Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Atomic Precision Donor Devices Fabricated on Strained Silicon on Insulator (sSOI) with SiGe E. YITAMBEN, E. BUSSMANN, D.A. SCRYMGEOUR, M. RUDOLPH, S.M. CARR, D.R. WARD, M.S. CARROLL, Sandia National Laboratories — Recently, Si:P donor spin qubits have achieved coherence times (nuclear & e-) that underscore their quantum computing potential. One next major challenge is to integrate donors into a gated structure where electrons can be moved between P, or drawn off of the P to interact, e.g. to an interface as in Kane's proposal. A key constraint is limited thermal budget, to limit P thermal segregation, which precludes typical gate oxidation of Si. We are developing an alternative materials stack utilizing an interfacial barrier layer of relaxed epitaxial SiGe, with donors placed in a strained Si-on-insulator (sSOI) substrate. We fabricate atomic precision donor structures in sSOI via STM hydrogen lithography. Utilizing Si microfabrication and STM in tandem with our Si and Ge molecular beam epitaxy (MBE), we fabricated devices to test our SiGe/sSOI stack concept and atomic-precision fab techniques. To establish our donor-doping capability, we made Hall and Van der Pauw devices in P:sSOI delta-doped layers exhibiting $n_e > 10^{14}/cm^2$ and mobilities of ˜100 cm^2/Vs (T=4K) similar to results reported relaxed Si reported elsewhere. Second, we have grown our concept epitaxial SiGe/sSOI stack, evaluated the morphology using STM, and fabricated Hall devices to evaluate low-T transport in our first SiGe/sSOI. Here, we report on these advances in atomic precision donor fab, along with STM analysis our MBE SiGe/sSOI. This work extends STM-based atom precision fab on strained Si toward a vertically gated architecture.

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Date submitted: 04 Nov 2015 Electronic form version 1.4