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M3Or3I-03: [Invited] Recent material developments for superconducting quantum circuits

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Superconducting circuits are a leading platform for quantum sensing and computing applications. Materials science of these superconducting circuits is considered with increasing importance to increase sensing fidelities and qubit coherence times, thus directly affecting the advancement of quantum applications. The choice of the material and nanofabrication process for superconducting devices directly affects their performance, reliability and functionality. Appropriate fabrication and film growth techniques need to be developed to incorporate quality-factor engineered components. A recent publication [1] demonstrated that switching from Nb to Ta based devices improved coherence times by a factor of two or more. This results was attributed to the oxide formation and stoichiometry of α-phase Ta films which leads to fewer sources of noise with which the qubit can incoherently exchange energy. In this presentation, we provide an overview of the most recent advancements in material science in the field of superconducting quantum circuits along with the challenges that remain and possible future research directions that need to be investigated. We will also present our findings regarding sputtered Ta and ALD-deposited TaC_x N_(1-x) and their quality factors from spectroscopic measurements of fabricated microwave resonators at varying powers in mK temperatures. Finally we will explore the current limitations in the fabrication and measurement processes that need to be taken into consideration for scaling up quantum circuits

[1] Place, Alexander PM, et al. "New material platform for superconducting transmon qubits with coherence times exceeding 0.3 milliseconds." Nature communications 12.1 (2021): 1779.

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