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Microscopic Sources of Paramagnetic Noise on α-Al2O3 Substrates for Superconducting Qubits[1] JONATHAN DUBOIS, DONGHWA LEE, VINCE LORDI, Lawrence Livermore Natl Lab — Superconducting qubits (SQs) represent a promising route to achieving a scalable quantum computer. However, the coupling between electro-dynamic qubits and (as yet largely unidentified) ambient parasitic noise sources has so far limited the functionality of current SQs by limiting coherence times of the quantum states below a practical threshold for measurement and manipulation. Further improvement can be enabled by a detailed understanding of the various noise sources afflicting SQs. In this work, first principles density functional theory (DFT) calculations are employed to identify the microscopic origins of magnetic noise sources in SQs on an α-Al2O3 substrate. The results indicate that it is unlikely that the existence of intrinsic point defects and defect complexes in the substrate are responsible for low frequency noise in these systems. Rather, a comprehensive analysis of extrinsic defects shows that surface aluminum ions interacting with ambient molecules will form a bath of magnetic moments that can couple to the SQ paramagnetically. The microscopic origin of this magnetic noise source is discussed and strategies for ameliorating the effects of these magnetic defects are proposed.

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