COLLEGE OF ENGINEERING
THE UNIVERSITY OF TOLEDO

UT Engineering New Research Grant Award

Project	BRIGE: Transition Metal Oxide Based Multifunctional Nanoelectronic Memristor Devices
Principal Investigator	Dr. Rashmi Jha Assistant Professor of Electrical Engineering and Computer Science
Co-Principal Investigator(s)	--
Sponsor(s)	National Science Foundation
Project Duration	October 2011 –September 2013
Sponsor Award Amount	$171,089

ABSTRACT

Intellectual Merit: The two terminal nanoelectronic memristor devices offer an attractive solution for addressing the needs of high-density non-volatile data storage beyond the fundamental limits of Complementary Metal Oxide Semiconductor (CMOS) technology. The unique charge-flux characteristics of memristor devices offers applications in several key areas including high-density and high-performance digital data storage, digital computing, analog non-volatile memory, adaptive neural circuits, and energy-efficient massively parallel neuromorphic computing. This BRIGE project experimentally investigates memristive devices with Hafnium dioxide (HfO2) based switching layer and metal electrodes such as Tungsten (W), Nickel (Ni), Titanium Nitride (TiN), and Ruthenium (Ru). The research develops a fundamental knowledge about the charge transport mechanisms responsible for the switching behavior and how it depends on several process and device parameters such as the composition and thickness of the switching layer, electrodes, and oxygen vacancies concentration in the switching layer. Finally, the project seeks to demonstrate the application of these devices for high-density and high-performance digital and analog memory by systematically studying the switching speed, non-volatile resistive states, reliability, durability, and data-loss effects.

Broader Impacts: The project on memristive devices is expected to have significant impact in the areas of consumer electronic products, energy- efficient extreme-scale computing, and development of self-learning adaptive circuits. The research will be tightly integrated with education at graduate, undergraduate, and high-school levels. The graduate and undergraduate students will gain significant experience in the areas of fabrication and electrical characterization of nanoelectronic devices, which will prepare them to address the challenges of nanoelectronics in 21st century. A course in the area of emerging memory devices will be developed by integrating lectures with hands-on laboratory experience for graduate and undergraduate students. An educational module with live demonstrations to teach the basics of semiconductor devices will be developed for the high school students. Participation in engineering research will be broadened at all levels through activities including research experience for undergraduates, and outreach activities focused on increasing the participation of underrepresented groups in engineering through summer camp for the high school girls, lab experience for the high school girls, active mentoring, and recruitment of the underrepresented students.

NGN: August 22, 2011