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A compact qubit with tuned protection from sparse defects NEDA FOROUZANI, TIM KOHLER, Laboratory for Physical Sciences, University of Maryland, College Park, BAHMAN SARABI, Intelligence Community Postdoctoral Research Fellowship Program, University of Maryland, College Park, ALEXANDER L. BURIN, Tulane University, KEVIN D. OSBORN, Laboratory for Physical Sciences, Joint Quantum Institute — Tunneling two-level systems (TLSs), which are present in imperfect insulating regions and Josephson junction barriers of superconducting qubits, are known to be a source of decoherence. Fortunately, qubits that are made with a sufficiently large area allow small influence from the imperfect regions due to the large capacitance from ideal regions, namely the crystalline substrate below and vacuum above its superconducting metal. On the other hand, it is desirable to have compact qubits for multi-qubit architectures, as this can enable a low residual qubit to qubit coupling. Although a compact qubit may have strong coupling to the defects and the possibility of added decoherence, it is also possible to take advantage of the finite number of TLSs in a small volume limit and thus to protect the qubit from the deleterious effects of TLSs. This is especially allowed if the defects can be tuned in energy. We present a compact design where the qubit and cavity share a piece of a deposited dielectric. While the qubit is coupled to TLSs located within the dielectric we can apply an electric field to bias the sparsely spaced TLSs out of the frequency range of the qubit. Additionally, the qubit state can be controlled independently from the near-resonance TLSs through microwave pulses.

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