Towards atomic-scale readout of acceptor cluster states in p-doped silicon.

T. Chutora[1], M. Yuan[1], C. Leon[1], F. Altincicek[1] , R. Achal[1], J. Croshaw[1], L. Livadaru[2], J. Pitters[3], R. Wolkow[1]

[1]Department of Physics, University of Alberta, Edmonton, Alberta T6G 2J1, Canada
[2]Quantum Silicon, Inc., Edmonton, Alberta T6G 2M9, Canada
[3]Nanotechnology Research Centre, National Research Council Canada, Edmonton, Alberta T6G 2M9, Canada;

chutora@ualberta.ca

Acceptor dopants in Si along with dangling bonds are enabling technologies for atomic-scale charge and spin-based qubit devices.[1] Additionally, recent advances in hydrogen lithography have enabled the patterning of quantum dot based circuit elements with atomic precision.[2] We used scanning probe microscopy to locate subsurface boron clusters that exhibit unique electronic signatures. By employing atomic fabrication, we coupled a boron cluster to a dangling bond wire on highly doped p-type H-Si(100) and characterized its electronic properties with scanning tunneling spectroscopy. dI/dV mapping reveals in-gap dopant hole states and features reminiscent of charging rings.[3] The coupled entity behaves like a conductive wire from which dopant hole states can be accessed and has a complex dependence on wire length. The ability to externally probe dopant acceptor states could potentially be used for readout and control of the qubit spin states.

References:

[1] A. Laucht et al., "Roadmap on quantum nanotechnologies", Nanotechnology, vol. 32, no. 16, p. 162003, 2021. Available: 10.1088/1361-6528/abb333

[2] T. Huff et al., "Binary atomic silicon logic", Nature Electronics, vol. 1, no. 12, pp. 636-643, 2018. Available: 10.1038/s41928-018-0180-3

[3] N. Turek, S. Godey, D. Deresmes and T. Mélin, "Ring charging of a single silicon dangling bond imaged by noncontact atomic force microscopy", Physical Review B, vol. 102, no. 23, 2020. Available: 10.1103/physrevb.102.235433