PCSI
Room Canyon/Sugarloaf - Session PCSI-2TuM
Superconductivity II

Moderator: Kyle Shen, Cornell University

11:00am **PCSI-2TuM-31 Fabrication of High Coherence Superconducting Qubits***, J Long, H Ku, X Wu,* NIST*; R Lake,* BlueFors*; **David Pappas**,* NIST **INVITED**

Scaling up qubit circuits and achieving high coherence relative to gate speed is imperative to realizing the full power of quantum computing. In this work we demonstrate superconducting transmons with coherence times ranging from 25 to 90 µs, significantly longer than typical gate speeds, which range from 10 to 200 ns for single and two-qubit interactions.

The circuits were fabricated on intrinsic Si(001) substrates (Fig. 1_. The metallization (gold) was NbTiN. The meander feedline (from Port 1 to Port 2), inductively couples to resonators (R1-R6, only R1 labeled for clarity) which are then capacitively coupled to concentric capacitor plates. The plates are connected together with a Josephson junction that was fabricated using a two-step overlap process [1] to form transmon qubits, Q1-Q6. Some of the methods used to enhance the coherence include using a nitride pre-treatment of the substrate prior to metallization, post-treatment of the circuit with buffered oxide etch, and extensive wire-bonding. Variations of coherence between qubits was about a factor of 2, and can be understood in some one case (the shortest) as being due to damage during wire-bonding. Fluctuations are hypothesized to be due to coupling of the qubits to two-level systems around the junctions [2].

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11:40am **PCSI-2TuM-39 UPGRADED: Interface Chemistry and Decoherence Processes in Superconducting Quantum Circuits***, **D. Frank Ogletree**,* Lawrence Berkeley National Lab*; V Altoe, X Liu, A Minor, S Cabrini, S Griffin,* Molecular Foundry, LBNL*; A Bannerjee,* Lawrence Berkeley National Lab*; J Kriekebaum, I Siddiqi,* University of California, Berkeley

Artificial atoms based on superconducting circuit elements including Josephson tunnel junctions and strip-line resonators can be used as “qubits” for quantum computation and simulations, and as platforms for studying quantum cavity electrodynamics and other quantum phenomena. The performance of these systems depends critically on achieving coherent lifetimes that are significantly longer than initialization and readout times. Significant progress has been made in increasing coherence over the last decade or two by better electromagnetic circuit design to control losses and cross-talk, by improved radio-frequency electronics [1], and by advances in shielding and measurement techniques [2]. Further progress can come from improvements in materials and fabrication and better control of interface chemistry [3].

We will report initial results on interfacial studies combining SEM, analytical STEM, and x-ray spectroscopy to understand substrate, vacuum and internal interfaces in both Al Josephson junctions and Nb resonator structures.

[1] C. Macklin, K. O’Brien, D. Hover et al., Science 350, 307 (2015).

[2] J.M. Kriekebaum, A. Dove, W. Livingston et al., Superconducting Sci. Tech. 29, 104002 (2016)

[3] C. Müller, J.H. Cole, J. Lisenfeld, arXiv 1705.01108v2 (2018)

Author Index

Bold page numbers indicate presenter