PRINCETON
Mechanical & Aerospace Engineering

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Maeder Hall, ACEE
3:30 PM

Materials by Design:
3-Dimensional Nano-Architected Meta-Materials

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Creation of extremely strong yet ultra-light materials can be achieved by capitalizing on the hierarchical design of 3-dimensional nano-architectures. Such structural meta- materials exhibit superior thermal, photonic, electrochemical, and mechanical proper- ties at extremely low mass densities (lighter than aerogels), rendering them ideal for many scientific and technological applications. The dominant properties of such "meta-materials", where individual constituent size (atoms to nanometers to microns) is comparable to the characteristic microstructural length scale of the constituent solid, are largely unknown because of their truly multi-scale nature. To harness the beneficial properties of 3-dimensional nano-architecter meta-materials, it is critical to assess properties at each relevant scale while capturing the overall structural complexity.

We fabricate 3-dimensional nano-architectures (i.e. nanolattices) whose constituents vary in size from several nanometers to tens of microns to millimeters and centimeters. We discuss the deformation, as well as mechanical, chemical, and photonic properties of a range of nano-sized solids with different microstructures deformed in an in-situ nanomechanical instrument. Attention is focused on the interplay between the internal critical microstructural length scale of materials and their external limitations in revealing the physical mechanisms that govern these properties, where competing material- and structure-induced size effects drive overall response.. Specific discussion topics include: fabrication and characterization of (often hierarchical) 3-dimensional nano-architected meta-materials for applications in chemical and biological sensors, ultra lightweight energy storage systems, damage- tolerant fabrics, and photonic crystals.

Greer's research focuses on creating 3-dimensional nano-architectures and designing experiments to assess their properties. These architected meta-materials have multiple applications as biomedical devices, battery electrodes, and lightweight structural materials and provide a rich "playground" for fundamental science. Greer has S.B. in Chemical Engineering (minor in Advanced Music Performance) from MIT in 1997, Ph.D. in Materials Science from Stanford, worked at Intel (2000-03) and was a post-doc at PARC (2005-07). Julia joined Caltech in 2007 and has appointments in Materials Science, Mechanical Engineering, and Medical Engineering.

Greer has over 100 publications; she was recently named a National Security Science and Engineering Faculty Fellow (2016), was selected as a Midwest Mechanics lecturer (2015), and her work was recognized among Top 10 Breakthrough Technologies by MIT's Technology Review (2015). She was a Gilbreth Lecturer at the National Academy of Engineering (2015), is a Young Global Leader by World Economic Forum (2014) and is a recipient of multiple awards: Kavli Early Career (2014), Nano Letters Young Investigator Lectureship (2013), Society of Engineering Science Young Investigator (2013), TMS Early Career Faculty (2013), NASA Early Career Faculty (2012), Popular Mechanics Breakthrough Award (2012), ASME Early Career (2011), DOE Early Career (2011), TMS's Young Leaders (2010), DARPA's Young Faculty (2009), Technology Review's TR-35, (2008), and NSF's CAREER (2007). Greer serves as an Associated Editor of Nano Letters and on the Board of Reviewing Editors for Science. She is also a concert pianist, with recent performances of "nanomechanics rap" with MUSE/IQUE, solo piano recitals and chamber concerts (2007-present), and as a soloist of Brahms Concerto No. 2 with Redwood Symphony (2006).

Social Period outside of Maeder Hall following the seminar

ALL VISITORS ARE WELCOME