USC University of Southern California

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Seminar - "Technology Development and Translation of Functional Molecular Imaging Approaches with Optical Coherence Tomography"

Thursday, October 11, 2018
3:00 pm to 4:00 pm
UPC – Denney Research Center (DRB), Room 145A

Abstract:
Over the past decade we have been working to develop functional and molecular imaging technologies for a variety of applications. A current focus is technologies capable of functional imaging of picometer scale vibrations in the ear. This collaboration with researchers in otolaryngology has led to several recent papers that contribute new understandings of inner ear function. These were enabled by our development of Optical Coherence Tomography (OCT) as a highly sensitive spatially resolved vibrometer. Building on this approach, we have begun to develop devices to fill unmet clinical needs for diagnosis and therapeutic guidance in humans. The first of those devices (cochleoscope) is an endoscopic OCT system designed to traverse the human ear canal and peer into the inner ear through the round window. This device would be used clinically to identify endolymphatic hydrops, anomalous vibratory response, and ischemia of the inner ear. We recently demonstrated this device in a porcine model and have IRB approval for a first-in-human trial at USC. A second device attaches to the standard operating microscopes in the hearing clinic, enabling noninvasive imaging of middle ear morphology and function. In vivo human testing of this device has shown that we can achieve a sensitivity to vibrations of of <2 pm in the middle ear. Applications include pre/post-surgical management of ossiculoplasty and tympanoplasty, and identification of cholesteatoma. We are developing a family of technologies that can provide high precision point-of-care diagnostics and guidance of therapies for ear disorders.

A second area of interest is the integration of molecular spectroscopy with OCT for molecular imaging. Given OCT's heavy clinical use in ophthalmology and its growing use in managing coronary artery disease and Barrett's esophagus, there is potential for rapid clinical adoption. Most recently our efforts have focused on integrating pump-probe spectroscopy of methylene blue with OCT. There are two main challenges we need to address, system expense and weak signal strength. We recently overcame the first of these, developing an approach for imaging methylene blue that uses an inexpensive (~$5k) diode laser. Our strategy to address the second challenge is to encapsulate methylene blue in poly(lactic-co-glycolic acid) micro/nanospheres. Advantages include, orders of magnitude stronger scattering, inhibition of redox reaction, reduced triplet oxygen production, and passive tagging based on particle size. Early results are promising with >20-fold drop in redox products for both micro (□2.69±1.05 μm) and nano (□84.0±39.5 nm) particles and a 97%/75% (micro/nano) reduction in singlet oxygen production. The regulatory pathway for this contrast agent is mitigated by the fact that methylene blue, marketed as Provayblue, is FDA approved and poly(lactic-co-glycolic acid) is a common biodegradable vessel for numerous FDA approved therapeutics. Expected applications include labeling leaky vasculature in tumors and age-related macular degeneration and chromoendoscopy on Barrett's esophagus.

Biography: Dr. Applegate received his B.S. in chemistry from Wright State University and his M.S. and Ph.D. in chemistry from The Ohio State University. After completing a postdoctoral fellowship in the Department of Chemistry at the University of North Carolina at Chapel Hill, working on water cluster growth in superfluid helium, he joined the Biophotonics group at Duke University directed by Prof. Joe Izatt. While at Duke, he won a National Institutes of Health NRSA postdoctoral fellowship award to support work in developing molecular imaging technologies. Upon completing his fellowship, he joined the Department of Biomedical Engineering at Texas A&M University where he is currently an Associate Professor. Research in his lab has been supported by grants from the Department of Defense CDMRP, National Institutes of Health, and the National Science Foundation, including an NSF CAREER award. He is a fellow of the Optical Society of America and serves as an Associate Editor for Optics Letters.

Hosted by: Kirk Shung