Sub-µm Josephson Junctions for Superconducting Quantum Devices

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Abstract - For high-performance superconducting quantum devices, based on Josephson junctions (JJs), decreasing lateral sizes is of great importance. Fabrication of sub-µm JJs is challenging, due to non-flat surfaces with step heights of up to several 100 nm generated during the fabrication process. We have refined a fabrication process with significantly decreased film thicknesses, resulting in almost flat surfaces at intermediate steps during the JJ definition. In combination with a mix-&-match process, combining electron-beam lithography (EBL) and conventional photolithography, we can fabricate JJs with lateral dimensions down to 0.023 µm². We propose this refined process as an alternative to the commonly used chemical-mechanical polishing (CMP) procedure. Transport measurements of JJs, having critical-current densities ranging from 50 to 104 A/cm² are presented at 4.2 K. Our JJ process yields excellent quality parameters, R_{sg}/RN up to ~50, V_m from 15 to 80 mV and V_{gap} up to ~50,V_m from 15 to 80 mV andV_{gap} up to 2.81 mV, and also allows the fabrication of high-quality, sub-µm wide, *long* JJs (LJJs) for the study of Josephson vortex behavior. The developed technique can also be used for similar multi-layer processes and is very promising for fabricating sub-µm JJs for quantum devices such as SQUIDs, qubits and SIS mixers.

Keywords - Josephson junctions, SIS mixers

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