Sonderforschungsbereich 631

Festkörperbasierte Quanteninformationsverarbeitung

TECHNISCHE UNIVERSITÄT MÜNCHEN

Seminar Announcement

TOWARDS ATOMIC-SCALE DEVICE FABRICATION IN SILICON

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Over the past three decades the driving force behind the expansion of the microelectronics industry has been the ability to pack ever more features onto a silicon chip, achieved by continually miniaturising the size of the individual components. However, after 2015 there is no known technological route to reduce device sizes below 10nm. In this talk we demonstrate a complete strategy towards atomic-scale (0.1nm) device fabrication in silicon using a combination of scanning tunnelling microscopy and atomic precision crystal growth as first envisaged by Tucker *et al*[1]. In particular we focus on the ability to place individual phosphorus atoms in silicon at precise locations[2] and encapsulate them in epitaxial silicon with minimal diffusion and segregation of the dopants[3]. We present results for the controlled fabrication of a nanoscale wire in silicon[4]. In particular we observe the cross-over from 2D to 1D behaviour as we confine the electrons using scanning probe microscopy. Finally we discuss the implications of this result for the construction of a solid-state silicon based quantum computer.

[1] J.R. Tucker and T.-C. Shen, Solid State Electron. **42**, 1061 (1998).

[2] S. R. Schofield, N. J. Curson, M. Y. Simmons, F. J. Ruess, T. Hallam, L. Oberbeck and R. G.Clark, "*Atomically precise placement of single dopants in Si*", Physical Review Letters **91**, 136104 (2003).

[3] L. Oberbeck, N. J. Curson, T. Hallam, M. Y. Simmons and R.G. Clark, "*STM imaging of buried P atoms in hydrogen terminated silicon for the fabrication of a Si:P quantum computer*", accepted for Thin Solid Films, 2004.

[4] F.J. Rueß, L. Oberbeck, M.Y. Simmons, K.E.J. Goh, A.R. Hamilton, T. Hallam, N.J. Curson and R.G. Clark, *"Fabrication of quantum wires using scanning probe microscopy"*, submitted to Nature March 2004.