

Nanobiophotonics and BioASICs for Molecular Medicine

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Abstract

In this talk, I will discuss innovative nanobiophotonics and Biofluidic Application Specific Integrated Circuits (BioASICs) for systematic biology and quantitative medicine. Using new paradigms of biological inspiration and understanding of electron transfer mechanism in biological systems, we have developed quantized Plasmon Resonance Energy Transfer (PRET) nanospectroscopy and spectro-imaging for living cells. For molecular optogenetics, we have developed Oligonucleotides on a Nanoplasmonic Carrier Optical Switches (ONCOS) to control gene regulation and protein expression for systematic biology and medical applications. ONCOS allows on-demand gene silencing with nanometer-scale spatial resolution and localized temperature modulation in living cells. Nanobiophotonic molecular ruler is also accomplished to measure the dynamics of DNA and protein interactions. In addition to *in-vivo* Surface Enhanced Raman Spectroscopy (SERS) probes, *in-vitro* integrated nanofluidic SERS and optofluidic microprocessors are also developed for label-free molecular diagnostics.

In order to accomplish physiologically relevant cell culture and stem cell biology, we have developed BioASICs by connecting novel microfluidics and nanofluidic circuits. The BioASICs can impact on high-speed and high-content precision biology, and quantitative medicine in new ways. We are creating a library of these "building blocks" to develop innovative single cell array, physiologically relevant dynamic cell culture array, and biological microprocessors with integrated optical controls and detections capability. For biologically inspired electronics, we are elucidating the electron transfer mechanism of natural photosynthesis to develop artificial photosynthesis on a chip. Finally, I will discuss the vision for molecular diagnostics by biological microprocessors. As an example, we accomplished quantitative real time nucleic acid detection via *i*NASBA (Integrated Nucleic Acid Sequence-Based Amplification), which can impact on environmental and medical diagnostics.



Prof. Luke P. Lee is Lloyd Distinguished Professor of Bioengineering at UC Berkeley. He is also Director of Biomolecular Nanotechnology Center and Co-Director of Berkeley Sensor & Actuator Center. He was Chair Professor in Systems Nanobiology at the Swiss Federal Institute of Technology (ETH, Zurich). He received both his B.A. in Biophysics and Ph.D. in Applied Physics/Bioengineering from UC Berkeley. He has more than ten years of industrial experience in integrated optoelectronics, Superconducting Quantum Interference Devices (SQUIDs), and magnetic bioassays. His current research interests are molecular imaging of living cells, single cell biophysics, systems nanobiology, molecular diagnostics, soft-state biological devices, and Biologically-inspired Photonic-Optofluidic-Electronics Technology and Science (BioPOETS). Prof. Lee has authored and co-authored over 220 papers on biophotonics, integrated molecular diagnostics, quantitative cell biology, BioMEMS, integrated optical microfluidics, SERS, SQUIDs, and nanogap biosensor for label-free biomolecule detection. <http://biopoets.berkeley.edu>

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