Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Characterisation of potential barriers in a donor quantum dot defined by hydrogen resist lithography.[1] ANDREAS FUHRER, NIKOLA PASCHER, IBM Research - Zurich — We use a four terminal donor quantum dot (QD) to characterize potential barriers between degenerately doped nanoscale contacts. The QD is fabricated by hydrogen resist lithography on Si(001) in combination with n-type doping from the gas-phase. The four contacts have different separations (d = 9, 12, 16 and 29 nm) to a central 6 nm x 6 nm island, leading to different tunnel- and capacitive coupling. We use cryogenic transport measurements in the Coulomb blockade regime to simultaneously probe current flow in the four terminals for various voltage configurations. The magnitude of the measured tunnelling currents as a function of applied bias and contact separation sets a limit of about 15 nm for tunnelling contacts and shows a strong increase of the barrier transmission with applied bias. Using a constant interaction picture we extract the mutual capacitances between the QD and the four contacts which are found to be in excellent agreement with numerically calculated values. Our results contribute to a better understanding of tunnelling barriers and gate electrodes in planar dopant devices and pave the way towards reliable quantum device fabrication at the atomic scale.

[1]Support from EU grants PAMS, SiSpin, SiAM and from Swiss NCCR QSIT is gratefully acknowledged

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Date submitted: 05 Nov 2015 Electronic form version 1.4