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From SFQ to Quantum Sensing: A Versatile NbTiN Superconducting Platform

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***Abstract*–At IMEC, we have developed a high critical current density Josephson junction platform based on niobium titanium nitride (NbTiN). This platform is particularly well-suited for the realization of high-density Single Flux Quantum (SFQ) digital circuits. The inherently high kinetic inductance of NbTiN enables a substantial reduction in the physical footprint of circuit inductors, thereby facilitating more compact designs. Additionally, the self-shunted nature of our Josephson junctions eliminates the need for external resistors, allowing for smaller junction footprint and further contributing to circuit miniaturization.**

Our fabrication approach leverages advanced 300 mm wafer processing and immersion 193nm lithography with feature sizes down to 50 nm, providing significant advantages in terms of scaling, uniformity, and yield. The platform is continuously evolving, with ongoing integration of additional layers and circuit elements—such as varactors—to support the development of complex superconducting circuits aimed at applications in high-performance computing and AI acceleration.

Beyond its suitability for SFQ logic, this platform also shows strong potential in the field of quantum sensing. The tunability of NbTiN's kinetic inductance, combined with seamless integration of SFQ-based readout circuitry, presents a compelling opportunity to enhance the functionality and performance of quantum sensing devices.

***Keywords (Index Terms)*–Josephson Junction, Nanofabrication, Quantum Computing, Single Photon Detector, Cryogenic Electronics**

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