



Physics colloquium

Making, Studying, and Designing Hierarchically Structured Soft Materials

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Abstract: Nature realizes extraordinary materials by structuring them precisely from the molecular scale to the macroscopic scale. While nature may have perfected this process over evolutionary time scales, synthetically recapitulating this level of control is tremendously difficult due to the large number of length scales involved and our limited knowledge of interactions between these scales. Faced with the daunting challenge of synthetically realizing soft hierarchical materials, we have adopted a three pronged strategy to: (1) make structures with control from the molecular scale to the macroscopic scale by directing bottom-up growth processes with top-down control, (2) learn how the properties of such materials emerge from their hierarchical structure, and (3) design the best performing structures using novel approaches borrowed from machine learning and autonomous research. In this talk, we will report recent progress in these complementary areas of making, studying, and designing hierarchical materials. In particular, we will focus on two major classes of materials, nanoparticle-based structures where the assembly and organization of particles leads to emergent mechanical properties at the bulk scale and polymer-based materials where we are connecting the synthesis, patterning, and properties of polymer structures across scales. In addition to lessons about the fundamental properties of hierarchically organized soft matter, we will highlight the synergies possible when combining, synthesis, detailed characterization, and advances in materials design.

Bio: Keith A. Brown is an Assistant Professor of Mechanical Engineering, Materials Science & Engineering, and Physics and the Moorman-Simon Interdisciplinary Career Development Professor at Boston University. He earned a Ph.D. as an NDSEG Fellow in Applied Physics at Harvard University with Robert M. Westervelt, an S.B. in Physics from MIT, and was an International Institute for Nanotechnology postdoctoral fellow with Chad A. Mirkin at Northwestern University. The Brown group merges top-down patterning and bottom-up assembly to realize new hierarchical materials, investigates the emergent behavior of these materials, and develops new paradigms for designing such hierarchical structures. Keith has co-authored 56 peer-reviewed publications, three issued patents, and has been recognized through awards including the Omar Farha Award for Research Leadership from Northwestern University and as a "Future Star of the AVS." Keith currently serves on the *Nano Letters* Early Career Advisory Board and is the Chair-Elect of the Nanoscale Science and Technology Division of the AVS.

