Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Nanoelectronics and quantum transport based on semiconductor nanowires[1]

CHARLES LIEBER[2], Harvard University

Semiconductor nanowires represent a uniquely powerful platform for exploring a diverse range of physical phenomena at the nanoscale due to the demonstrated capabilities of rational design and precise control of diameter, composition, morphology electronic properties during synthesis. In this talk, we will review advances of nanowires as high performance transistor and quantum devices with a focus on the prototypical Ge/Si core/shell nanowire heterostructure model system. First, a clean one-dimensional hole gas is formed due to band structure design, which sustains ballistic transport up to room temperature. Large subband spacing indicates a truly one-dimensional channel. Second, field-effect transistors utilizing Ge/Si nanowire heterostructure as the active channel are discussed with results demonstrating that these devices can outperform state-of-the-art Si MOSFETs. Third, the scaling of transistors with sub-100 nm channels are discussed with respect to pushing performance limit. Measurements and analyses show that devices with channel lengths down to 40 nm operate close to the ballistic limit and provide an intrinsic speed of 2 THz. Finally, advances in top-gate defined multi-quantum dot devices are reviewed, where control of contact transparency is used to enable studies in different quantum regimes. A fully tunable double quantum dot with integrated charge sensor is demonstrated. The characterization of charge transport and spin states, as well as its promise as a long coherence time spin qubit will be discussed.

[1]Presented by Yongjie Hu.

[2]Quantum dot studies done in collaboration with F. Kuemmeth, H. Churchill, C. Marcus.