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MIT technology insider

JULY – SEPTEMBER 2003

Quarterly Report

AN MIT ENTERPRISE
TECHNOLOGY
REVIEW

MIT RESEARCH AND DEVELOPMENT INFORMATION
FROM THE 3RD QUARTER, 2003

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Quarterly Report

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Patents

PATENTS ISSUED TO MIT DURING THE FIRST QUARTER OF 2003

PATENT TITLE	PATENT NO.	ISSUE DATE	COUNTRY
New ligands for ADH:multiple cinchona alkaloid units attached to a central heterocyclic core	2120919	July 1	Canada
High-density mechanical memory and Turing machine	6587408	July 1	US
Bipolar cascade arrow laser	6587492	July 1	US
Optical and electrical methods and apparatus for molecule detection	05-519396	July 4	Japan
Microturbomachinery	2262854	July 8	Canada
Double-chirped mirror systems and methods	6590925	July 8	US
Multiple-viewer auto-stereoscopic display systems	6593957	July 15	US
Force reflecting haptic interface	2172825	July 22	Canada
Method for identifying or characterizing properties of polymeric units	6591996	July 22	US
Jetting layers of powder and the formation of fine powder beds thereby	6596442	July 22	US
EGL-1, a new protein required for programmed cell death in c. elegans that interacts with the BCL-2-like protein CED-9	6596495	July 22	US
Digital circuit synthesis system	6597664	July 22	US
Periodic dielectric structure having a complete three-dimensional photonic band gap	6597851	July 22	US
Closed-loop multistage beamformer	6598014	July 22	US
Compositions and methods comprising helicobacter antigens for the treatment and prevention of inflammatory bowel disease	6599509	July 29	US
Semiconductor nanocrystals for inventory control	6602671	August 5	US
Method and apparatus for detecting malfunctions in communication systems	6603112	August 5	US

PATENT TITLE	PATENT NO.	ISSUE DATE	COUNTRY
Nanostructured thermoelectric materials and devices	6605772	August 12	US
Tellurium-containing nanocrystalline materials	6607829	August 19	US
Suppression of immune response via inhibition of cathepsin S	6608030	August 19	US
High-definition imaging apparatus and method	6608585	August 19	US
Speed-adaptive and patient-adaptive prosthetic knee	6610101	August 26	US
Controlled conversion of metal oxyfluorides into superconducting oxides	6610428	August 26	US
Laser intensity noise suppression using unbalanced interferometer modulation	6616353	September 9	US
Poly (ethylene oxide) coated surfaces	6616982	September 9	US
System and method for increasing the diffraction efficiency of holograms	6621633	September 16	US
Optical waveguides with trench structures	6621972	September 16	US
Digital array stretch processor employing two delays	6624783	September 23	US
Polarized light scattering spectroscopy of tissue	6624890	September 23	US
Thin film filters using omnidirectional reflectors	6624945	September 23	US
Superlattice structures having selected carrier pockets and related methods	6627809	September 30	US
High definition imaging apparatus and method	6628844	September 30	US

Technology Transfer

LICENSES GRANTED BY MIT TO COMPANIES DURING THE THIRD QUARTER OF 2003

DATE	LICENSE AGREEMENT	DEVELOPER	COMPANY
August 7	MIT Case No. 9930, "Program Shepherding," by Saman Amarasinghe, Derek Bruening and Vladimir Kiriansky	Nand Mulchandani	Araksha 350 Marine Parkway Suite 220 Redwood City, CA 94065 nand@araksha.com 650-637-5502
August 15	MIT Case No. 8006, "Nonaqueous solutions or suspensions of proteins and nucleic acids for pulmonary delivery of such pharmaceutical biomacromolecules," by Alexander M. Klibanov	Mark Gabrielson	Pulmatrix 650 Albany St Boston, MA 02118 mgabrielson@pulmatrix.com

Published Research

A SELECTION OF RECENT PAPERS PUBLISHED BY MIT RESEARCHERS

Most papers can be purchased online through Science Direct (www.sciencedirect.com).

TITLE **Fabrication of ultra-thin strained silicon on insulator**

AUTHORS Drake, T.S., C. Ní Chléirigh, M. L. Lee, A. J. Pitera, E. A. Fitzgerald, D. A. Antoniadis, D. H. Anjum, J. Li, R. Hull, N. Klymko, and J. L. Hoyt

PUBLICATION *Journal Of Electronic Materials*, Vol. 32, Issue 9, September 2003, pp. 972-975.

SUMMARY A bond and etch back technique for the fabrication of 13-nm-thick, strained silicon directly on insulator has been developed, with surface roughness of less than 1 nm. Ultra-thin strained silicon-on-insulator substrates are promising for the fabrication o strained silicon metal-oxide semiconductor field-effect transistors (MOSFETs).

TITLE **Embryonic stem cell-specific MicroRNAs**

AUTHORS Houbaviy, Hristo B., Michael F. Murray, and Phillip A. Sharp

PUBLICATION *Developmental Cell*, Vol. 5, Issue 2, August 2003, pp. 351-358

SUMMARY The authors identified microRNAs in undifferentiated and differentiated mouse embryonic stem cells. Their results suggest that miRNAs may have a role in the maintenance of the pluripotent cell state and in the regulation of early mammalian development.

TITLE **Terahertz quantum-cascade laser using metal waveguide for mode confinement**

AUTHORS Williams, Benjamin, S. Kumar, H. Callebaut, Qing Hu, and J. L. Reno

PUBLICATION *Applied Physics Letters*, Vol. 83, Issue 11, Sept. 15, 2003, pp. 2124-2126

SUMMARY A laser emitting 3.0-terahertaz pulses (wavelength about 100 micrometers) was fabricated using a quantum-cascade structure in which mode confinement was provided by a double-sided metal waveguide. This type of waveguide is expected to be increasingly advantageous at even longer wavelengths.

TITLE **Thermoelectric properties of superlattice nanowires**

AUTHORS Lin, Yu-Ming and Mildred S. Dresselhaus

PUBLICATION *Physical Review B*, Vol. 68, Issue 7, Aug. 15, 2003

SUMMARY A theoretical model was developed for the electronic structure and transport properties of superlattice nanowires. The authors studied the thermoelectric properties of superlattice nanowires made of various lead salts as a function of the segment length, wire diameter, crystal orientation along the wire axis, and the length ratio of the constituent nanodots of the superlattice. They conclude that superlattice nanowires hold promise for thermoelectric applications.

PUBLISHED RESEARCH CONTINUED

TITLE **Subwavelength imaging in photonic crystals**

AUTHORS Luo, C. Y. , S. G. Johnson, J. D. Joannopoulos, and J. B. Pendry

PUBLICATION *Physical Review B*, Vol. 68, Issue 4, July 15, 2003

SUMMARY The researchers investigated the transmission of evanescent waves through a slab of photonic crystal; they explore the recently suggested possibility of a "superlens" that focuses light with subwavelength resolution.

TITLE **Emotion and sociable humanoid robots**

AUTHORS Cynthia Breazeal

PUBLICATION *International Journal Of Human-Computer Studies*, Vol. 59, Issue 1-2, July 2003, pp. 119-155

SUMMARY The author focuses on the role of emotion and expressive behavior in regulating social interaction between humans and expressive anthropomorphic robots. She presents the scientific basis underlying a humanoid robot's emotion models and expressive behavior, and shows how these scientific viewpoints have been adapted in a robot that can recognize affective intent through tone of voice.

TITLE **Rehabilitation robotics: Performance-based progressive robot-assisted therapy**

AUTHORS Krebs, Hermano Igo, Jerome J. Palazzolo, Laura Dipietro, Bruce T. Volpe, and Neville Hogan

PUBLICATION *Autonomous Robots*, Vol. 15, Issue 1, July 2003, pp. 7-20

SUMMARY Clinical studies involving more than 200 stroke patients shows that repetitive, task-specific, goal-directed, robot-assisted therapy is effective in reducing motor impairment in the affected arm after a stroke.

News

TOP STORIES REPORTED FROM LABS AFFILIATED WITH MIT

Mammoth Magnet

A 150-ton magnet developed in part by MIT engineers is pulling the world closer to nuclear fusion as a source of energy. Over the last three years "we've shown that we can design a magnet of this size and complexity and make it work," said Joseph Minervini, a senior research engineer at MIT's Plasma Science and Fusion Center and Department of Nuclear Engineering. Minervini notes, however, that a better understanding of certain results is necessary to reduce costs for the researchers' ultimate goal: a magnet weighing 925 tons that will be key to the International Thermonuclear Experimental Reactor (ITER). That magnet, in turn, will be part of a total magnet system weighing some 10,000 tons. ITER goals include demonstrating the feasibility of nuclear fusion as an energy source, which Congress has recently shown increased interest in. In September 2002 a Department of Energy panel recommended that the United States re-join the multi-nation ITER collaboration. In 1999 Congress appropriated funding for completion of R&D commitments toward ITER, but not for an extension of participation in the project. Fabrication of the U.S. portion of the magnet was funded by the Department of Energy, primarily through a multi-year grant to MIT. Other U.S. industrial tasks were performed by more than 20 vendors.

Physical Protection of Data

Researchers at MIT's Center for Bits and Atoms reported a new physical approach to protecting information such as credit card numbers sent over the Internet or electronic cash stored in smart cards. These types of data are currently protected by cryptographic techniques, but the mathematical algorithms that underlie these techniques would be threatened by the development of quantum computers. In addition, skilled engineers could tamper with the chips used to store cryptographic secrets. MIT alumnus Ravikanth Pappu—working with Neil Gershenfeld, associate professor and director of the Center for Bits and Atoms, and MIT Media Lab graduate students—introduced the concept of physical rather than mathematical one-way functions. (A one-way function is easy to evaluate but hard to unravel, such as multiplying large prime numbers vs. finding the factors of their product.) The MIT researchers create a physical one-way function by connecting cryptography with mesoscopics, the study of how waves travel in disordered materials. The researchers believe this new approach will improve information security on the Internet and elsewhere. Their work was supported by the National Science Foundation, corporate partners in the MIT Media Lab, and an IBM research fellowship.

Advances against Schizophrenia

The discovery by researchers in the Picower Center for Learning and Memory of a gene variation in mice that could cause schizophrenia may lead to the first gene-targeting drug for this debilitating mental illness. The study was led by Nobel laureate Susumu Tonegawa, director of the Picower Center. It involved breeding genetically altered mice that lacked a key brain protein, calcineurin. The absence of this protein was previously thought to result only in loss of short-term memory. However, the researchers also found that calcineurin-deficient mice displayed symptoms of schizophrenia, like attention deficits and abnormal social behavior.

In additional tests, scientists from MIT and from Rockefeller University in New York checked DNA samples from schizophrenia patients and their relatives for the calcineurin gene. These tests revealed links between schizophrenia and a particular calcineurin gene—one similar to but not identical with the gene in the mice study. "The combination of evidence from the genetically altered mice, along with the human gene studies, gives a strong indication of calcineurin's link with schizophrenia," says MIT research scientist David Gerber.

Fighting Pollution in Megacities

MIT professor Mario Molina—winner of the 1995 Nobel Prize in chemistry for work that proves chlorofluorocarbon gases are destroying the ozone layer—is leading a group that is studying effective strategies for fighting air pollution in large urban centers. Mexico City, one of the world's most polluted cities, is serving as a case study.

The group, which includes scientists from MIT, the Harvard School of Public Health, and other U.S., Mexican, and European institutions, is using computer models to simulate atmospheric chemistry and to assess various pollution-control measures, such as restricting vehicle circulation and closing industrial plants near the city. To construct reliable models, the researchers are using their comprehensive field work in Mexico City as a source of accurate data about pollution. Employing a van carrying more than $1.5 million worth of instruments, Molina's group chased cars, trucks, and buses, measuring their emissions in real time.

The researchers are now analyzing hundreds of gigabytes of collected data. Ultimately, they hope their work will lead to cleaner air in other large polluted cities such as São Paulo, Bangkok, and Beijing.

Treatment for Chronic Lung Disease

A new method to increase the amount of oxygen in the bloodstream developed by an MIT-affiliated researcher could improve the quality of life of people with chronic lung disease. It could also decrease the mortality rate of those awaiting lung transplants by serving as a transition therapy. Richard Gilbert, a physician allied with the Department of Mechanical Engineering, devised the method for extracting oxygen from the water within a patient's blood cells. That oxygen then binds to the hemoglobin in the cells, raising the oxygen level in the blood until it matches that produced by healthy lungs. The patient's blood is removed from the body (as in kidney dialysis) and passed over a piece of glass coated with a thin skin of titanium oxide. Ultraviolet light energizes the titanium, which draws electrons from the water, freeing oxygen molecules. Then the oxygenated blood is pumped back into the body. Gilbert believes his system could allow people afflicted with chronic lung disease to lead normal lives. The first device to employ this system will be a portable one about the size of a breadbox. Gilbert estimates it will be available within five to ten years.