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Hydrogen-manipulated atomic layer epitaxy of titanium nitride for superconducting devices

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Advanced epitaxy techniques have become essential for superconducting quantum circuits due to their ability to fabricate high-quality and low-loss superconductors. Atomic layer deposition, which provides precise layer-by-layer growth, is widely adopted in complex 3D architectures in advanced silicon manufacturing, such as FinFETs and gate-all-around transistors. In this study, we investigate the structural and electrical transport properties of titanium nitride (TiN) thin films grown by hydrogen-manipulated atomic layer epitaxy (HM-ALE). The epitaxial growth results in high-quality thin films, confirmed by synchrotron-based grazing-incidence wide-angle X-ray scattering (GIWAXS) and X-ray photoelectron spectroscopy (XPS). Electrical transport measurements on Hall bar devices reveal a superconducting transition temperature of 2.2 K with a kinetic inductance of 15 pH/sq, and superconducting resonators exhibit internal quality factors above 10000. Our findings highlight HM-ALE as a promising epitaxial method for superconducting quantum research and applications.

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