Nanoelectronics & Integrated Systems

BOISE STATE UNIVERSITY Research MATTERS

Boise State is Idaho's leader and a national player in nanotechnology research that could open the doors to a broad range of new microelectronics products and applications. From revolutionizing how computers store information to enabling satellites to probe farther into space, our program is focused on the future.

DEFINITIONS

NANOELECTRONICS is the technology of electronic devices on a nanoscale level, generally defined as between 1 and 100 nanometers in size. (A nanometer is one-billionth of a meter; a sheet of paper is about 100,000 nanometers thick.) At a nanoscale level, materials can exhibit unusual physical, chemical and biological properties that can be harnessed to develop electronic devices with new or expanded capabilities.

Boise State's nanoelectronics program involves an "atoms to systems" approach with a focus on developing **INTEGRATED SYSTEMS** for use in next-generation computers, satellites, sensing systems and for many other uses.

AT-A-GLANCE

STATEWIDE RESEARCH initiative for non-volatile memory research established by U.S. Air Force Research Laboratory at Boise State

PH.D., MASTER'S, and undergraduate students work as paid members of faculty research teams and present findings at conferences around the world

PENDING PATENTS for Forced Ion Migration for Chalcogenide Phase Change Memory Device, and for Multi-State Memory and Multi-Functional Devices; faculty also are recipients of many other awarded patents

INDUSTRY PARTNERSHIPS with Micron Inc., Stellar Micro Devices and others, as well as collaborations with NASA, FAA, U.S. Air Force Research Lab, U.S. Department of Energy, U.S. Department of Defense and many other federal and state agencies

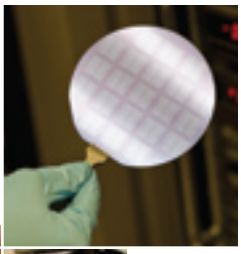
INTERNATIONAL SYMPOSIUM on non-volatile memory research hosted annually by Boise State University draws top researchers from around the world

INTERDISCIPLINARY PROGRAMS bring together faculty in chemistry and biochemistry, materials science and engineering, and electrical and computer

PROJECTS

Nanoelectronics projects pursued by Boise State researchers include:

Computer Memory research aimed at developing new types of non-volatile memory (NVM). Unlike volatile memory, NVM remains even when a computer is not powered



Vacuum Electronics studies to develop a new generation of "smart" microwave vacuum electron devices (MVEDs) for use in radar, jamming, communication and imaging systems

Research on Ferroelectric thin films – materials only a few nanometers thick that can be polarized into switchable electric states

Multi-State Memory device development that utilizes properties of an alloy that automatically changes shape in the presence of a magnetic field

Spintronics-Based research to develop new types of computer processors. Spintronics is an emerging field of nanoscale electronics involving the detection and manipulation of electron spin

Wireless Sensor Platform development to test new computer memory technologies, allowing faults to be identified and corrected early

'Nanoionic' Computer Memory development that utilizes the electrochemical properties of chalcogenide glasses to develop new types of non-volatile computer memory. This type of memory relies on ion transport and chemical change at the nanoscale level and can be downscaled to provide more storage in a smaller space

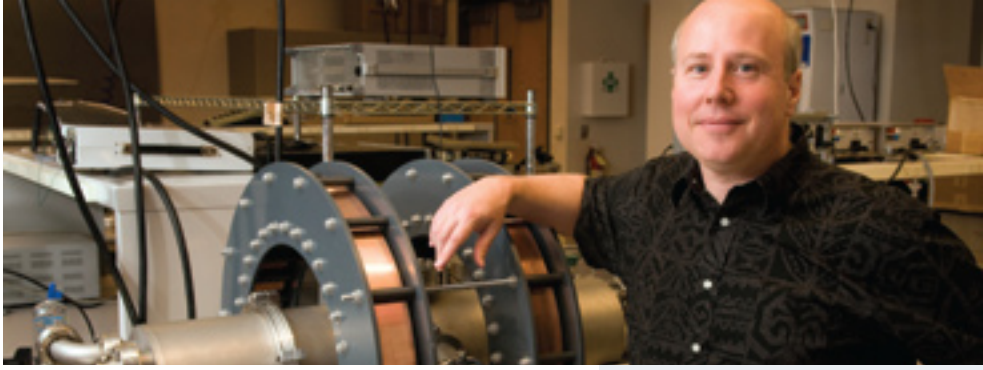
CAPABILITIES

Facilities include the Idaho Microfabrication Laboratory, the SPM Systems and Nanofabrication Laboratory, the Device and IC Characterization Laboratory, the C-MEMS Laboratory and others

"Our goal is to address some of the fundamental limitations of computer data storage. By focusing on issues such as size, speed, volatility and power, we can help pave the way for a new generation of microelectronics products."

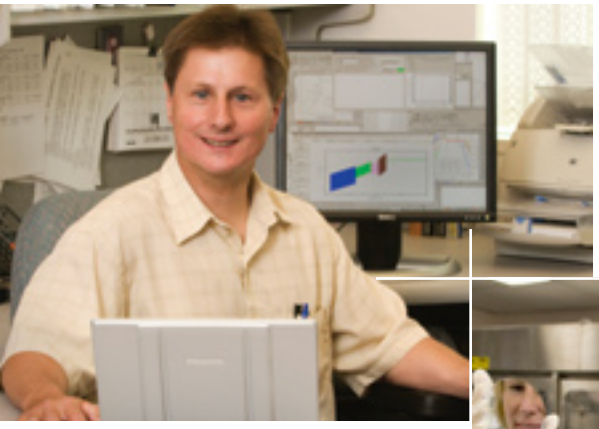
— Dr. Kris Campbell, (pictured above)
Associate professor, Department of Electrical and Computer Engineering, principal investigator for statewide Non-Volatile Memory Research Initiative

BOISE STATE PROFILES/ Nanoelectronics & Integrated Systems



WILLIAM KNOWLTON, PH.D.

Research conducted by Dr. Knowlton (pictured below) and his students could lead to advances in the durability, performance and energy requirements of cell phones, computers, MP-3 players and other microelectronics devices. Dr. Knowlton and his team are



studying the mechanisms by which electrons travel through the nanoscale layers of insulator materials found in a common type of circuitry called metal oxide semiconductors or MOS. By understanding the complex electrical behavior in devices with a number of extremely thin insulator layers stacked on top of each other, researchers can develop new types of computer memory for next-generation microelectronics products. The research involves lab experiments, including studying the materials at extremely low temperatures and over a broad range of voltages, and the development of computational models. Dr. Amit Jain is collaborating with Dr. Knowlton on the development of a second computer program as part of this project.

JIM BROWNING, PH.D.

With funding from the U.S. Department of Defense, Dr. Browning (pictured top right) is conducting research to develop a new generation of "smart" microwave vacuum electron devices (MVEDs) for use in radar, jamming, communication and imaging systems. The "smart" devices would be capable of automatically changing operating modes in real time in order to maintain constant output and performance – an advance that could be used to improve the efficiency and capabilities of radar systems and other applications.

Dr. Browning is pursuing research involving vacuum technologies with partnerships in both the public and private sectors. With funding from the DOD, he also is working with Stellar Micro Devices of Austin, Texas, to develop a miniaturized device to generate high-frequency electromagnetic waves. The tiny device, called a micro vacuum backward wave oscillator, would be capable of generating electromagnetic waves at a frequency of more than 100 billion cycles per second (100 Ghz). It might someday be used as the source to analyze material properties, provide satellite-to-satellite communication, or to provide medical imaging in place of X-rays.

BETH COOK, GRADUATE STUDENT FROM MERIDIAN, IDAHO

Cook works with Dr. Kris Campbell on the development of new types of non-volatile memory, or NVM. The research project has kept Cook employed at Boise State and has also sent her around the world. During summer 2009, Cook spent a month at Kirkland Air Force Base in Albuquerque, N.M., after being named an Air Force Research Lab Space Scholar. Cook's main task at Kirkland was to conduct characterization tests on Campbell's NVM devices, including tests to determine how the devices were affected by radiation. She and Dr. Campbell also traveled to Utrecht, The Netherlands, to present a research paper at the International Conference on Amorphous and Nanocrystalline Semiconductors. After completing her master's degree next year, Cook plans to enroll in Boise State's Ph.D. program in electrical engineering and to pursue a career in research and academia.

RESEARCH GRANTS

Here is a sampling of grants related to nanoelectronics research at Boise State:

Reconfigurable Electronics and Non-Volatile Memory Research
U.S. Department of Defense
$2.8 million

Ultraviolet Raman Spectroscopy of Ferroelectric and Multiferroic Nanostructures
Research Corporation
$40,968

Development and Investigation of Transition-Metal-Doped Ferromagnetic SN02 Thin Films and Structures
National Science Foundation
$400,000

A Smart Microwave Vacuum Electron Device Using Field Emitters
U.S. Department of Defense
$541,607

Lattice Dynamics and Phase Transitions in Nanoscale Ferroelectric Heterostructures
National Science Foundation
$240,000

Numerical and Experimental Study of Electrodynamics and Electron Interaction in Surface Plasmon-Polariton Nanophotonic Heterostructure Devices
National Science Foundation
$400,000

Acquisition of Mode-Locked Pulsed Laser Source and Measurement System
National Science Foundation
$627,125

BOISE STATE UNIVERSITY Research MATTERS

As an emerging metropolitan research university of distinction, Boise State University is committed to fostering an environment where exceptional research and creative activity thrive.

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