Fabrication of On-Chip Microwave Antenna for Spin Qubit Control

Musqan Nighojkar
Kieran Spruce, Rajath Ravichandar, David Jonas, Mark Buitelaar, Taylor Stock

London Centre for Nanotechnology, 19 Gordon St, London WC1H0AH, U.K.

musqan.nighojkar.23@ucl.ac.uk

Donor spin qubits in silicon are promising candidates for quantum computing architectures due to their long coherence times and compatibility with existing semiconductor fabrication techniques. Using scanning tunnelling microscopy (STM) hydrogen-resist lithography, individual donor atoms can be positioned in the silicon lattice with atomic precision and assembled into planar nanostructures such as single-electron transistors (SETs), quantum dots, and single-donor atom qubits [1]. Building on established single-electron device characterization— including independent spin-state readout and spin correlation measurements— the next step is achieving local control of individual qubit spin states. This can be realized by post-fabrication integration of a microwave antenna on the surface of the donor device chip. These antennas guide input microwave signals along transmission lines terminating in short-circuit loops adjacent to the qubits, generating oscillating magnetic fields that drive spin-state transitions. This work presents the design and fabrication of these integrated control antennas and outlines future directions for advancing coherent control in donor-based quantum devices.

References

[1] Stock, T. J. Z.; Warschkow, O.; Constantinou, P. C.; Li, J.; Fearn, S.; Crane, E.; Hofmann, E. V. S.; Kölker, A.; McKenzie, D. R.; Schofield, S. R.; Curson, N. J. ACS Nano 2020, 14 (3), 3316–3327.

Figures

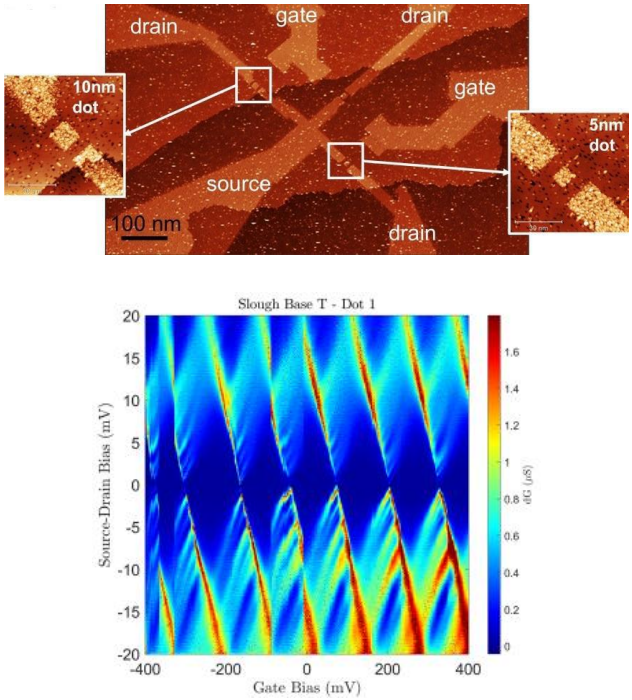

Figure 1: (a) Three-way quantum dot SET fabricated in silicon via STM hydrogen-resist lithography and **(b)** Coulomb diamond measurements of the same device.

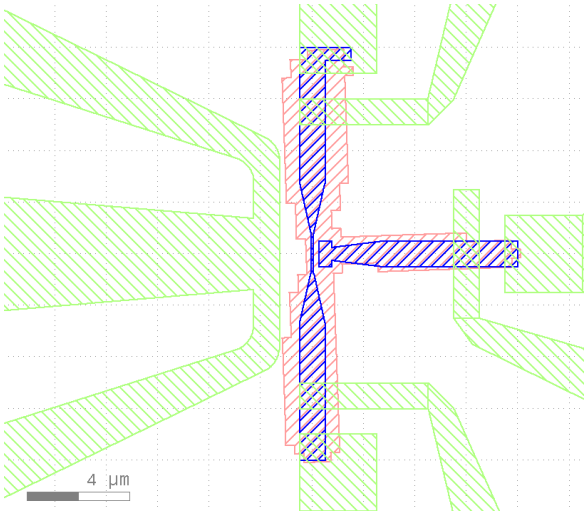

Figure 2: Microwave antenna (green) aligned to the device location determined post-fabrication (pink); nominal device design shown in blue. The device is contacted (green) based on this post-fabrication location.