Quantum computing promises to revolutionize information technology as we know it today by changing the physical nature of information. However, the challenges of creating a quantum computer originate in our ability to manipulate and control the basic materials that comprise quantum computing devices. In this seminar, fundamental concepts of quantum computing will be reviewed in order to provide motivation for two materials synthesis projects focused on superconducting qubits.

The first project creates a high-purity single crystal elemental superconductor used for passive circuit components. Metamorphic epitaxial aluminum is grown via molecular beam epitaxy on silicon substrates. The superconducting thin films exhibit an atomically abrupt metamorphic Al-Si interface. Characterization of the interface purity and atomic resolution imaging of the structured semi-coherent interface are correlated with low-power internal quality factors of quarter-wave coplanar waveguide resonators that are near 1M.

The second project is motivated to create both high-quality superconductors for passive circuit components and epitaxial Josephson junctions. Binary and ternary nitride superconductors are grown with plasma assisted molecular beam epitaxy on silicon substrates and designed to enable epitaxial heterostructures. TiN growth is completed under nitrogen-rich conditions to produce polycrystalline thin films that sit on an amorphous nitride layer. These films currently exhibit significant crystalline disorder and higher levels of impurities. Nonetheless, TiN superconducting resonators demonstrate internal quality factors over 1M at low-powers.

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