Manufacturing Science and Technology
Room: C3 - Session MS+GR+MI-ThM

Manufacturing Issues for Beyond CMOS Nanoelectronics
Moderator: R.E. Geer, University at Albany

8:40am **MS+GR+MI-ThM3 Spin-Polarized Electrons in Silicon**, ***B. Huang***, *I. Appelbaum*, University of Maryland **INVITED**

In this talk, I will show how ballistic hot electron transport can be used for spin injection and detection in silicon. With this technique, we measure long conduction electron spin lifetimes which enable spin transport in silicon over long distances (up to 2mm). I will also discuss our investigations of spin dephasing and spin precession in oblique magnetic fields, and show how we realized spin precession control with an electric field.

9:20am **MS+GR+MI-ThM5 Methods for Characterizing Variations in Excitation Mode Frequency and Linewidth in Spin Transfer Nanocontact Oscillators**, ***M.R. Pufall***, *W.H. Rippard*, National Institute of Standards and Technology **INVITED**

Resonance probing of magnetoelectronic nanostructures with AC spin torque promises to provide a new means to understand their magnetic behavior, and their interaction with spin-polarized currents. An AC current produces an AC spin polarized current, which in turn produces a time-varying torque. By varying the frequency of the current, the resonance spectrum of the structure can be investigated. By this method, the ferromagnetic resonance mode of metallic and tunnel junction nanopillars has been investigated, and in nanocontact structures, enables probing the ferromagnetic resonance and damping of continuous films at unprecedented length scales.

However, for this tool become the more generally useful, the details of the signals produced by AC spin torque must be better understood. Beyond the ferromagnetic resonance mode, other responses are observed that have not been predicted; in nanocontacts, due to the unbounded geometry, prediction of modes beyond the ferromagnetic resonance in even more difficult. Furthermore, the shape of the ferromagnetic resonance line itself can vary in a complicated way, depending on the sample geometry and materials. As a step towards the goal of developing a robust tool that gives quantitative information about nanocontact spin transfer oscillators, I will present AC spin torque measurements from a variety of field geometries, and of materials with either in- or out-of-plane anisotropy, describing the basic behavior observed in each case. Then, I will compare different methods of ferromagnetic resonance detection (frequency-swept linewidth, field swept linewidth, field or microwave modulation) and discuss the challenges associated with interpreting these results to obtain the damping constant and the zero-field field-swept linewidth.

10:40am **MS+GR+MI-ThM9 Large Area, Continuous Single- and Few- Layer Graphene Films on Insulating Substrates**, ***J. Kong***, Massachusetts Institute of Technology **INVITED**

Graphene has exceptional electronic, thermal and mechanical properties. For the realization of graphene-related applications, it is necessary to develop reliable and low cost fabrication methods of graphene-based structures, ideally on any substrates. In this talk I will present our method of fabricating large area (~cm^2) films of single- to few-layer graphene and transferring the films to arbitrary substrates. The graphene films are synthesized by ambient pressure Chemical Vapor Deposition, consist of regions of 1 to ~10 graphene layers and have an average thickness of 2-3 nm. The structure of the graphene films are characterized with various methods, such as atomic force microscope, transmission electron microscope, scanning tunneling microscope and Raman. Detailed understanding in the growth mechanism provides guidance for improving the quality of the graphene films. The method presented in this work can potentially be scaled to industrial production of graphene films, for applications such as ultra-thin conductive and transparent electrodes, or devices and interconnect for integrated circuits.

11:20am **MS+GR+MI-ThM11 Graphene Nanoelectronics for Post-CMOS Logic Switches**, ***C.Y. Sung***, IBM T.J. Watson Research Center **INVITED**

Electron charge has been the computational state variable for decades. However, a new switch is urgently needed because scaling may fail to keep providing performance-cost benefits. We report the scaling limits and graphene research in monolayer synthesis, transistor engineering and new state variable logic switches. We demonstrate graphene nanoelectronics feasibility by monolayer-control wafer-scale synthesis, high performance device fabrication, bandgap engineering, for low-power, low noise performance and process integration. Computation with less power requires switches with alternative state variables. Graphene, with many desirable properties, emerge as a promising post-CMOS logic candidate.

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