Journal of Rehabilitation Research and Development
Vol. 39, No. 3 (Supplement), May/June 2002
VA/NIH Prosthetics Roundtable
Pages 3–4

Presentation highlights: Micro-Electro-Mechanical Systems (MEMS)

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BIOGRAPHICAL INFORMATION

Dr. Murat Okandan is a senior technical staff member in Micro-Electro-Mechanical Systems (MEMS) Science and Technology—BioMEMS, at Sandia National Laboratories, Albuquerque, NM. He received his PhD in Electrical Engineering from the Pennsylvania State University.

His research interests primarily include microsystems technology (MEMS), which has been under development at Sandia for over a decade. One of his current development thrusts is aimed at leveraging this technology into the biological and medical sciences, with potential applications including:

- integrated sample handling,
- research tools (such as cellular manipulation systems—micromachined patch clamp array, neural probes, microreaction chambers),
- therapeutic devices (drug delivery, sample collection), and
- a large array of sensor-based applications.

PRESENTATION

The world of MEMS is one in which machine gears are no bigger than a grain of pollen and the laws of gravity and inertia give way to atomic forces and surface science. MEMS are essentially the next great revolution in biotechnology, fueling the advancement of genetics research and other cutting-edge technologies. This technology involves dynamic systems, complete with power sources and not just individual devices. Components such as gyroscopes, accelerometers, actuators, resonators, motors, and comb drives can operate and interact as part of a system that fits on a silicon chip. The goal of this technology is a system that thinks, senses, acts and communicates for the benefit of the user.

There are numerous demonstration devices, in different developmental stages, that illustrate the potential of micromachines in biomedicine. Systems implanted near cavities in the body could generate electrical or magnetic fields to trigger chemical reactions. A tiny polysilicon pump, about 150 μm across, aids peristalsis. A "microtransfixion" device, with a silicon microprobe, mechanically opens the membrane of red blood cells to enable the delivery of large molecules into the cells.

The potential biomedical applications for micromachines include drug delivery, cellular manipulation, neuroprostheses, and biosensors. Systems that would be needed for sensing nerve inputs or interconnecting into biological systems are going to be on the scales of micrometers, tens of micrometers, or hundreds of micrometers; this technology will help with that integration.

It seems feasible that there could be a prosthetic system with biocompatible, implanted micromachines that would help restore natural gait to patients with artificial legs. A better understanding of the observed abnormalities of gait following limb loss could be used to "feed" a micromachinery device, enabling it to constantly readjust gait patterns. Rapid clinical applications may be close at hand.

KEY POINTS

- Neuroprostheses, drug delivery, cellular manipulation and biosensors are areas of current exploration for MEMS scientists.

- MEMS can support and interact with other technologies, such as tissue engineering, in developing biocompatible implants to improve prosthetic function.

REFERENCE INFORMATION

Citations

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Web Site

http://www.mems.sandia.gov.
[Sandia National Laboratories Intelligent Micromachines Initiative]