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Gate-tunable transmons using selective-area-grown superconductor-semiconductor hybrid structures on silicon [1]

Gate-voltage tunable transmon qubits (gatemons), based on superconducting semiconductor (super-semi) junctions, have emerged as an attractive candidate for controllable and scalable quantum information processors [2]. In recent years gatemons have been realized in several material systems, ranging from vapor-liquid-solid (VLS) nanowires [3], two-dimensional electron gases (2DEG) [4] to graphene-based devices [5]. In our work [1], we focus on gatemons based on selective-area-grown Al-InAs hybrid structures on a high resistivity silicon substrate that has planar III-V buffer layers (Si SAG). We show that low loss superconducting resonators can be realized on these substrates after the removal of buffer layers. We proceed with demonstrating coherent control and readout of the gatemon device with a relaxation time of $T_1 \approx$ 700 ns, and dephasing times $T_2^* \approx$ 20 ns and $T_{2,echo} \approx$ 1.3 µs. With further improvement of coherence, this material platform opens new possibilities for scalable highly integrated quantum circuits.

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