**Photonic Crystal Enhanced Microscopy:
A New Tool for Imaging Cell-Surface Interactions and High Sensitivity Biomolecule Detection**

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The processes by which cells interact with basement membranes of biological tissues are fundamental aspects of important processes that include stem cell differentiation, cancer cell metastasis, apoptosis, division, and chemotaxis. Existing tools such as bright field microscopy and fluorescence microscopy of stained cells, lack the ability to quantify and to image the strength of live cell membrane interactions with surfaces over extended time scales that are required for processes that occur over the course of hours or days. To address this need, our group recently introduced Photonic Crystal Enhanced Microscopy (PCEM), in which a conventional bright field microscope is modified to enable detection of the resonant wavelength of a photonic crystal (PC) biosensor surface with ~0.6 μm spatial resolution. Using PCs coated with extracellular matrix material to mimic the surface experienced by live cells within tissue, cell-surface interactions can be visualized and quantified without the use of fluorescent tags or colored stains, enabling dynamic tracking of focal adhesions, cell-surface attachment boundary, and cell attachment gradients within individual cells.

Due to the high sensitivity afforded by PCEM, we have demonstrated the ability to detect and image the adsorption of individual dielectric and metallic nanoparticles, extending down to ~35 nm diameter. In this talk, we demonstrate that utilizing gold nanorod tags with surface plasmon resonances that match the resonant wavelength of the PC, the signal-to-noise ratio for nanoparticle detection is enhanced, offering a path to use PCEM as a platform for detection and monitoring of biomolecular interactions with single molecule resolution for applications that include high sensitivity disease diagnostics.

In this talk, Prof. Cunningham will describe the operation, design, and fabrication of photonic crystal biosensors, describe the operation of the PCEM, and share recent results in which PCEM has been applied to stem cell imaging, fluorescence enhancement, and single nanoparticle detection.