PURDUE UNIVERSITY

School of Mechanical Engineering

# Seminar
# Thursday December 7, 2017
# ME 2054

## MECHANICS-GUIDED, DETERMINISTIC 3D ASSEMBLY


### Dr. Yonggang Huang



**Abstract:**

Complex three-dimensional (3D) structures in biology (e.g., cytoskeletal webs, neural circuits, and vasculature networks) form naturally to provide essential functions in even the most basic forms of life. Compelling opportunities exist for analogous 3D architectures in human-made devices, but design options are constrained by existing capabilities in materials growth and assembly. We report routes to previously inaccessible classes of 3D constructs in advanced materials, including device-grade silicon. The schemes involve geometric transformation of 2D micro/nanostructures into extended 3D layouts by compressive buckling. Designs inspired by kirigami/origami enable the formation of mesostructures with a broad variety of 3D geometries, either with hollow or dense distributions. Demonstrations include experimental and theoretical studies of more than 100 representative geometries, from single and multiple helices, toroids, boxes, pyramids and conical spirals to structures that resemble spherical baskets, cars, houses, cuboid cages, flowers, scaffolds, each with single- and/or multiple-level configurations. We further introduce concepts in physical transfer, patterned photopolymerization and non-linear plasticity to enable integration of 3D mesostructures onto nearly any class of substrate, with additional capabilities in access to fully or partially free-standing forms, all via mechanisms quantitatively described by theoretical modeling. Compatibility with the well-established technologies available in the semiconductor industries suggest a broad range of application opportunities. Illustrations of these ideas include their use in building 3D structures as radio frequency devices for tunable electromagnetic properties, as open-architecture electronic scaffolds for formation of dorsal root ganglion (DRG) neural networks, as ultra-stretchable interconnects for soft electronics and as catalyst supports for propulsive systems in 3D micro-swimmers with geometrically controlled dynamics.


**Bio:**

Dr. Yonggang Huang is the Walter P Murphy Professor at Northwestern University where he has been on the faculty since 2007. His research focusses on mechanics across scales and includes the mechanism based strain gradient plasticity and atomistic-based continuum theories. His recent work relates to the mechanics of stretchable and dissolvable electronics, and the mechanically guided self-assembly of small structures. His is the current editor of the Journal of Applied Mechanics and was the President of the Society of Engineering Science. Dr. Huang is a member of the US National Academy of Engineering and the European Academy of Sciences and Arts. His work was recognized by several awards, including most recently the 2017 SES Prager Medal and the ASME 2016 Nadai Medal.

**Faculty Host:** Professor Siegmund. If you would like to meet Dr. Huang please contact secretary Martha Lucht mlucht@purdue.edu to see if we can accommodate your request within his schedule.