Coherent control of a few-channel hole type gatemon qubit*

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Gatemons are the electrically tunable cousins of superconducting transmon qubits, in which the metallic Josephson junction is replaced by a gate-tunable superconducting weak link [1,2]. This allows the qubit frequency to be tuned by a gate voltage. Currently, gatemons are mostly realized in InAs platforms, relying on the unique epitaxially grown aluminum layer to provide a high-quality interface. Here, we demonstrate the full coherent control of a gatemon based on hole carriers in Ge/Si core/shell nanowires. For this purpose, we take advantage of the high-quality Josephson junctions that we obtain by simple ex-situ annealing step, in which superconducting Al penetrates into the Ge core of a nanowire from the reservoirs on both sides. We report full coherent control of the gatemon, with energy relaxation time up to ~1.3 µs, which is the longest coherence time in group IV material gatemons to date. In addition, we characterize the anharmonicity of the excitation spectrum in the device and show that the supercurrent through the nanowire junction is dominated by at most two conducting channels, with transparencies up to unity. Our results establish Ge/Si core/shell nanowires as a unique platform for novel quantum technologies, potentially also useful for other types of qubits like Andreev spin qubits [3], or for circuit QED experiments [4] with hole-carriers having a very large spin-orbit interaction.

References

[1] T.W. Larsen et al., Phys. Rev. Lett. 115 (2015) 127001.
[2] G. de Lange et al., Phys. Rev. Lett. 115 (2015) 127002.
[3] M. Hays et al., Science 373 (2021) 430.
[4] M. Mergenthaler et al., Phys. Rev. Applied 15 (2021) 064050.

*This research was supported by the Swiss National Science Foundation SNSF, Swiss Nanoscience Institute SNI, European Commission Horizon-2020 projects FET-open AndQC and TOPSQUAD.