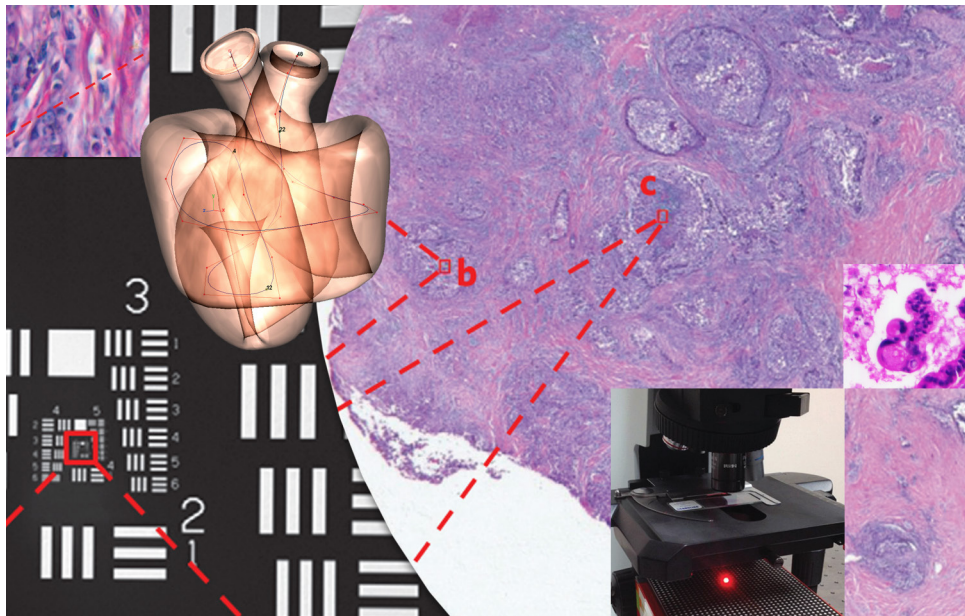


Caltech

The Athenaeum, Main Lounge
551 South Hill Avenue
Pasadena, CA



MEDICAL ENGINEERING OVERVIEW AND LUNCHEON

FEBRUARY 10, 2014

www.mede.caltech.edu

Hosted by

Ares J. Rosakis

*Otis Booth Leadership Chair, Division of
Engineering and Applied Science; Theo-
dore von Kármán Professor of Aeronau-
tics and Mechanical Engineering*

arosakis@caltech.edu

(626) 395-4514

Yu-Chong Tai

*Anna L. Rosen Professor of Electrical
Engineering and Mechanical
Engineering; Executive Officer for
Medical Engineering*

yctai@its.caltech.edu

(626) 395-8317

Medical Engineering Overview and Luncheon Program



11:10am-11:20am

Welcome

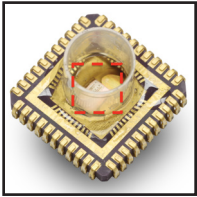
Ares J. Rosakis, *Otis Booth Leadership Chair, Division of Engineering and Applied Science; Theodore von Kármán Professor of Aeronautics and Mechanical Engineering*



11:20am-11:35am

Caltech Innovation and Technology Translation

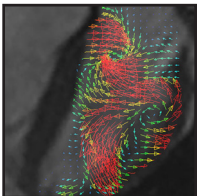
Mory Gharib, *Hans W. Liepmann Professor of Aeronautics and Bioinspired Engineering; Vice Provost*



11:35am-11:50am

Low Cost Diagnostic and Therapeutic Devices

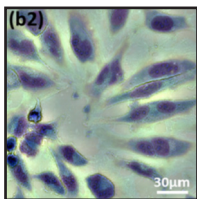
Ali Hajimiri
Thomas G. Myers Professor of Electrical Engineering



11:50am-12:05pm

Your Next Cardiologist: A Smart Phone

Mory Gharib
Hans W. Liepmann Professor of Aeronautics and Bioinspired Engineering; Vice Provost

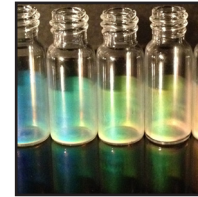


12:05pm-12:20pm

Rethinking Microscopy

Changhuei Yang
Professor of Electrical Engineering and Bioengineering

12:20 pm **Lunch**

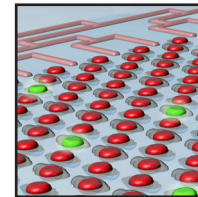


12:30pm-1:00pm

Designing Polymeric Materials for Biomedical Applications

Bob Grubbs
Victor and Elizabeth Atkins Professor of Chemistry; Nobel Laureate in Chemistry

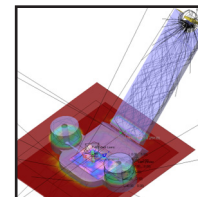
1:00pm-1:10pm **Break**



1:10pm-1:25pm

Diagnostics for Global Health

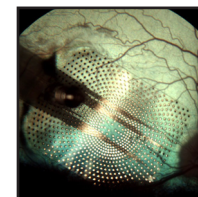
Rustem Ismagilov
Ethel Wilson Bowles and Robert Bowles Professor of Chemistry and Chemical Engineering; Director of the Jacobs Institute for Molecular Engineering for Medicine



1:25pm-1:40pm

Lab-on-Chip to Lab in the Body: Miniaturization for Point-of-Care Medicine

Axel Scherer
Bernard Neches Professor of Electrical Engineering, Applied Physics and Physics



1:40pm-2:00pm

Micro Implants for Our Body and Wrap-Up

Yu-Chong Tai
Anna L. Rosen Professor of Electrical Engineering and Mechanical Engineering; Executive Officer for Medical Engineering

2:00pm-3:00pm **Dessert and Discussion**

Faculty of the Department of Medical Engineering



Joel Burdick

Richard L. and Dorothy M. Hayman Professor of Mechanical Engineering and Bioengineering

Professor Burdick researches robotic locomotion, sensor-based motion planning algorithms, multi-fingered robotic manipulation, applied nonlinear control theory, neural prosthetics, and medical applications of robotics. Professor Burdick has been focusing more of his expertise in robotics to the development of human prosthetics for paralysis. He has been collaborating with neuroscientists and has demonstrated rehabilitation technology that could repair paralyzing spinal cord injuries successfully.



Hyuck Choo

Assistant Professor of Electrical Engineering

Glaucoma is a leading cause of blindness, affecting an estimated 4 million Americans and 70 million individuals globally. As glaucoma typically affects the elderly, the aging demographic trends indicate that this disease will continue to be an increasing socioeconomic burden to society. In spite of its growing importance in our society, the pathogenesis of glaucoma has not been clearly determined, and only elevated intraocular pressures (IOP) have been identified as a major risk factor. Using their expertise in MEMS/NEMS, micro-/nano-scale optics/photonics, and novel micro-/nano-scale fabrication, Choo's group is developing minimally-invasive medical device technologies that would improve the patient management of glaucoma and increase the understanding of its pathogenesis. Initially, they are focusing efforts on developing micro-/nano-scale pressure sensors that could easily and accurately measure IOPs in glaucoma patients and serve as very effective clinical management tools.



Tim Colonius

Professor of Mechanical Engineering

Acoustic waves, especially high-intensity ultrasound and shock waves, are used for medical imaging and, increasingly, in manipulation of cells, tissue, and urinary calculi. They are used to treat kidney stone disease, plantar fasciitis, and bone nonunion, and are being investigated as a technique to ablate cancer tumors and mediate drug delivery. In many applications, acoustic waves interact with bubbles whose presence can either mediate the desired mechanical stresses and strains, or lead to collateral damage. Professor Colonius' interdisciplinary research group uses theory and large-scale numerical simulations to study the dynamics and interaction of ultrasound and shock waves with inhomogeneous materials and bubbles, and to predict and optimize the local stresses and strains generated by insonification. They work with other engineers, scientists, and medical professionals to translate the fundamental mechanics into improvements in the design and clinical application of shockwave lithotripters.



John Dabiri

Professor of Aeronautics and Bioengineering

Heart disease remains a leading cause of death worldwide. Previous research has indicated that the dynamics of the cardiac left ventricle (LV) during diastolic filling may play a critical role in dictating overall cardiac health. Hence, numerous studies have aimed to predict and evaluate global cardiac health based on quantitative parameters describing LV function. However, the inherent complexity of LV diastole, in its electrical, muscular, and hemodynamic processes, has prevented the development of tools to accurately predict and diagnose heart failure at early stages, when corrective measures are most effective. In previous work, Dabiri's group demonstrated that major aspects of cardiac function are reflected uniquely and sensitively in the optimization of vortex formation in the blood flow during early diastole, as measured by a dimensionless numerical index. Ongoing research aims to develop noninvasive technologies to quantify this numerical index using principles from hydroacoustics.



Azita Emami

Professor of Electrical Engineering

Azita Emami's research covers a wide range of topics in mixed-signal integrated circuits and systems. Her research group focuses on developing novel circuit and system-level solutions for a variety of applications. These include the design of high-performance, low-power and minimally invasive implantable and wearable medical devices for neural recording, neural stimulation and drug delivery. She is also developing adaptive, reconfigurable and reliable microelectronics, low-power sensors and efficient signal processing techniques for medical applications.



Andrei Faraon

Assistant Professor of Applied Physics and Materials Science

Andrei Faraon's research is in integrated optics. He is working on developing on-chip optical devices for bio-sensing, and neural implants for optogenetic applications. The bio-sensing devices integrate optical networks and microfluidics, where optical resonators are used to monitor biochemical reactions in microfluidic chambers. The neural implants integrate optics and electronics. Optical waveguides are used to deliver light that excites or inhibits neuronal activity using optogenetic techniques, while electrodes record action potentials at the same location.

Faculty of the Department of Medical Engineering



Mory Gharib

Hans W. Liepmann Professor of Aeronautics and Bioinspired Engineering; Vice Provost

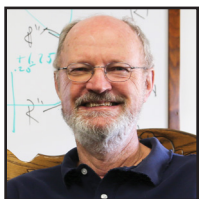
Professor Gharib's broad range of research interests in medical engineering can be categorized in three areas: bio-inspired design and engineering; cardiovascular research; and microfluidics. In bio-inspired design and engineering, he is looking into the use of nanoscale carbon-tube carpet to develop medical adhesives and painless nanoscale needles. In the area of cardiovascular research, he is studying the hemodynamics and wave dynamics of large blood vessels, embryonic heart flow which includes computational studies, 3D studies of blood flow inside left ventricle, design and analysis of mechanical and bio-prosthetic heart valves, and the effect of epigenetic factor on valvulogenesis. He also researches fluid control and mixing in microfluidic devices for biomedical applications such as microscale on-chip analysis.



Julia Greer

Professor of Materials Science and Mechanics

Creation of extremely strong yet ultra-light materials can be achieved by capitalizing on the hierarchical design of 3-dimensional nano-lattices. Such structural meta-materials exhibit superior thermomechanical properties at extremely low mass densities (lighter than aerogels), making these solid foams ideal for many scientific and technological applications, especially in the medical field. The medical research thrusts in the Greer group span from biomimicking to creating nanostructured 3-dimensional scaffolds for cell growth to body-compatible batteries to power devices like pacemakers. A new pursuit in her group is to investigate the mechanical properties of trabecular bone, focusing on the effects of anisotropy on fracture and deformation behavior with the goal of creating more resilient artificial bones.



Bob Grubbs

Victor and Elizabeth Atkins Professor of Chemistry; Nobel Laureate in Chemistry

Professor Grubbs pursues research in: organometallic synthesis and mechanisms; organic synthesis and reagents; and polymer synthesis. As a world-renowned expert in material synthesis, he is interested in synthesizing various optical/mechanical sensing materials and smart reshapable structural materials for medical applications. He has developed light-triggered shape-morphing polymers and demonstrated their use in light-adjustable intraocular lens that could reshape and compensate for the astigmatism that frequently results from cataract surgery.



Ali Hajimiri

Thomas G. Myers Professor of Electrical Engineering

Professor Hajimiri's research in medical engineering spans the fields of biosensors, drug delivery, terahertz imaging, and bio-inspired engineering. In biosensors, his group leverages electrical engineering and biochemistry to make very low cost handheld diagnosing devices for various diseases. They design and use silicon-based electronic chips in existing technologies for detection and monitoring of various conditions, such as cancer, tuberculosis, or hepatitis C. In therapeutics, they use magnetic particles for drug delivery in the brain. To accomplish this they have developed a sophisticated dynamic magnetic manipulation setup that allows them to 'navigate' magnetic particles to deliver drugs to the targeted cancer sites for improved efficacy. They also have developed low-cost handheld imagers in the terahertz range of electromagnetic waves for low-cost medical imaging.



Rustem Ismagilov

Ethel Wilson Bowles and Robert Bowles Professor of Chemistry and Chemical Engineering; Director of the Jacobs Institute for Molecular Engineering for Medicine

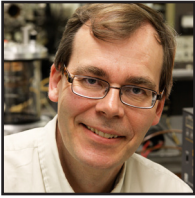
Professor Ismagilov is interested in controlling and understanding dynamics of complex networks in space and time, and using this understanding to solve problems. The networks he studies span networks of reactions, networks of cells, and networks of organisms. The problems include global health (including simple solutions for resource-limited settings) and environment. He finds microfluidics to be useful in his work, both as a tool with which to control and understand networks, and as a tool with which to implement ideas.



Kenneth Pickar

Visiting Professor of Mechanical and Civil Engineering

Professor Pickar is interested in creating products that help the lives of people who are at the bottom of the pyramid. He has worked in both Guatemala and now in India where his class is jointly taught with IIT Gandhinagar. The Indian focus is on medical products to detect or treat disease or ancillary products that protect against injury. He is also interested in the process of entrepreneurship where laboratory discoveries are transferred to the market place in this country.



Axel Scherer

*Bernard Neches Professor of Electrical Engineering,
Applied Physics and Physics*

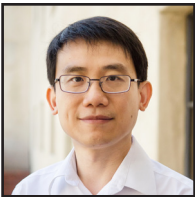
Utilizing semiconductor batch fabrication techniques, Professor Scherer's nanofabrication group have created inexpensive and fully automated tools that identify diseases at the point of care. His group also develops wireless "health monitors" that enable the patient to continuously monitor their health status. Early examples include continuous glucose monitors for diabetes and cardiovascular monitors that predict blood clot formation.



Yu-Chong Tai

Anna L. Rosen Professor of Electrical Engineering and Mechanical Engineering; Executive Officer for Medical Engineering

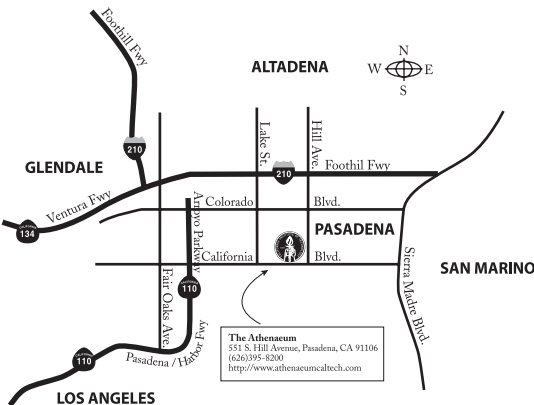
Over the past 15 years, Professor Tai has launched a major research effort to apply all these technologies to medical devices. Research examples include HPLC-on-a-chip, blood-labs-on-a-chip, and micro drug delivery. His group has had a major program for miniature or micro implants. To this end, Professor Tai collaborates with many medical doctors and biologists to develop integrated implants for cortical, retinal, and spinal applications. Micro implant devices included spinal neural stimulators, ECG implants, retinal prosthetic devices, intraocular lenses, etc.



Changhui Yang

Professor of Electrical Engineering and Bioengineering

Professor Yang's research area is biophotonics—the imaging and extraction of information from biological targets through the use of light. His research efforts can be categorized into two major groups: chip-scale microscopy imaging and time-reversal based optical imaging.



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