Interfaces and growth of NbTiN-AlN heterostructures on sapphire as epitaxial Josephson junctions

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Plasma assisted Molecular beam epitaxy (PAMBE) is used to grow niobium titanium nitride alloys ($Nb_xTi_{1-x}N$) and wide bandgap nitride (AlN) superconductors directly on c-plane sapphire wafers. This combination of nitride materials provides sufficient degrees of freedom that synthesis of an epitaxial Josephson junction may be possible while satisfying the device requirements for superconducting quantum circuits. Thin films of various $Nb_xTi_{1-x}N$ alloys are grown using the abrupt metamorphic growth paradigm and show the ability to tune the lattice parameters and critical temperatures of the superconducting films. Surface topology, degree of twinning, and superconducting loss are used to evaluate the fitness of these layers.

A prototype NbTiN/AlN/NbTiN (superconductor-insulator-superconductor) Josephson junction structure has been grown. The structural, superconducting, and current-votlage characterization of these heterostructures will be presented.

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Supplementary information:

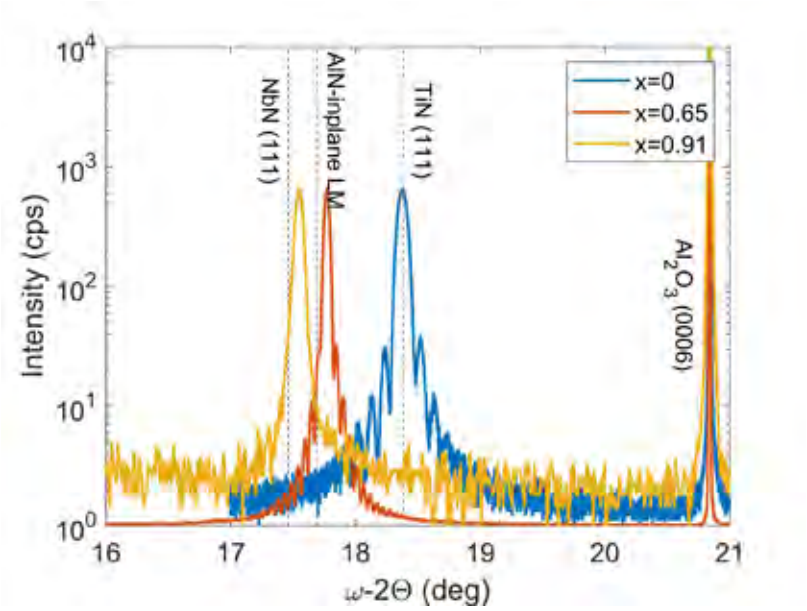

Figure (1) Symmetric x-ray diffraction measurements of several $Nb_xTi_{1-x}N$ alloys grown metamorphically on sapphire showing the crystal quality and ability to adjust the lattice parameter of the superconductor films.

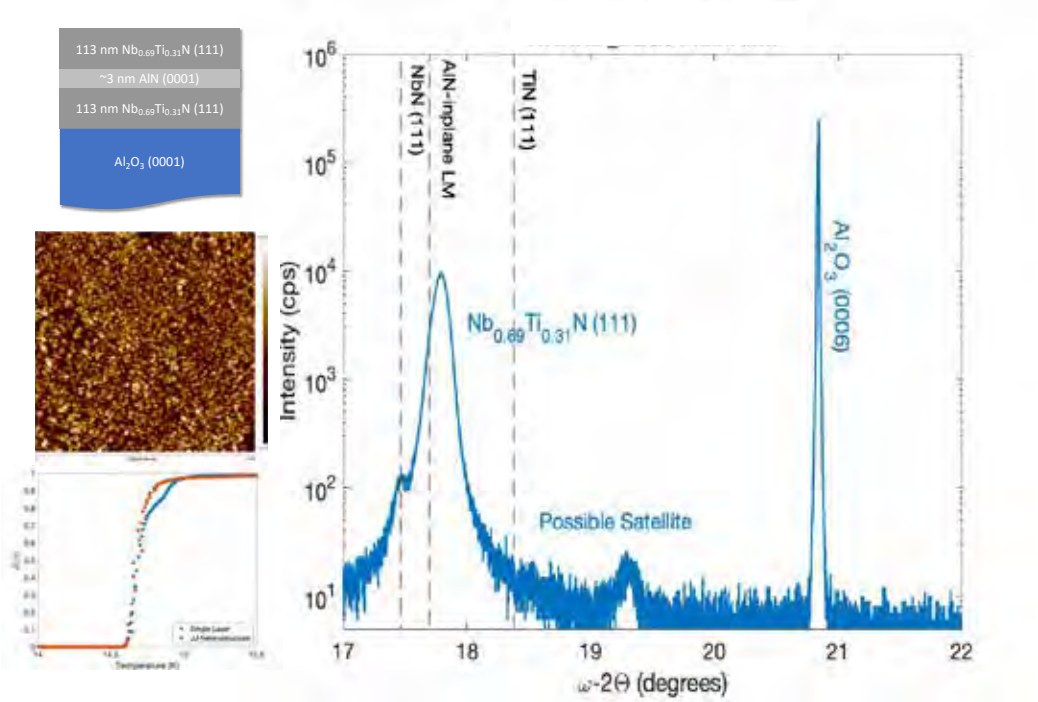

Figure (2) (left in descending order) schematic of the trilayer design, final surface topology measured using AFM, and in-plane conductance measurement showing Tc above 14.5 K. (right) x-ray diffraction showing growth of the structure showing several features indicating and near-epitaxial structure.