UNIVERSITY OF CALIFORNIA, IRVINE

THE DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Is Proud to Host a Seminar by:

ASST. PROFESSOR SUNG HOON KANG

Dept. of Mechanical Engineering

Johns Hopkins University

Thursday, October 6, 2022

2:00-3:20 PM

Location: McDonnell Douglas Engineering Auditorium

BIO-INSPIRED MATERIALS WITH SELF-ADAPTABLE MECHANICAL BEHAVIORS AND ARCHITECTED MATERIALS WITH EXTREME ENERGY ABSORPTION & DEEP SUBWAVELENGTH SOUND ABSORPTION

Abstract: I will present our ongoing efforts to synthesize and manufacture novel materials and structures guided by mechanics and numerical modeling and/or enabled by 3D printing. First, I will present a material system that triggers mineral deposition from ionic solutions on scaffolds upon mechanical loadings so that it can self-adapt to mechanical loadings inspired by bone [1]. For example, the mineralization rate could be modulated by controlling the loading condition and a 30-180% increase in the modulus of the material was observed upon cyclic loadings whose range and rate of the property change could be modulated by varying the loading condition. Moreover, our preliminary results showed that the material system showed a decrease in crack propagation speed by ~90%, resulting in significantly improved fatigue lifetime from its damage mitigation mechanism. We envision that our findings open new strategies for making synthetic materials with self-adaptable mechanical properties. Second, I will present architected materials (or metamaterials) with extreme energy dissipation and improving energy absorption with increasing strain rate [2]. We utilize energy dissipation mechanisms across different length scales by utilizing architected liquid crystalline elastomers. As a result, our energy-absorbing materials show about an order of magnitude higher energy absorption density at quasi-static condition compared with the previous studies and even higher energy dissipation at faster strain rates with power-law relation, whose exponent can be tuned. We also found that we can further enhance the energy absorption density by vertical stacking from the synergy of nonlinear behaviors of materials and structures. The findings from our study can be beneficial for various applications, including aerospace, automotive, and personal protection. Third, I will present architected materials absorbing deep subwavelength sounds with tunable frequency ranges [3]. The acoustic meta-absorber couples thermo-viscous loss with resonance loss through 3D-printed Moiré cavity grating. The coupled Moiré grating has a deep subwavelength (thickness/wavelength~0.002-0.015) and shows high sound absorption coefficient (SAC) within 400–4,500 Hz with peak SAC of 0.7-1. Acoustic simulations showed its excellent sound absorption performance is attributed to both scattering-induced localization and transverse directional local resonance. Compared with current sound-absorbing materials, the Moiré grating requires one to two orders of magnitudes lower thickness and covers a wider range of frequency. Furthermore, it can be rolled, bent and stretched while maintaining its sound absorption performance through cuts (Kirigami). Thus, it can find applications in various environments such as automotive, airplanes, home, hospitals and factories.

Bio: Sung Hoon Kang is an Assistant Professor in the Department of Mechanical Engineering at Johns Hopkins University. He earned a Ph.D. degree in Applied Physics at Harvard University and M.S. and B.S. degrees in Materials Science and Engineering from MIT and Seoul National University, respectively. Sung Hoon has been investigating solutions to address current challenges in engineering materials, structures and devices with applications including resiliency, sensing, energy, and healthcare. In particular, he investigates synthesis and manufacturing of materials and structures with novel properties based on principles of mechanics and physics and tools such as numerical modeling, 3D printing, 3D structural/material/mechanical characterizations, and *in vitro/in vivo* testing. His research has been supported by AFOSR, NSF, NIH, ARO, ONR, State of Maryland, and private foundations. Throughout his career, Sung Hoon has co-authored 58 papers, has given ~170 presentations (including >100 invited talks), and has six patents and five pending patents. His honors include 2022 Hanwha Non-Tenured Faculty Award, Invitee for 2022 U.S.-Africa Frontiers of Science, Engineering, and Medicine Symposium, 2021, 2020 Air Force Summer Faculty Fellowship, 2020 Johns Hopkins University Catalyst Award, 2019 Johns Hopkins University Whiting School of Engineering Research Lab Excellence Award, Invitee for 2019 China-America Frontiers of Engineering Symposium, FY 2018 Air Force Office of Scientific Research Young Investigator Program Award, Invitee for 2016 National Academy of Engineering US Frontiers of Engineering Symposium, and 2011 Materials Research Society Graduate Students Gold Award. He served as an editorial board member of Scientific Reports and a guest editor of Materials Research Society Bulletin. Currently, he serves as an editorial board member of Multifunctional Materials and Sensors, respectively. He has been co-organizing ~35 symposia on bioinspired materials, 3D printing, and mechanical metamaterials at international conferences. He is a member of American Society of Mechanical Engineers (ASME), Materials Research Society (MRS), American Physical Society (APS), and Society of Engineering Science (SES). He served as the Chair, Vice Chair, Secretary, and Editor of ASME Technical Committee on Mechanics of Soft Materials.