Hole-based quantum nanoelectronics

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Abstract

Hole spins in semiconductor quantum dots are emerging as a promising candidate for the realization of scalable spin-qubit architectures. Following an introduction to the field, I shall present recent advances in the development of hole-spin qubits based on foundry-compatible Si-MOS devices: the discovery of operational sweet spots maximizing hole-spin coherence[1] and the first demonstration of a strong-coupling between a hole-spin and a microwave photon in a superconducting resonator[1]. I shall conclude with an outlook on hole devices made from Ge/SiGe heterostructures, an emerging platform offering a unique combination of attractive properties[3].

References

[1] Piot et al., Nat. Nanotechnol. 17, 1072 (2022). https://doi.org/10.1038/s41565-022-01196-z
[2] Yu et al., Nat. Nanotechnol. (2023). https://doi.org/10.1038/s41565-023-01332-3
[3] Scappucci et al., *Nat Rev Mater* **6**, 926 (2021). https://doi.org/10.1038/s41578-020-00262-z

Figures

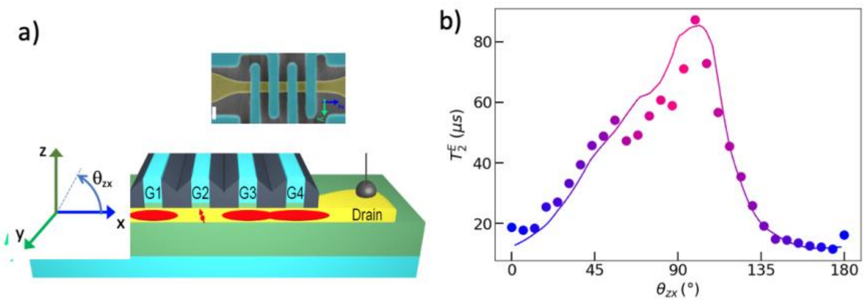

Figure 1: a) Four-gate Si-MOS device confining a single-hole spin qubit. b) Hahn-echo hole-spin coherence as a function of magnetic field angle. A sweet spot is obtained by aligning the field to the z axis.

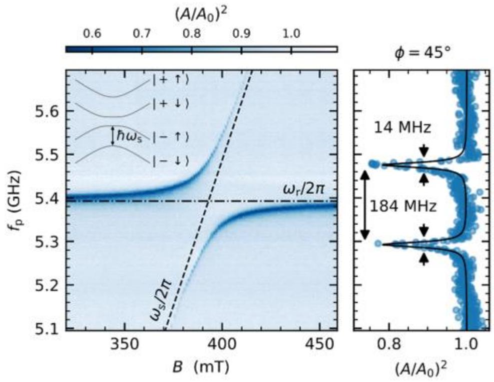

Figure 2: Vacuum Rabi splitting indicating strong quantum mechanical coupling between a microwave photon in a superconducting coplanar resonator and a hole spin confined in a device similar to the one in Fig. 1a.