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Role of tunnel barrier crystallinity in the coherence properties of superconducting phase qubits SEONGSHIK OH, NIST, JEFFREY KLINE, MIKA SILLANPAA, ADAM SIROIS, KATARINA CICAK, KEVIN OSBORN, RAYMOND SIMMONDS, DAVID PAPPAS — The standard amorphous AlO_x tunnel barriers in superconducting qubits contain many nanoscopic fluctuators. These nanoscopic fluctuators destroy the coherent quantum information stored in the qubit. Recently, we eliminated 80% of these fluctuators using single-crystal Al_2O_3 tunnel barriers. This clearly shows that the tunnel barrier crystallinity is important for coherent superconducting qubits. Along this line, we started investigating another well-known crystalline tunnel barrier, MgO. Unlike the aluminum oxide tunnel barrier, which requires $\sim$800 $^\circ$C for crystallization, the MgO tunnel barrier grows crystalline even at room temperature. We will compare the Josephson junctions and the superconducting phase qubits made out of amorphous AlO_x, single-crytal Al_2O_3 and single-crystal MgO tunnel barriers, and discuss the effect of barrier crystallinity and electrode/tunnel-barrier interface quality on the performance of the coherent quantum-devices.

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