Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Annealing shallow traps in electron beam irradiated high mobility metal-oxide-silicon transistors JIN-SUNG KIM, ALEXEI TYRYSHKIN, STEPHEN LYON, Princeton University, Department of Electrical Engineering — In metal-oxide-silicon (MOS) quantum devices, electron beam lithography (EBL) is known to create defects at the Si/SiO_2 interface which can be catastrophic for single electron control. Shallow traps ($\sim$meV), which only manifest themselves at low temperature ($\sim$4 K), are especially detrimental to quantum devices but little is known about annealing them. In this work, we use electron spin resonance (ESR) to measure the density of shallow traps in two sets of high mobility (μ) MOS transistors. One set (μ=14,000 cm^2/Vs) was irradiated with an EBL dose (10 kV, 40$\mu C/cm^2$) and was subsequently annealed in forming gas while the other remained unexposed (μ=23,000 cm^2/Vs). Our ESR data show that the forming gas anneal is sufficient to remove shallow traps generated by the EBL dose over the measured shallow trap energy range (0.3-4 meV). We additionally fit these devices' conductivity data to a percolation transition model and extract a zero temperature percolation threshold density, n_0 ($\approx 9\times10^{10}$ cm^{-2} for both devices). We find that the extracted n_0 agrees within 15% with our lowest temperature (360 mK) ESR measurements, demonstrating agreement between two independent methods of evaluating the interface.

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Date submitted: 11 Nov 2016 Electronic form version 1.4