Optimization of Silicon Nitride Films For Use in Phase Qubits

ADAM J. SIROIS, Univ. of Colorado, NIST-Boulder, MARTIN E. HUBER, Univ.
of Colorado - Denver, KEVIN D. OSBORN, JOSHUA A. STRONG, RAYMOND
W. SIMMONDS, NIST-Boulder — The lifetime (coherence time) of superconduct-
ing phase qubits is currently severely limited by lossy materials used in standard fab-
rication techniques. In particular, the insulator material - typically Silicon Nitride-
used to isolate and physically separate different layers of the qubit is of interest.
We have conducted a fractional factorial design experiment to optimize SiNₓ loss
properties with respect to several deposition parameters in an Electron Cyclotron
Resonance (ECR) Plasma-Enhanced Chemical Vapor Deposition (PECVD) reactor.
Our experimental design included a three-level, four-parameter matrix with N₂/SiH₄
ratio, microwave power, rf power, and pressure as the parameters. The test-bed for
these films is a low temperature microwave LC resonator circuit in which the vari-
ous insulator films are used as the dielectric between a parallel plate capacitor and
the Q (Quality Factor) of the circuit gives the relevant loss information for qubit
operations.

¹Supported by NIST and DTO.