College of Engineering
Department of
Mechanical & Industrial Engineering

The Sidney E. Fuchs Seminar Series

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1200 Patrick F Taylor Auditorium

Mechanics of Cell-Matrix Interactions in Three-Dimensions

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Biological cells are complex living systems that can be viewed as micromachines, which derive many of their mechanical functions from the molecular motors within the cell. The force that cells apply to their surrounding extracellular matrix through focal adhesions control processes such as growth, adhesion, development, and migration. A new experimental approach to quantify three-dimensional full-field displacements and tractions due to cells embedded in a fibrous matrix is presented. Cells and their surrounding matrix are imaged in three dimensions using laser scanning confocal microscopy. Cell-induced matrix displacements are computed using digital volume correlation. The simultaneous imaging of the cell and the labeled matrix enables the study of cell-matrix interactions and the consequences of matrix remodeling due to cell-induced forces. The three-dimensional traction force microscopy technique is used to investigate how cells employ physical forces during cell division, spreading, and sensing. A constitutive model for a fibrous material to simulate deformations induced by cells is developed. It is shown that cells in a fibrous matrix induce deformation fields that propagate over a longer range than predicted by linear elasticity. The model captures measured cell-induced matrix displacements from experiments and identifies loss of compression stiffness due to microbuckling of fibers as an important mechanism for long-range cell mechanosensing.

* Guruswami (Ravi) Ravichandran is the John E. Goode, Jr. Professor of Aerospace and Mechanical Engineering and Otis Booth Leadership Chair of the Division of Engineering and Applied Science at the California Institute of Technology. He received his Ph.D. in Engineering (Solid Mechanics and Structures) from Brown University. He is an elected member of the National Academy of Engineering, International Academy of Engineering, Academy of Europe, and European Academy of Sciences and Arts. He is a Fellow of the American Society of Mechanical Engineers (ASME), Society for Experimental Mechanics (SEM) and American Academy of Mechanics (AAM). He was named Chevalier de l'ordre des Palmes Academiques by the Republic of France. His awards include A.C. Eringen Medal from the Society of Engineering Science, Warner T. Koiter Medal from ASME, and William M. Murray Lecture Award from SEM. His research interests are in mechanics of materials including deformation, damage and failure, micro/nano mechanics, wave propagation, composites, active materials, biomaterials and cell mechanics, and experimental methods.