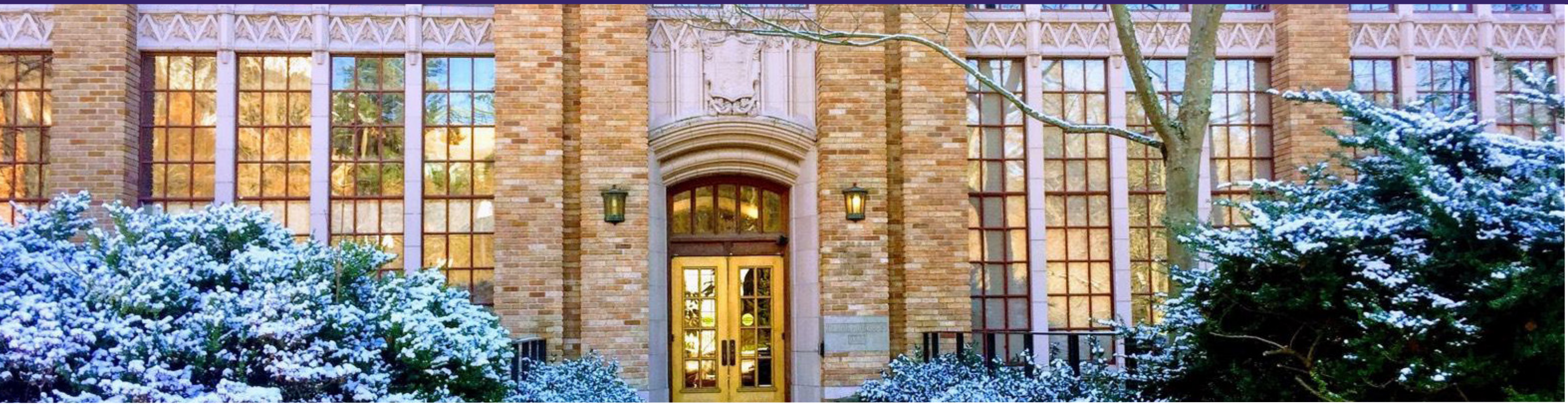
MSE SPECIAL SEMINAR

MATERIALS SCIENCE & ENGINEERING

THURSDAY, MARCH 15, 2018 | 153 MUELLER HALL | 3:30 PM



Autonomous Detection of Mechanical Damage and Self-Healing

Materials are susceptible to damage in the form of small cracks, which are often difficult to detect. Even at small scales, crack damage can significantly compromise the integrity and functionality of polymeric materials. Damage to protective coatings on metal substrates initiates corrosion undercutting and other forms of environmental degradation. Barely visible impact damage of composite materials leads to significant decrease in mechanical performance. The ability to enhance the detection of small-scale damage prior to catastrophic material failure is important for improving the safety and reliability of critical components, while simultaneously reducing life cycle costs associated with regular maintenance and inspection. In this talk, a simple, robust, and sensitive mechanochromic approach for autonomous indication of damage in polymeric and composite materials will be described. Fluorogenic and chromogenic components are incorporated into material matrices via core-shell microcapsules. With this detection scheme, mechanical damage triggers rapid generation of a local fluorescence signal or a color change that is easily visualized and provides excellent contrast between intact and damaged regions of a material. The general indication mechanism enables the unaided detection of damage less than 2 microns in size in a wide variety of materials prepared using diverse fabrication methods. For internal microcracks in polymers, photoacoustic probes are exploited to achieve damage detection with centimeter penetration. By synergistically integrating the detection ability into a self-healing material, the autonomous performance restoration is revealed in real-time, providing a powerful tool for assessing the material integrity.

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Dr. Wenle Li received his Ph.D. in Materials Science and Engineering from Virginia Tech in 2012, and then held a postdoctoral position in the Department of Chemical Engineering. Since 2014, he has been working with Prof. Nancy Sottos and Prof. Scott White at the University of Illinois at Urbana-Champaign as a Postdoctoral Research Associate. His research interests encompass advanced inorganic porous materials, colloidal assembly, interfacial science, and the development of smart composite materials with autonomous functionalities, such as self-reporting and self-healing materials. His studies have been featured on journal covers (e.g., Advanced Materials and ACS Central Science), Nature Reviews Materials, and broader publications such as Chemical & Engineering News. In 2016, his work on Autonomous Damage Indication fought off stiff competition to win the Oil and Gas Award at the IChemE Global Awards.

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