Bone as a Structural and Biological Material

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Abstract:

Bone is a biological material with excellent mechanical properties for its structural functions: it is stiff, strong, tough, and lightweight. These superior properties are due to bone's composite and hierarchical structure. In this presentation, we first study bone as a hierarchical composite material. We distinguish the following length scales: nanoscale (1*nm* -1μm, apatite crystal and collagen fibril level), sub-microscale (1-10μm, single lamella level), microscale (10 -500 μm, single trabecula or osteon level), mesoscale (1–10 *cm*, involving a random network of struts in trabecular bone, or a random arrangement of osteons in cortical bone), and macroscale (whole bone level). We characterize bone at each of these structural scales and model it either analytically, using micromechanics theories, or numerically, using finite elements. Then, we present an overview on the bone as a biological material, with a focus on bone adaptation and regeneration. This study has applications in orthopedics and provides a framework for studying other materials with hierarchical structures. It also provides guidance on designs of bioinspired materials.

Brief Vita:

Iwona Jasiuk received her Ph.D. in theoretical and applied mechanics at Northwestern University. Before joining the Department of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign (UIUC), she held faculty positions at Michigan State University, Georgia Institute of Technology and at Concordia University in Montreal. At UIUC, she also holds affiliate faculty positions in Bioengineering and Civil and Environmental Engineering Departments and part-time faculty of Institute for Genomic Biology and Beckman Institute. Her research is in mechanics of materials, with focus on nanocomposite materials, cellular materials, and biological materials. She published over 120 journal papers and over 60 conference papers. She is a co-editor of *Journal of Mechanics of Materials and Structures*, and she has served on editorial boards of the *International Journal of Solids and Structures*, *Computers in Biology and Medicine*, *International Journal for Multiscale Computational Multiscale, and International Journal of Damage Mechanics*, among others. She is a Fellow of the American Society of Mechanical Engineers since 2003, a Fellow of the Society of Engineering Science (SES) since 2012, and in 2006 she served as president of the SES.