Gate-tunable transmon qubit in 2-dimensional Germanium hole gas

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Abstract

Gatemons are superconducting qubits similar to transmons except that the Josephson element consists of a gate-tunable semiconducting weak link. Here, we present the realization of a gatemon device obtained by fabricating a microwave circuit in Aluminium on a SiGe heterostructure embedding a Ge quantum well. Owing to the superconducting proximity effect between the Al and Ge, the high-mobility two-dimensional hole gas confined in this well gives rise to a Josephson effect which can be tuned via a gate-dependent hole density. This system forms a transmon qubit when placed in parallel with a large shunt capacitance in the correct regime. We measure as a function of qubit frequency the relaxation times (T1) and Ramsey coherence times (T2) to find that T1 is likely limited by dielectric losses, while the limiting factor for T2 remains unknown. We also find that the energy-level anharmonicity is highly reduced from the charging energy suggesting a strong contribution of high transparency conduction channels on the standard transmon potential. These results validate this material system and our fabrication strategy for making a planar cos(2 phi) qubit.

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