteins for orthogonal and sequential release," *Angewandte Chemie*, 52, 13803-807 (2013). (Cited 39 times)

H. Wang, M.W. Tibbitt, S.J. Langer, L.A. Leinwand and **K.S. Anseth**," Hydrogels preserve native phenotypes of valvular fibroblasts through an elasticity-regulated PI3K/AKT pathway," *PNAS*, 110, 19336-341 (2013). (Cited 40 times)

M.W. Tibbitt and **K.S. Anseth**, "Dynamic environments: The fourth dimension," *Science Translational Medicine, 4,* 160ps24 (2012). (Cited 56 times)

C.A. DeForest and **K.S. Anseth**, "Photoreversible patterning of biomolecules within click-based hydrogels," *Angewandte Chemie*, *51*, 1816-19 (2012). (Cited 126 times)

C.A. DeForest and **K.S. Anseth**, "Cytocompatible click-based hydrogels with dynamically-tunable properties through orthogonal photoconjugation and photocleavage reactions," *Nature Chemistry*, 3, 925-31 (2011). (Cited 236 times)

C. Lin and **K.S. Anseth**, "Cell-cell communication mimicry with PEG hydrogels for enhancing β–cell function," *PNAS*, 108, 6380-85 (2011). (Cited 96 times)

B.J. Adzima, Y. Tao, C.J. Kloxin, C.A. DeForest, **K.S. Anseth** and C.N. Bowman, "Spatial and Temporal Control of Alkyne—Azide Reaction: Photoinitiated Click Reactions for Synthesis, Polymerization, and Modification," *Nature Chemistry*, *3*, 256-59 (2011). (Cited 166 times)

A.M. Kloxin, M.W. Tibbitt and **K.S. Anseth**, "Synthesis of photodegradable hydrogels as dynamically tunable materials for 2D and 3D cell culture," *Nature Protocols*, 5, 1-21 (2010). (Cited 151 times)

C.A. DeForest, B.D. Polizzotti and **K.S. Anseth**, "Sequential click reactions for synthesizing and patterning 3D cell microenvironments," *Nature Materials*, *8*, 659-64 (2009). (Cited 454 times)

A.M. Kloxin, A.M. Kasko, C.N. Salinas and **K.S. Anseth,** " Photolabile hydrogels for dynamic tuning of physical and chemical properties," *Science*, *324,* 59-63 (2009). (Cited 799 times)

B.D. Fairbanks, T.F. Scott, C.J. Kloxin, **K.S. Anseth** and C.N. Bowman, "Thiol-yne photopolymerizations: Novel mechanism, kinetics and step growth formation of highly crosslinked networks," *Macromolecules, 42,* 211-17 (2009). (Cited 234 times)

B.D. Fairbanks, M.P. Schwartz, A.E. Halevi, C.R. Nuttelman, C.N. Bowman, and **K.S. Anseth**, "A Versatile Synthetic Extracellular Matrix Mimic Via Thiol-Norbornene Photopolymerization," *Advanced Materials, 21,* 5005 - 5010 (2009). (Cited 256 times)

D.S.W. Benoit, M.J Schwartz, A.R. Durney and **K.S. Anseth**, "Small molecule functional groups for the controlled differentiation of human mesenchymal stem cells encapsulated in poly(ethylene glycol) hydrogels," *Nature Materials, 7,* 816 - 823 (2008). (Cited 476 times)

M.C. Cushing and **K.S. Anseth**, "Hydrogel Cell Cultures," *Science*, *316*, 1133-34 (2007). (Cited 358 times)

J.A. Burdick and **K.S. Anseth**, "Photoencapsulation of Osteoblasts in Injectable RGD-Modified PEG Hydrogels for Tissue Engineering," *Biomaterials,* 23, 4315 – 4323 (2002). (Cited 763 times)

S.J. Bryant and and **K.S. Anseth**, "Hydrogel Properties Influence ECM Production by Chondrocytes Photoencapsulated in Poly(Ethylene Glycol) Hydrogels," Journal of Biomedical Materials Research, 59, 63 – 72 (2002). (Cited 570 times)

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY
Departments of Chemical,
Biological and Mechanical Engineering

KOCH INSTITUTE
for Integrative Cancer Research at MIT

imes

Robert Langer
Institute Professor

October 14, 2016

Dear Nominating Committee:

I am very pleased to write a letter in support of Dr. Kristi Anseth's ACS Polymer Chemisty Award.

Kristi is a leading researcher and inventor in the fields of biomaterials and regenerative medicine. She won an NIH proposal in which she ranked in the top 0.1 percentile. She has shown how control of the chemical, biological, and physical properties of biomaterials enables one to probe fundamental cell biology questions and use this information in targeted applications in tissue regeneration. Recognized for blending modern molecular and cellular biology with engineering and quantitative methods to generate the next-generation of biomaterials for cell culture, delivery, and tissue regeneration, her contributions have been translated to include *in situ* forming materials for enhanced bone regeneration (Abbott Laboratories and Bioplant), hydrogels for chondrocyte delivery (Advanced Tissue Sciences, Smith & Nephew, and Cartilix), and materials that promote healing of skin (Mosaic Biosciences). She is ranked 1st among all US bioengineers in highly cited papers in the fields of biomaterial "Hydrogels" (2000-2014).

Kristi has published nearly 300 papers in publications including *Macromolecules*, *Science* and *Nature Biotechnology*, and has written 15 patents. Pioneering new directions in the synthesis of bioresponsive materials that can promote or suppress cell functions towards the goal of engineering tissues, her group was the first to demonstrate the ability to use a photoinitiated polymerization of PEG macromers to encapsulate chondroctyes and successfully regenerate cartilaginous. These gels provided an environment for cell encapsulation. Kristi's group is demonstrating highly controlled reaction mechanisms to create protein and peptide functionalized gels. These biomaterial niches have been demonstrated in controlling the differentiation of human mesenchymal stem cells, increasing survival and insulin secretion of islets studying tumor cell biology, enzyme-responsive drug delivery, and influencing extension of axons from neural precursor cells. She and her collaborators have also developed the premier models that provide the first complete and quantitative analysis of the effects of dynamic changes in microenvironmental properties.

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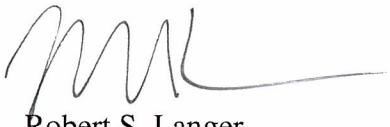
Mailing address: MIT, Room 76-661, 77 Massachusetts Avenue, Cambridge, MA 02139-4307
Telephone: (1) 617-253-3107 Fax: (1) 617-258-8827 E-mail: rlanger@mit.edu
http://web.mit.edu/langerlab

Kristi's dedication has been recognized by honors including election to three US National Academies - the National Academy of Sciences, the National Academy of Engineering and the National Academy of Medicine. *Popular Science* labeled her as one of the "Brilliant 10" of 2008. Kristi's research represents extremely important new directions in the area of biomedical materials. As an ideal candidate for the ACS Polymer Award, I give her my strongest possible recommendation.

Sincerely,



Robert S. Langer

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David A. Tirrell
Ross McCollum – William H. Corcoran Professor
Professor of Chemistry and Chemical Engineering
Director, Beckman Institute

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tirrell@caltech.edu

October 30, 2016

Daniel K. Schwartz
Glenn L. Murphy Professor of Engineering
Department of Chemical & Biological Engineering
University of Colorado
Boulder, CO 80309

Dear Dan:

I'd like to lend my most enthusiastic support to your nomination of Kristi Anseth for ACS Award in Polymer Chemistry. Kristi's contributions to polymer chemistry, to biomaterials science and engineering, and to regenerative medicine and cellular transplantation, have been phenomenal. Kristi has been astonishingly successful in merging fundamental insights in cell and molecular biology with state-of-the-art advances in polymer chemistry to create new matrices for drug delivery, tissue engineering and regenerative medicine. Her experiments have provided fundamentally new modes of attack on problems of enormous fundamental and practical significance.

Kristi combines a thorough knowledge of chemical and engineering principles with an unusually broad awareness of important biomedical problems that are amenable to materials-based solutions. This combination has led her to remarkably creative uses of photopolymerization and other chemistries for fabrication of hydrogels and other polymeric systems for therapeutic applications. Shortly after starting her independent career at Boulder, for example, Kristi and her coworkers were able to demonstrate rapid, photoinitiated crosslinking of methacrylic anhydride monomers related to those previously approved by the FDA for use in treatment of glioblastoma, an aggressive, invariably fatal form of brain cancer. This work required imaginative materials design, careful chemical synthesis, and thorough analysis of crosslinking chemistry in complex geometries relevant to biomaterials applications.

More recently, Kristi has built on her early successes in photopolymerization and photopatterning to prepare promising new polymeric materials for orthopedic tissue engineering and regenerative medicine, and she's defined and explored many of the most critical issues that will determine the ultimate clinical performance of her systems. This work spans fundamental studies of network formation and modification, methods of cellular encapsulation, effects of network structure on the behavior of encapsulated cells

(including attachment and matrix deposition), controlled release behavior, kinetics of polymer degradation, and reversible introduction of signaling molecules with excellent spatial and temporal control. I believe it's fair to say that there is *no one* else working in polymeric biomaterials who is addressing such a broad range of issues so effectively, or who has had more influence on the field in recent years. It would be great to see Kristi's contributions recognized by the ACS Award in Polymer Chemistry.

Best regards,

David A. Tirrell
Ross McCollum – William H. Corcoran Professor
Professor of Chemistry and Chemical Engineering
Director, Beckman Institute