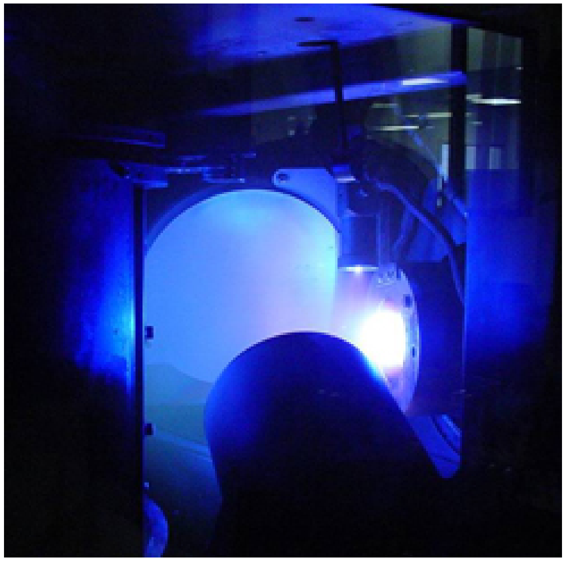
Nanoelectronics Research



My research group is focused on the study of spin dependent phenomenon in thin films and alternating multilayers of magnetic and non-magnetic metals, semiconductors and insulators. These structures exhibit large changes in resistance depending on the relative orientation of the magnetic layers and can be utilized for novel non-volatile random access memories or for read heads for magnetic hard drives and as nano-oscillators for a new paradigm of computation. (see below) Related structures that can utilize spin as a new state variable consisting of magnetic nanopillars embedded in a ferroelectric matrix can also be utilized as a novel non-volatile memory, and as reconfigurable logic, a potential replacement for conventional CMOS. The ultimate spintronic structure contains a single electron in either self-organized or electrically confined nano-structures and the electron spin can be manipulated by electric fields. Finally, we continue to explore multiferroics and novel metal magnetic oxide materials including iron, bismuth iron and manganese based materials. We have recently initiated a small effort on developing new hybrid superconducting/magnetic nanostructures and we hope this work will be expanded in the near future.
We are also exploring strongly correlated oxides, especially those that exhibit a metal to insulator transition. Our main focus has been on vanadium dioxide but more recently have been exploring other transition metal oxides.

Stuart Wolf

Professor
Director, University of Virginia Institute for Nanoscale & Quantum Scientific & Technological Advanced Research

saw6b@virginia.edu
www.virginia.edu/ms/people/faculty/wolf.html

Dept. of Materials Science & Engineering
University of Virginia
Charlottesville, VA
434.924.3503

"Pushing the frontiers in spintronics and quantum information."

UNIVERSITY of VIRGINIA ENGINEERING

Spintronics and Nanomagnetics

As conventional CMOS technologies are running into multiple "red brick walls" that are likely to slow down or even stop Moore's Law scaling during the next decade, there is a need for new material discoveries and new nanodevice and circuit paradigms that allow new applications that would be impractical or even impossible using traditional methods. Such new materials and design paradigms can revolutionize the semiconductor industry and have a significant impact on the society as a whole by allowing further exponential technical growth that has been the engine of progress for the economy and society in the past several decades. A major new effort in our lab centers around the fabrication, modeling, simulation, design space exploration and applications for Spin Torque Nano-Oscillators (STNOs). Specifically, we are emphasizing nano-arrays of such oscillators formed using patterned magnetic tunnels junctions with modulated coupling either through spin waves in the substrate or through electrical coupling with AC currents through the leads of the STOs.

Superconductivity and Superconducting Devices:

We have begun exploring a new memory structure combining a superconducting Josephson Junction surrounding a magnetic spin valve. This project will be a collaboration between my group and the superconducting electronics group at Northrop Grumman. Additionally, my group has made a theoretical prediction on a technique for raising the transition temperature of the already record breaking cuprates using a nanopatterning technique. We will be collaborating with the Lawrence Berkeley Laboratory on the project to demonstrate this enhancement.

Nanoelectronics:

We are exploring the metal insulator transition in vanadium oxide and other transition metal oxides for various switching and imaging applications. Vanadium oxide exhibits a four order of magnitude change in resistance and very large change in optical properties through this transition and we hope to exploit this in various high speed switching and imaging applications.

RECENT RESEARCH DEVELOPMENTS

- Found several new magnetic compounds that have properties ideal for magnetic random access memories including low damping
- Predicted a method for enhancing the transition temperature of cuprate superconductors
- Demonstrated the ability to tailor the transition temperature and properties of the metal to insulator transition (MIT)in VO_2
- Demonstrated the ability to fabricate single phase niobium dioxide with a >700C MIT

RECENT GRANTS

- NSF – EAGER:Nano-Patterned Coupled Spin Torque Oscillator (STO) Arrays-a Potentially Disruptive Multipurpose Nanotechnology
- Nanoelectronics Research Initiative – Virginia Nanoelectronics Center
- DOD/Army – Workshop on Future Direction in Physics and Materials Science: A Strategic Vision
- NSF – Novel Tunnel Barriers & Electrodes for Advanced Magnetic Tunnel Junctions

SEAS Research Information

Pamela M. Norris, Associate Dean

University of Virginia

Box 400242

Charlottesville, VA 22903

pamela@virginia.edu

434.243.7683

University of Virginia Engineering