The Chinese University of Hong Kong
Biomedical Engineering Seminars Series

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Microfluidic Platforms as in vitro and in vivo Tools for Diagnosis and Physiological Studies

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Abstract

This presentation focuses on two distinct uses of microfluidic platforms in biomedical engineering: one is to diagnose disease states in vitro with collected bodily fluids and the other with implanted devices to interface chemically and electrically in vivo with bodily tissues, particularly neuronal tissues.

First, the in vitro microfluidic platforms in this study leverage the fact that the mechanical structures inside a cell play important roles in healthy cell functions such as growth, proliferation, migration, differentiation and embryogenesis. Similarly, they provide important mechanical biomarkers for diseases such as cancer metastasis, cardiovascular diseases, arthritis and immune dysfunction. We seek to establish tools that allow the use of mechanical properties of live cells in an in vitro environment to diagnose various disease states. In particular, two microfluidic platforms have been demonstrated to establish the feasibility of disease diagnosis through biomechanics at the cellular level: one with controlled fluidic channel properties for diagnosing malaria and the other with inertial microfluidics and functionalized microchannels to isolate and capture circulating tumor cells.

Second, neural implants are developed to interact with the nervous system in hopes of restoring sensory, motor, or cortical functions that can improve or maintain the health of individuals suffering from various forms of neural trauma or degenerations. Intraneural electrodes show the most promise for potential use in neuroprosthetic system because they exhibit high selectivity and signal-to-noise ratio. The major challenge of any in vivo devices is the collection of natural immune responses to foreign bodies. The chronic recording functions of neural probes, in particular, often degrade over time and stop completely in less than one year. Initial mechanical trauma from implantation causes an acute inflammatory response that is often followed by chronic foreign body reactions including macrophage glial scaring and fibrotic encapsulation. The current studies aim at addressing the chronic recording needs beyond one year by integrating electrophysiological measurements with fluidic delivery capabilities. The ability to introduce neurotropic drugs and growth factors allows the potential to minimize inflammatory responses and promote neural regeneration.

Biography

William C. Tang received his BS, MS, and Ph.D. in Electrical Engineering & Computer Sciences from the University of California at Berkeley in 1980, 1982, and 1990, respectively. His seminal thesis work and invention on the electrostatic comb drive has become a crucial building block for many microactuator and microsensor research in the field, and was, and continues to be recognized internationally as one of the most influential and foundational work. Since his graduation, he continued his contribution to the Micro-Electro-Mechanical Systems (MEMS) field first in the automotive industry and later in space exploration. From July 1999 to June 2002, he served as the Manager of the MEMS program at the Defense Advanced Research Projects Agency (DARPA).

Since July 2002, Dr. Tang has been on faculty as a professor with the Department of Biomedical Engineering at the University of California, Irvine, with a joint appointment with the Department of Electrical Engineering and Computer Science. He was the first Associate Dean for Research in the Henry Samueli School of Engineering from March 2008 to June 2013. His current research interests are in micro- and nano-scale technologies for wireless medical implants, micro biomechanics, and navigation, positioning, and timing micro systems. In addition, because of his expertise in space applications of MEMS technology, both DARPA and the US Army contracted him to develop micro propulsion engines for futuristic space uses. He was also funded by DARPA to contribute towards developing revolutionary prosthetic arms that interface directly with the nervous system. Including the patent on electrostatic comb-drive actuator, Dr. Tang was awarded 7 U. S. patents and two patents pending on MEMS designs and technologies. He is the author and co-author for over ninety conference and refereed papers in the MEMS field, and is frequently invited to speak in seminars and workshops. Dr. Tang is a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), a Fellow and Chartered Physicist with the Institute of Physics (IOP), and a Fellow of the American Institute for Medical and Biological Engineering (AIMBE).