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Distinguished & Student Choice Seminar

Wednesday, October 2, 2019
Seminar Presentation: 11:00am – 12:00pm
SME room 248

"Using light to probe biomechanical behavior and nonlinear optics of nanomaterials"

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Abstract: This presentation will discuss how integrated optical devices can be used to make advances in two very different applications: biomechanics and nonlinear optics. Understanding the mechanical behavior of biological materials is immensely complex due to the heterogeneity of the architecture at both the nano- and micro-scale. For example, in a tissue slice, cells are connected by the extracellular matrix (ECM). While it is clear that the ECM and the cells have different stiffness values, recent results show an inter-dependence between the two systems. However, it is not clear if the cells change in response to changes in ECM stiffness or vice versa. The nature of this dependence is of particular importance in tissue where the structure and mechanical properties directly determine the physiological behavior. Therefore, understanding the cause and effect has the potential to inform treatment; for example, understanding resistance to therapies, organ rejection, and disease progression. However, measuring the sample stiffness in unprocessed tissue is a particularly complex task. We have recently demonstrated a fully integrated polarimetric elastography instrument for characterizing the mechanical properties of visco-elastic materials, including living, resected tissue. This portion of the presentation will discuss a couple examples, including results from living, undigested tissue from a range of organ systems.

While integrated photonics based on classic optical materials, like lithium niobate and silicon, can solve many current technical challenges in a lab-setting, reaching extremely high performance devices requires turning to alternative material systems, like silica. Unfortunately, many of these materials and devices suffer from reproducibility issues and environmental degradation over time. Additionally, they require heterogeneous integration, which is plagued by challenges, including different lattice constants, thermal expansion coefficients, and fabrication compatibilities; all of which can impact the final device performance and lifetime. Therefore, new materials and material systems as well as fabrication methods are desired. One approach is to combine the conventional top-down fabrication methods and optical materials with bottom-up fabrication and nanomaterials. These hybrid systems provide access to optical behavior and performance not attainable with conventional material systems. This portion of the presentation will discuss a couple examples of nanomaterial enhanced devices, including approaches based on organic small molecules and metal doped films.

Biosketch: Andrea Armani received her BA in physics from the University of Chicago and her PhD in applied physics with a minor in biology from the California Institute of Technology. She is currently the Ray Irani Chair of Engineering and Materials Science and a Professor of Chemical Engineering and Materials Science at the University of Southern California. She is the Director of the Northrop Grumman-Institute of Optical Nanomaterials and Nanophotonics and of two nanofabrication cleanrooms: the W. M. Keck Photonics Cleanroom and the soon to open John D. O'Brien Nanofabrication Laboratory. She is on the Editorial Board of ACS Photonics and Optics Letters and the World Economic Forum's Expert Network, a member of Sigma Xi and NAI, a senior member of IEEE and AIChE, and a Fellow of OSA and SPIE. She has received several awards, including the ONR Young Investigator Award, the PECASE, and the NIH Director's New Innovator Award, and she was named a Young Global Leader by the World Economic Forum.