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Comparison of 2D transmon coherence for different capacitive shunt fabrication methods JONILYN YODER, MIT Lincoln Laboratory, ARCHANA KAMAL, FEI YAN, MIT, THEODORE GUDMUNDSEN, MIT Lincoln Laboratory, PAUL WELANDER, SLAC National Accelerator Laboratory, SIMON GUSTAVSSON, MIT, DAVID HOVER, ANDREW KERMAN, ADAM SEARS, WILLIAM OLIVER, MIT Lincoln Laboratory — Improvements in superconducting qubit coherence times and reproducibility have been demonstrated using capacitive shunting. In this study, we present a side-by-side comparison of two distinct methods for preparing the aluminum shunt capacitor material for 2D transmon superconducting qubit devices. The first method involved *in situ* wafer outgassing prior to molecular beam epitaxy aluminum evaporation. The second method involved *ex situ* wafer annealing prior to electron gun aluminum evaporation. Materials analysis for each process will be detailed. Experimental results, including qubit coherence times and superconducting coplanar waveguide resonator internal quality factors, will be presented for representative devices prepared using both methods. This work is sponsored by the Assistant Secretary of Defense for Research and Engineering under Air Force Contract FA8721-05-0002. Opinions, interpretations, conclusions, and recommendations are those of the authors and are not necessarily endorsed by the United States Government.

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