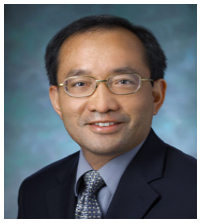
Discerning rare disease biomarkers by micro- and nanotechnologies



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LECTURE ABSTRACT

Genomic analysis of biomarkers, including genetic markers such as point mutations and epigenetic markers such as DNA methylation, has become a central theme in modern disease diagnosis and prognosis. Recently there is an increasing interest in using confocal single-molecule spectroscopy (SMS) for genomic detection. The driving force not only comes from its ultrahigh sensitivity that allows detection of low-abundance nucleic acids without the need for amplification but also from its potential in achieving high-accuracy quantification of rare targets via single-molecule sorting. DNA extraction and processing is a critical first step that underpins nearly all of genetic and epigenetic biomarker analyses. We develop a silica coated nanomembrane that contains a high density of nanoscale folds, wrinkles, and creases. The nanoscale surface topography enables high surface area silica based DNA extraction while eliminating column or particle based shear forces to facilitate high yield and high purity DNA recovery with exceptional DNA quality. On the other hand, microfluidic technologies offer an exciting opportunity to realize the use of biomarkers in routine clinical settings via the development of miniaturized diagnostic systems. These platforms may function as portable bench-top environments that dramatically shorten the transition of a bench-top assay into a point-of-care format. We have developed highly sensitive, quantitative and clinically relevant technologies for analysis of genomic markers based on the convergence of SMS, microfluidic manipulations, and silica nanomaterials. Extraordinary performances of these new technologies have been exemplified by analysis of a variety of biomarkers including point mutations, DNA integrity and DNA methylation in clinical samples.

SPEAKER BIOSKETCH

Jeff Wang is a professor in the Department of Mechanical Engineering, where he has served on the faculty since 2002. He earned his bachelor's and master's degrees from National Taiwan University in 1988 and 1994, and his doctorate from University of California, Los Angeles in 2002, all in mechanical engineering. His research focuses on the development of new technologies for molecular analysis and biomedical research via advances in micro- and nano-scale sciences. He has contributed to developments in single-molecule fluorescence spectroscopy, microfluidics and nano-biosensors for genetic and epigenetic biomarker-based diagnostics of cancer, infectious disease and an array of other diseases. Wang also has taken the leading role in the development of quantum dot-fluorescence resonance energy transfer (QD-FRET) DNA nanosensors, which have been used to detect a variety of cancer biomarkers, including point mutations, DNA methylation and gene copy variations in clinical laboratories. In addition, he has pioneered the development of single molecule detection (SMD) technologies for biomarker screening. Wang is an inventor of 20 patents, and has authored more than 100 research articles and more than 120 abstracts and oral presentations. He received the NSF CAREER Award in 2006, CSR Jorge Heller Award in 2007, ASGR Excellence in Research Award in 2007, the JALA Ten Award in 2011, and several Best Paper Awards in technical conferences and workshops. He is a Fellow of the American Institute for Medical and Biological Engineering (AIMBE).