THE MATERIALS SCIENCE AND ENGINEERING DEPARTMENT
FALL COLLOQUIUM SERIES PRESENTS:

Dow Lecture

Professor Eric Appel

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Stanford University

Dynamic Biomaterials Enabling Innovations in Cell and Drug Delivery

Dynamic biomaterials exhibit highly useful properties that are impossible with traditional materials but crucial for a wide variety of emerging applications in biomedicine. These materials typically employ enthalpy-dominated crosslinking interactions that become weaker at elevated temperatures, leading to significant softening. Herein, we will discuss the development of a physical hydrogel platform exploiting dynamic and multivalent interactions between biopolymers and nanoparticles that are strongly entropically driven, providing alternative temperature dependencies than typical for materials of this type. We will discuss the implications of these crosslinking thermodynamics on the observed mechanical properties and discuss the desired mechanical properties for injectability, including viscous flow under shear stress (shear-thinning) and rapid recovery of mechanical properties when the applied stress is relaxed (self-healing). Moreover, the hierarchical construction of these biphasic hydrogels enables innovative approaches to formulation and delivery of a diverse array of compounds over user-defined timeframes ranging from days to months. In one example application, we demonstrate that these unique material characteristics can be leveraged for controlled locoregional exposure of immunomodulatory cargo to greatly enhance anti-cancer immune responses. In another example, we demonstrate that the dynamic structure of these materials can be leveraged for co-delivery of immunostimulatory cytokines and CAR-T cells to improve cancer treatments. Overall, this talk will illustrate our recent efforts exploiting dynamic and multivalent interactions between polymers and nanoparticles to generate injectable hydrogel depot technologies exhibiting properties not previously observed in biomaterials and affording unique opportunities in biomedicine.

Eric A. Appel is an Associate Professor of Materials Science & Engineering at Stanford University. He received his BS in Chemistry and MS in Polymer Science from California Polytechnic State University in San Luis Obispo, CA. Eric performed his MS thesis research with Dr Jim Hedrick and Dr Robert Miller at the IBM Almaden Research Center in San Jose, CA. He then obtained his PhD in Chemistry with Prof. Oren A. Scherman at the University of Cambridge. Upon graduating from Cambridge, he was awarded a National Research Service Award from the NIBIB and a Wellcome Trust Postdoctoral Fellowship to work with Prof. Robert Langer at MIT. Eric's research at Stanford focuses on the development of biomimetic polymeric materials that can be used as tools to better understand fundamental biological processes and to engineer advanced healthcare solutions. His research has led to 150 publications, over 40 patents, and formed the basis for four start-up companies. He has been awarded young faculty awards from the Hellman Foundation, American Diabetes Association, American Cancer Society, and PhRMA Foundation. Eric received the IUPAC Hanwha-TotalEnergies Young Polymer Scientist Award in 2022, the Society for Biomaterials Young Investigator Award in 2023, and the Biomaterials Science Lectureship Award in 2023. In 2024, he was named a Fellow of the American Institute for Medical & Biological Engineers, and he was recently awarded the Kathryn C. Hach Award for Entrepreneurial Success from the American Chemical Society.

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In person only; no Zoom

Questions? Contact allison.macknick@northwestern.edu

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