

Stanford



Eric Appel

Assistant Professor of Materials Science and Engineering and, by courtesy, of Bioengineering and of Pediatrics (Endocrinology)

Materials Science and Engineering

Bio

BIO

Eric A. Appel is an Assistant Professor of Materials Science & Engineering at Stanford University. He received his BS in Chemistry and MS in Polymer Science from Cal Poly, San Luis Obispo. Eric performed his MS thesis research with Robert D. Miller and James L. Hedrick at the IBM Almaden Research Center in San Jose, CA. He then obtained his PhD in Chemistry working in the lab of Dr. Oren A. Scherman in the Melville Laboratory for Polymer Synthesis at the University of Cambridge. His PhD research focused on the preparation of dynamic and stimuli-responsive supramolecular polymeric materials. For his PhD work, Eric was the recipient of the Jon Weaver PhD prize from the Royal Society of Chemistry and a Graduate Student Award from the Materials Research Society. Upon graduating from Cambridge in 2012, he was awarded a National Research Service Award from the NIH (NIBIB) and pursued a Wellcome Trust Postdoctoral Fellowship at MIT working with Robert S. Langer on the development of supramolecular biomaterials for drug delivery and tissue engineering. During his post-doctoral work, he received a Margaret A. Cunningham Immune Mechanisms in Cancer Research Award. He recently received a Terman Faculty Fellowship from the School of Engineering at Stanford University.

ACADEMIC APPOINTMENTS

- Assistant Professor, Materials Science and Engineering
- Assistant Professor (By courtesy), Bioengineering
- Assistant Professor (By courtesy), Pediatrics - Endocrinology and Diabetes
- Member, Bio-X
- Member, Cardiovascular Institute
- Member, Maternal & Child Health Research Institute (MCHRI)
- Faculty Fellow, Stanford ChEM-H

HONORS AND AWARDS

- Junior Faculty Development Award, American Diabetes Association (2018-2022)
- Hellman Faculty Fellowship, Hellman Fellows Fund (2016-2017)
- PhRMA Research Starter Grant, PhRMA Foundation (2016-2017)
- Margaret A. Cunningham Immune Mechanisms in Cancer Research Award, Proctor Foundation (2015-2016)
- Wellcome Trust Fellowship, Wellcome Trust (2013-2017)
- National Research Service Award, National Institute of Biomedical Imaging and Bioengineering (2013-2016)
- Graduate Student Award, Materials Research Society (2012)
- Jon Weaver PhD Prize, Royal Society of Chemistry of the United Kingdom (2013)

PROFESSIONAL EDUCATION

- Postdoc, MIT , Bioengineering
- Ph.D., University of Cambridge , Chemistry (2012)
- M.S., Cal Poly, SLO , Polymer Science (2008)
- B.S., Cal Poly, SLO , Chemistry (2008)

PATENTS

- E.A. Appel. "United States Methods of producing moldable hydrogels and uses thereof", Leland Stanford Junior University
- E.A. Appel, J.Y. Woo, L.M. Stapleton. "United States Adhesion Prevention with Shear-thinning Polymeric Hydrogels", Leland Stanford Junior University
- Eric Appel. "United States Co-formulation of Amylin Analogues with Insulin Analogues", E.A. Appel, B. Buckingham, D. Maahs, C. Maikawa, G. Agmon
- J.L. Hedrick, E.A. Appel, R.D. Miller, F. Nederberg, R.M. Waymouth. "United States Methods for Making Multi-Branched Polymers", Leland Stanford Junior University
- E.A. Appel, J.L. Hedrick, V.Y. Lee, R.D. Miller, J. Sly. "United States Star Polymers, Methods of Preparation Thereof, and Uses Thereof", IBM
- M.J. Webber, E.A. Appel, R. Langer, D.G. Anderson. "United States Supramolecular Modification of Proteins", Massachusetts Institute of Technology
- O.A. Scherman, E.A. Appel, X.J. Loh, F. Biedermann, M. Rowland. "United Kingdom Cucurbituril-Based Hydrogels", Cambridge Enterprises Limited
- E.A. Appel, M.W. Tibbitt, R. Langer. "United States Shear-thinning Self-healing Networks", Massachusetts Institute of Technology
- E. Abo-Hamed, O.A. Scherman, E.A. Appel. "United Kingdom Hydrogen Storage and Catalysts", The inventors
- Y. Dong, W. Wang, E.A. Appel, B.C. Tang, M.J. Webber, O. Veiseh, K. Xue, R. Langer, D.G. Anderson. "United States Polymers, Hydrogels, and Uses Thereof", Massachusetts Institute of Technology
- O.A. Scherman, E.A. Appel, T.L. Hughes. "United States Viscous Wellbore Fluids", Schlumberger Technology Corp

LINKS

- Lab Site: supramolecularbiomaterials.com
- LinkedIn: <https://www.linkedin.com/in/eric-appel-29203111>

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

The underlying theme of the Appel Lab at Stanford University integrates concepts and approaches from supramolecular chemistry, natural/synthetic materials, and biology. We aim to develop supramolecular biomaterials that exploit a diverse design toolbox and take advantage of the beautiful synergism between physical properties, aesthetics, and low energy consumption typical of natural systems. Our vision is to use these materials to solve fundamental biological questions and to engineer advanced healthcare solutions.

Teaching

COURSES

2019-20

- Biomaterials for Drug Delivery: BIOE 385, MATSCI 385 (Aut)
- Materials Science Colloquium: MATSCI 230 (Aut, Win, Spr)
- Organic and Biological Materials: MATSCI 190, MATSCI 210 (Spr)
- Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life: BIOE 158, MATSCI 158 (Win)

2018-19

- Materials Science Colloquium: MATSCI 230 (Aut, Win, Spr)

- Organic and Biological Materials: MATSCI 190, MATSCI 210 (Spr)
- Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life: BIOE 158, CHEMENG 160, MATSCI 158 (Win)

2017-18

- Materials Science Colloquium: MATSCI 230 (Win, Spr)
- Organic and Biological Materials: MATSCI 190, MATSCI 210 (Spr)
- Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life: BIOE 158, CHEMENG 160, MATSCI 158 (Win)

2016-17

- Materials Science Colloquium: MATSCI 230 (Win, Spr)
- Organic and Biological Materials: MATSCI 190, MATSCI 210 (Spr)
- Soft Matter in Biomedical Devices, Microelectronics, and Everyday Life: BIOE 158, CHEMENG 160, MATSCI 158 (Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Camila Arantxa Cendra Guinassi, Aadithya Kannan, Chris Lindsay, Aliyeh Mousavi, Lyndsay Stapleton, Riley Suhar

Postdoctoral Faculty Sponsor

Santiago Correa, Hector Lopez

Doctoral Dissertation Advisor (AC)

Gillie Agmon, Doreen Chan, Emily Gale, Abby Grosskopf, Celine Liong, Caitlin Maikawa, Joseph Mann, Catie Meis, Anthony Yu

Master's Program Advisor

Kushagra Agarwal, Esteban Baeza Ruz, Ziheng Cao, Ziqi Wang, Jihan Zhuang

Doctoral Dissertation Co-Advisor (AC)

Huada Lian

Postdoctoral Research Mentor

Santiago Correa, Hector Lopez

Doctoral (Program)

Rachel Huang, Catie Meis, Louis Wang, Felipe de Quesada

Publications

PUBLICATIONS

- **Wildfire prevention through prophylactic treatment of high-risk landscapes using viscoelastic retardant fluids.** *Proceedings of the National Academy of Sciences of the United States of America*
Yu, A. C., Lopez Hernandez, H., Kim, A. H., Stapleton, L. M., Brand, R. J., Mellor, E. T., Bauer, C. P., McCurdy, G. D., Wolff, A. J., Chan, D., Criddle, C. S., Acosta, J. D., Appel, et al
2019
- **Use of a supramolecular polymeric hydrogel as an effective post-operative pericardial adhesion barrier.** *Nature biomedical engineering*
Stapleton, L. M., Steele, A. N., Wang, H., Lopez Hernandez, H., Yu, A. C., Paulsen, M. J., Smith, A. A., Roth, G. A., Thakore, A. D., Lucian, H. J., Totherow, K. P., Baker, S. W., Tada, et al
2019; 3 (8): 611–20
- **Supramolecular polymeric biomaterials.** *Biomaterials science*
Mann, J. L., Yu, A. C., Agmon, G., Appel, E. A.
2017

- **A Multiscale Model for Solute Diffusion in Hydrogels.** *Macromolecules*
Axpe, E., Chan, D., Offeddu, G. S., Chang, Y., Merida, D., Hernandez, H. L., Appel, E. A.
2019; 52 (18): 6889–97
- **Block copolymer composition drives function of self-assembled nanoparticles for delivery of small-molecule cargo** *JOURNAL OF POLYMER SCIENCE PART A-POLYMER CHEMISTRY*
Maikawa, C. L., Sevit, A., Lin, B., Wallstrom, R. J., Mann, J. L., Yu, A. C., Waymouth, R. M., Appel, E. A.
2019; 57 (12): 1322–32
- **A Biocompatible Therapeutic Catheter-Deliverable Hydrogel for In Situ Tissue Engineering** *ADVANCED HEALTHCARE MATERIALS*
Steele, A. N., Stapleton, L. M., Farry, J. M., Lucian, H. J., Paulsen, M. J., Eskandari, A., Hironaka, C. E., Thakore, A. D., Wang, H., Yu, A. C., Chan, D., Appel, E. A., Woo, et al
2019; 8 (5)
- **A Biocompatible Therapeutic Catheter-Deliverable Hydrogel for In Situ Tissue Engineering.** *Advanced healthcare materials*
Steele, A. N., Stapleton, L. M., Farry, J. M., Lucian, H. J., Paulsen, M. J., Eskandari, A., Hironaka, C. E., Thakore, A. D., Wang, H., Yu, A. C., Chan, D., Appel, E. A., Woo, et al
2019: e1801147
- **Non-Newtonian Polymer-Nanoparticle Hydrogels Enhance Cell Viability during Injection** *MACROMOLECULAR BIOSCIENCE*
Hernandez, H., Grosskopf, A. K., Stapleton, L. M., Agmon, G., Appel, E. A.
2019; 19 (1)
- **Non-Newtonian Polymer-Nanoparticle Hydrogels Enhance Cell Viability during Injection.** *Macromolecular bioscience*
Lopez Hernandez, H., Grosskopf, A. K., Stapleton, L. M., Agmon, G., Appel, E. A.
2018: e1800275
- **Self-assembled biomaterials using host-guest interactions** *SELF-ASSEMBLING BIOMATERIALS: MOLECULAR DESIGN, CHARACTERIZATION AND APPLICATION IN BIOLOGY AND MEDICINE*
Yu, A. C., Stapleton, L. M., Mann, J. L., Appel, E. A., Azevedo, H. S., DaSilva, R. M.
2018: 205–31
- **Engineering the Mechanical Properties of Polymer Networks with Precise Doping of Primary Defects.** *ACS applied materials & interfaces*
Chan, D., Ding, Y., Dauskardt, R. H., Appel, E. A.
2017
- **Decoupled Associative and Dissociative Processes in Strong yet Highly Dynamic Host-Guest Complexes** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*
Appel, E. A., Biedermann, F., Hoogland, D., del Barrio, J., Driscoll, M. D., Hay, S., Wales, D. J., Scherman, O. A.
2017; 139 (37): 12985–93
- **Mixed Reversible Covalent Crosslink Kinetics Enable Precise, Hierarchical Mechanical Tuning of Hydrogel Networks** *ADVANCED MATERIALS*
Yesilyurt, V., Ayoob, A. M., Appel, E. A., Borenstein, J. T., Langer, R., Anderson, D. G.
2017; 29 (19)
- **Single-Chain Polymeric Nanocarriers: A Platform for Determining Structure-Function Correlations in the Delivery of Molecular Cargo** *BIOMACROMOLECULES*
Chan, D., Yu, A. C., Appel, E. A.
2017; 18 (4): 1434-1439
- **Engineering the Mechanical Properties of Polymer Networks with Precise Doping of Primary Defects** *ACS Applied Materials and Interfaces*
Chan, D., Ding, Y., Dauskardt, R., Appel, E. A.
2017; 9: 42217-42224
- **Mechanistic understanding of in vivo protein corona formation on polymeric nanoparticles and impact on pharmacokinetics.** *Nature communications*
Bertrand, N., Grenier, P., Mahmoudi, M., Lima, E. M., Appel, E. A., Dormont, F., Lim, J. M., Karnik, R., Langer, R., Farokhzad, O. C.
2017; 8 (1): 777
- **Synthesis and Biological Evaluation of Ionizable Lipid Materials for the In Vivo Delivery of Messenger RNA to B Lymphocytes** *Advanced Materials*
Fenton, O. S., et al

2017; 29: e1606944

- **Distinguishing the Respective Mechanical Contributions of Polymer and Supramolecular Dynamics in Transiently Crosslinked Polymeric Networks** *Polymer Chemistry*
Tan, C. S., Agmon, G., Hoogland, D., Janecek, E., Toprakcioglu, C., Appel, E. A., Scherman, O. A.
2017; 8: 5336-5343
- **Decoupled Associative and Dissociative Processes in Strong yet Highly Dynamic Host-Guest Complexes** *Journal of the American Chemical Society*
Appel, E. A., Biedermann, F., Driscoll, M. D., Hay, S., Wales, D. J., Scherman, O. A.
2017; 139: 12985-12993
- **Supramolecular Polymeric Biomaterials** *Biomaterials Science*
Mann, J. L., Yu, A. C., Agmon, G., Appel, E. A.
2017; 6: 10-37
- **Mechanistic understanding of in vivo protein corona formation on polymeric nanoparticles and impact on pharmacokinetics** *Nature Communication*
Bertrand, N., et al
2017; 8: e777
- **Supramolecular PEGylation of biopharmaceuticals** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Webber, M. J., Appel, E. A., Vinciguerra, B., Cortinas, A. B., Thapa, L. S., Jhunjhunwala, S., Isaacs, L., Langer, R., Anderson, D. G.
2016; 113 (50): 14189-14194
- **Scalable manufacturing of biomimetic moldable hydrogels for industrial applications** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Yu, A. C., Chen, H., Chan, D., Agmon, G., Stapleton, L. M., Sevit, A. M., Tibbitt, M. W., Acosta, J. D., Zhang, T., Franzia, P. W., Langer, R., Appel, E. A.
2016; 113 (50): 14255-14260
- **Injectable and Glucose-Responsive Hydrogels Based on Boronic Acid-Glucose Complexation** *LANGMUIR*
Dong, Y., Wang, W., Veiseh, O., Appel, E. A., Xue, K., Webber, M. J., Tang, B. C., Yang, X., Weir, G. C., Langer, R., Anderson, D. G.
2016; 32 (34): 8743-8747
- **Bioinspired Alkenyl Amino Alcohol Ionizable Lipid Materials for Highly Potent In Vivo mRNA Delivery** *ADVANCED MATERIALS*
Fenton, O. S., Kauffman, K. J., McClellan, R. L., Appel, E. A., Dorkin, J. R., Tibbitt, M. W., Heartlein, M. W., DeRosa, F., Langer, R., Anderson, D. G.
2016; 28 (15): 2939-2943
- **Supramolecular biomaterials** *NATURE MATERIALS*
Webber, M. J., Appel, E. A., Meijer, E. W., Langer, R.
2016; 15 (1): 13-26
- **Injectable Self-Healing Glucose Responsive Hydrogels with pH-Regulated Mechanical Properties** *Advanced Materials*
Yesilyurt, V., Webber, M. J., Appel, E. A., Godwin, C., Langer, R., Anderson, D. G.
2016; 28: 86-91
- **Water soluble, biodegradable amphiphilic polymeric nanoparticles and the molecular environment of hydrophobic encapsulates: Consistency between simulation and experiment** *POLYMER*
Miller, R. D., Yusoff, R. M., Swope, W. C., Rice, J. E., Carr, A. C., Parker, A. J., Sly, J., Appel, E. A., Nguyen, T., Piunova, V.
2015; 79: 255-261
- **Formation of Cucurbit[8]uril-Based Supramolecular Hydrogel Beads Using Droplet-Based Microfluidics** *BIOMACROMOLECULES*
Xu, X., Appel, E. A., Liu, X., Parker, R. M., Scherman, O. A., Abell, C.
2015; 16 (9): 2743-2749
- **Exploiting Electrostatic Interactions in Polymer-Nanoparticle Hydrogels** *ACS MACRO LETTERS*
Appel, E. A., Tibbitt, M. W., Greer, J. M., Fenton, O. S., Kreuels, K., Anderson, D. G., Langer, R.
2015; 4 (8): 848-852
- **A Facile Method for the Stain-Free Visualization of Hierarchical Structures with Electron Microscopy** *JOURNAL OF POLYMER SCIENCE PART A-POLYMER CHEMISTRY*
Williams, P. E., Appel, E. A., Jones, S. T., del Barrio, J., Lan, Y., Scherman, O. A.

2015; 53 (7): 842-845

- **Non-Cell-Adhesive Substrates for Printing of Arrayed Biomaterials** *ADVANCED HEALTHCARE MATERIALS*
Appel, E. A., Larson, B. L., Luly, K. M., Kim, J. D., Langer, R.
2015; 4 (4): 501-505
- **Self-Assembled Hydrogels Utilising Polymer-Nanoparticle Interactions** *Nature Communications*
Appel, E. A., Tibbitt, M. W., Webber, M. J., Mattix, B. A., Veiseh, O., Langer, R.
2015; 6: e6295
- **The control of cargo release from physically crosslinked hydrogels by crosslink dynamics** *BIOMATERIALS*
Appel, E. A., Forster, R. A., Rowland, M. J., Scherman, O. A.
2014; 35 (37): 9897-9903
- **GLUING GELS A nanoparticle solution** *NATURE MATERIALS*
Appel, E. A., Scherman, O. A.
2014; 13 (3): 231-232
- **Activation Energies Control Macroscopic Properties of Supramolecular Crosslinked Materials** *Angewandte Chemie International Edition*
Appel, E. A., Forster, R. A., Koutsoumpas, A., Scherman, O. A.
2014; 53: 10038-10043
- **Rapidly Healable, Temporally Stable and Stiff Hydrogels: Combining Conflicting Properties Using Highly Dynamic and Selective Three-Component Recognition with Reinforcing Cellulose Nanorods** *Advanced Functional Materials*
Jason, M., Appel, E. A., Seitsonen, J., Kontturi, E., Scherman, O. A., Ikkala, O.
2014; 24: 2706-2713
- **Dynamically crosslinked materials via recognition of amino acids by cucurbit[8]uril** *JOURNAL OF MATERIALS CHEMISTRY B*
Rowland, M. J., Appel, E. A., Coulston, R. J., Scherman, O. A.
2013; 1 (23): 2904-2910
- **Triggered insulin release studies of triply responsive supramolecular micelles** *POLYMER CHEMISTRY*
Loh, X. J., Tsai, M., del Barrio, J., Appel, E. A., Lee, T., Scherman, O. A.
2012; 3 (11): 3180-3188
- **Ultra-High Water-Content Hydrogels from Renewable Resources Exhibiting Multi-Stimuli Responsiveness** *J. Am. Chem. Soc.*
Appel, E. A., Loh, X., Jones, S. T., Biedermann, F., Dreiss, C. A., Scherman, O. A.
2012; 134: 11767-11773
- **Triply Triggered Doxorubicin Release From Supramolecular Nanocontainers** *BIOMACROMOLECULES*
Loh, X. J., del Barrio, J., Toh, P. P., Lee, T., Jiao, D., Rauwald, U., Appel, E. A., Scherman, O. A.
2012; 13 (1): 84-91
- **Toward biodegradable nanogel star polymers via organocatalytic ROP** *CHEMICAL COMMUNICATIONS*
Appel, E. A., Lee, V. Y., Nguyen, T. T., McNeil, M., Nederberg, F., Hedrick, J. L., Swope, W. C., Rice, J. E., Miller, R. D., Sly, J.
2012; 48 (49): 6163-6165
- **High Molecular Weight Polyacrylamides by ATRP: Enabling Advancements in Water-based Applications** *J. Poly. Sci. Part A: Polym. Chem.*
Appel, E. A., del Barrio, J., Loh, X., Dyson, J., Scherman, O. A.
2012; 50: 181-186
- **Metastable single-chain polymer nanoparticles prepared by dynamic cross-linking with nor-seco-cucurbit[10]uril** *CHEMICAL SCIENCE*
Appel, E. A., del Barrio, J., Dyson, J., Isaacs, L., Scherman, O. A.
2012; 3 (7): 2278-2281
- **Enhanced Stability and Activity of Temozolomide in Primary GBM Cells with Cucurbit[n]uril** *Chemical Communications*
Appel, E. A., Rowland, M. J., Loh, X., Heywood, R. M., Watts, C., Scherman, O. A.
2012: 9843-9845
- **Supramolecular polymeric hydrogels** *CHEMICAL SOCIETY REVIEWS*
Appel, E. A., del Barrio, J., Loh, X. J., Scherman, O. A.

2012; 41 (18): 6195-6214

- **Formation of Single-Chain Polymer Nanoparticles in Water through Host-Guest Interactions** *ANGEWANDTE CHEMIE-INTERNATIONAL EDITION*
Appel, E. A., Dyson, J., del Barrio, J., Walsh, Z., Scherman, O. A.
2012; 51 (17): 4185-4189
- **Sustained Release of Proteins from a High-Water-Content Supramolecular Polymer Hydrogel** *Biomaterials*
Appel, E. A., Loh, X., Jones, S. T., Dreiss, C. A., Scherman, O. A.
2012; 33: 4646-4652
- **Postpolymerization Modification of Hydroxyl-Functionalized Polymers with Isocyanates** *MACROMOLECULES*
Biedermann, F., Appel, E. A., del Barrio, J., Gruendling, T., Barner-Kowollik, C., Scherman, O. A.
2011; 44 (12): 4828-4835
- **Supramolecular gold nanoparticle-polymer composites formed in water with cucurbit[8]uril** *CHEMICAL COMMUNICATIONS*
Coulston, R. J., Jones, S. T., Lee, T., Appel, E. A., Scherman, O. A.
2011; 47 (1): 164-166
- **Supramolecular Cross-Linked Networks via Host-Guest Complexation with Cucurbit[8]uril** *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY*
Appel, E. A., Biedermann, F., Rauwald, U., Jones, S. T., Zayed, J. M., Scherman, O. A.
2010; 132 (40): 14251-14260
- **Hierarchical Supermolecular Structures for Sustained Drug Release** *SMALL*
Tan, J. P., Kim, S. H., Nederberg, F., Appel, E. A., Waymouth, R. M., Zhang, Y., Hedrick, J. L., Yang, Y. Y.
2009; 5 (13): 1504-1507
- **Simple Approach to Stabilized Micelles Employing Miktoarm Terpolymers and Stereocomplexes with Application in Paclitaxel Delivery** *BIOMACROMOLECULES*
Nederberg, F., Appel, E., Tan, J. P., Kim, S. H., Fukushima, K., Sly, J., Miller, R. D., Waymouth, R. M., Yang, Y. Y., Hedrick, J. L.
2009; 10 (6): 1460-1468