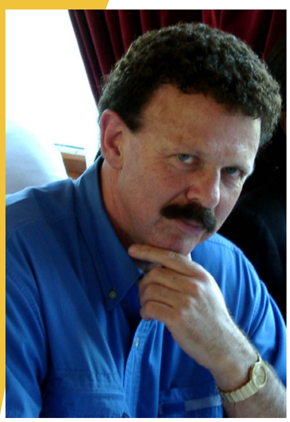
LSU DEPARTMENT OF MECHANICAL ENGINEERING

The Sidney E. Fuchs Seminar Series

3:30-4:30pm, Friday, March 30, 2012

Frank H. Walk Design Presentation Room



Bone as a Structural Material

Multi-Length Scale Origins of its Fracture, Resistance and Biological Degradation

by **Robert O. Ritchie***

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The age-related deterioration in the quantity of bone and its architecture and resultant fracture properties, coupled with increased life expectancy, are responsible for increasing incidences of bone fracture in the elderly segment of the population. Here we examine the origins of the toughness of human cortical bone in terms of the contributing micro-mechanisms and their characteristic length scales in relation to its hierarchical structure. It is shown that at length-scales at or below a micrometer or so, the toughening mechanisms in bone are primarily intrinsic (they are essentially “plasticity” mechanisms), and principally include fibrillar sliding at the collagen fibril (i.e., ~100 nm) level. At length-scales above a micrometer or so, the toughening mechanisms are primarily extrinsic, and are associated with crack deflection/twist and crack bridging (at the ~1 to 100s µm level). In terms of the toughness of bone, the latter mechanisms are particularly potent; they affect the growth rather than the initiation of cracks and as such lead to resistance-curve toughening behavior. In this context, realistic short-crack measurements of the crack initiation and growth toughnesses are used to evaluate the effects of aging, irradiation, certain drug treatments and diseases in bone, and are combined with extensive structure characterization to determine the microstructural features that underlie the toughness and biological degradation of bone at multiple length-scales.

* The H.T. & Jessie Chua Distinguished Professor of Engineering in the Materials Science & Engng. and Mechanical Engng. Departments at U. C. Berkeley; also Senior Materials Scientist at the Lawrence Berkeley National Laboratory. Received a B.A. degree in physics and metallurgy in 1969, and M.A. (1973), Ph.D. (1973) and Sc.D. (1990) degrees in materials science, all from Cambridge University. Known for his research into the mechanics and mechanisms of fracture/fatigue of structural and biological materials, having authored over 600 technical papers. His research interests are currently focused on the biological and disease-related deterioration of bone and the development of damage-tolerant metallic glasses and bio-inspired structural materials. Member of the National Academy of Engineering, the U.K. Royal Academy of Engineering, and the Russian Academy of Sciences.