Observation of coherent states in coupled nanocrystalline Si double dots at 4.2K

M. A. H. Khalafalla[*1,4], H. Mizuta[2,4], Z. A. K. Durrani[1,4], H. Ahmed[1,4] and S. Oda[3,4]

[1] *Microelectronics Research Centre, University of Cambridge*

[2] *Department of Physical Electronics, and* [3] *Research Center for Quantum Effect Electronics, Tokyo Institute of Technology*

[4] *CREST JST (Japan Science and Technology)*

[*] Email: mahk2@cam.ac.uk

We investigated coherent electron coupling effects at 4.2 K in Si quantum dots, formed by few nano-scale Si grains within a point-contact transistor defined in a ~40 nm thick nanocrystalline Si film. The point contacts are ~30 nm × 30 nm × 40 nm in size, with two side-gates. The grain size varies from sub-10 nm to 25 nm. Low temperature (650 °C – 750 °C) oxidation was used to oxidise the grain boundary tunnel barriers selectively. The process was optimised to obtain strong tunnel coupling between the Si grains. Conductance measured at 4.2 K as a function of the two side gate voltages showed Coulomb oscillation peaks, which partially form a charge stability diagram for two Si grains. The oscillation peak lines showed strong splitting caused by electrostatic interactions when the energy levels in the adjacent grains are resonant. We observed sets of four peaks in the split region, which fit well to the sum of four Lorentzian peaks. These peaks are attributable to resonant tunnelling through bonding-like and anti-bonding-like states, formed due to the wavefunction coupling across the adjacent grains.