PCSI

Room Keauhou II - Session PCSI-SuE

Coherent Effects in 0D Systems

Moderator: Erik Bakkers, Eindhoven University of Technology

7:30pm **PCSI-SuE-1 Rational Design of Coordination Complexes for Quantum Information***, **Danna Freedman**,* Northwestern University **INVITED**

Careful synthetic design of molecules and coordination materials enables the construction of systems with precise control over electronic spin location and nuclear spin distance. Harnessing the tools of synthetic chemistry we can address simple questions such as the relationship between electronic spin coherence time and nuclear spin proximity. We can progress from asking those questions to constructing materials where candidate qubits or quantum sensors are precisely positioned with atomic level reproducibility. Conferring a high level of precision to the location and orientation of quantum objects is a vital prerequisite for the design of quantum sensors and quantum information processing systems. This talk will focus on fundamental questions that can be addressed by coordination chemistry.

8:00pm **PCSI-SuE-7 Detecting Low-Intensity Light at the Interface of Chromophores and Diamond***, **Nicholas Harmon**, M Flatté,* University of Iowa

Long spin coherence times of nitrogen vacancy (NV) center spins in diamond under ambient conditions have made these systems attractive candidates for quantum information processing. Substantial progress has been accomplished in using NV centers as nanoscale magnetometers. Aside from zero-field splitting, the spin-orbit interaction in conjunction with an electric field also induces spin splitting of the $m_s = \pm 1$ states. The dependence of the NV ground state on electric field suggests these centers are also useful as electric field sensors.

We develop a theory in which the optical output of an NV center is used to determine the presence of an electric field. Beyond this utility, we also present a nanoscale model of few photon detection accomplished when a chromophore lies at the interface of a NV center in diamond. Photons incident upon the chromophore induce a conformational change which includes a sizable charge polarization and electric dipole moment (>10 D). Using the formalism of positive operator values measurements (POVMs), we predict the existence of the photo-excited electric dipole field and, by extension, the incident photon given a measured readout state (photoemission) from the NV center. We find that an applied magnetic field plays a non-trivial role that can reduce the error rate. We describe a scheme by which the time of the incident photon can be resolved. Finally we investigate the role of multiple, coupled NV centers interfaced with multiple chromophores in offering spatial resolution to the detection.

8:15pm **PCSI-SuE-10 A New Approach to Magnetic Resonance at Heterointerfaces: Spin Dependent Charge Pumping in 4H-SiC MOSFETs***, **Patrick Lenahan**, M Anders,* The Pennsylvania State University*; A Lelis,* U.S. Army Research Laboratory **INVITED**

Although 4H SiC MOSFETs have great promise in high power and high temperature applications, their great promise is limited by the presence of a defective silicon carbide- silicon dioxide interface region. We have utilized a new electron paramagnetic resonance (EPR) approach to explore the defect structure at these SiC- oxide interfaces in fully processed transistors: multi-field and RF frequency spin dependent charge pumping.

Conventional electron paramagnetic resonance (EPR) offers unrivalled analytical power for the identification of point defects in semiconductors and insulators. Unfortunately, the sensitivity of conventional EPR measurements is, at best, about ten billion total defects. This sensitivity is inadequate for measurements in most devices of technological significance. A second limitation of conventional EPR in device physics studies is that it is sensitive to all paramagnetic defects within structure under study. EPR detection via electrically detected magnetic resonance (EDMR) can overcome both of these limitations. It provides a sensitivity typically at least ten million times higher than that of conventional EPR and is also exclusively sensitive to defect centers which impact the electronic behavior of the devices.

EDMR studies nearly always utilize spin dependent recombination (SDR). SDR is quite sensitive to deep level defects but, in studies of heterointerfaces such as the SiC/SiO_2 boundary, defects throughout the entire interface bandgap can be important. In this study, we utilize a new EDMR approach to investigate the silicon carbide silicon dioxide interface: multi-magnetic field and RF frequency spin dependent charge pumping (SDCP).

SDCP allows quite sensitive EDMR measurements of interface defects with levels throughout nearly the entire interface bandgap. The SDCP sensitivity is very nearly magnetic field and frequency independent and is typically more sensitive than SDR. The enhanced sensitivity as well as the field and frequency independence allows us to make measurements at resonance frequencies as high as 16 GHz and as low as 85 MHz. The multi-field and frequency measurements yield information about the relative contributions of hyperfine and spin orbit interactions and thereby aid in defect identification. In this presentation I will briefly review the physics involved in SDCP and discuss the defects which we observe via SDCP. In addition, I will briefly outline the close connection between the low frequency SDCP and a near zero field non- resonant response in the charge pumping currents. The near zero field response may one day provide a remarkably simple tool for the study of interface defect structure.

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