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Biographical Sketch

Professor Jongyoon Han is a principal investigator in the Research Laboratory of Electronics (RLE) at MIT. He received the B.S. degree in the department of physics of Seoul National University, Seoul, Korea, in 1992. He received the M.S. degree in physics from the same department in 1994.

Professor Han received his Ph.D. from the School of Applied and Engineering Physics, Cornell University, Ithaca, NY, in 2001.
Before joining MIT as an Assistant Professor of Electrical Engineering in July 2002, he was a research scientist at Sandia National Laboratories, Livermore, CA where he studied protein microfluidic separation systems. In 2003, he received a second MIT faculty appointment as Assistant Professor of Biological Engineering. He was the recipient of 2003 National Science Foundation (NSF) — Faculty Early Career Development (CAREER) Award, and 2009 Analytical Chemistry Young Innovator Award from American Chemical Society
Professor Han ' s current research interests revolve around the application of micro and nanofabrication technology to a wide range of applications, including the molecular separation and concentration, biosensing, cell manipulation and separation, neuroscience and technology, and even desalination.
(bio updated 10/2012)

Research Summary

In recent years, Professor Han ' s Group research focused at molecular and cell separation / sorting technologies, as well as novel use of various types of ion selective membranes. Specific examples include:

1. Biomolecule separation using nanofluidic molecular sieve: Currently, most of biomolecule purification and separation uses random nanoporous materials as molecular sieving matrix. We are developing MEMS(Micro-Electro-Mechanical System)-based nanofluidic molecular sieves that can filter and separate various biomolecules based on their size or charge density. Unlike polymeric gels or nanoporous molecular filters, nanofluidic molecular sieves and filters could be engineered to have precise physical and chemical characteristics, therefore can have higher separation efficiency and selectivity.
2. Biomolecule and cell concentration / sensing using ion selective membranes: Ion selective membranes, such as nanofluidic channels and charged gels, can create the phenomenon of ion concentration polarization (ion depletion), which moves around ions and charged molecules in a controllable manner in a microfluidic system. We have developed various biomolecule and cell concentration devices using this phenoemenon, enabling higher detection sensitivities for immuoassays, enzyme activity assays, and cell based assays.
3. Small scale seawater desalination: Using the ion concentration polarization, we have developed an energy efficient but scalable seawater desalination and water purification system. The separation mechanism is appliable to a broad class of contaminants, including salts, heavy metal ions, virus and bacteria particles, and other colloid in a single step operation. The energy efficiency of this desalination process is comparable to the current state-of-the-art large scale reverse osmosis, but the technology is scalable and miniaturiazable, ideally suited for portable, self-powered water purification, for remote and disaster relief applications.
4. Electrochemical modulation of nerve cells using ion selective membranes: Ion selective membranes can be used to convert electric signals into electrochemical one, by modulating ion concentrations near the nerve cells. We are currently studying the method of locally modulating various ion concentrations near the nerve cells, in order to change the nerve cells ' excitability on demand. This could have broad implacations in neural prosthetics engineering, by facilitating low-current nerve stimulation and inactivation for the next generation neural prosthetics.

Keywords

Micro/Nanofabrication, Separation and Analysis of Biomolecules, BioMEMS, Cell Sorting, Inertial Microfluidics, Microfluidics and Nanofluidics, Electrokinetics and Its Applications, Biological and Physiological Transport Phenomena, Neural Prosthetics and Neurotechnology, Desalination and Chemical Separation

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