Characterization of NbN Tunnel Junctions with Radical-nitrided AlN_x Barriers

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Abstract - We report on electrical characteristics of NbN tunnel junctions fabricated using radical nitridation of an Al layer deposited on a base NbN layer as a barrier formation method. The junctions show low sub-gap leakage currents and a steep current rise at the gap voltage (V_g) in current-voltage characteristics at 4.2 K. In addition, good critical current (I_c) uniformity is obtained, and the maximum-to-minimum spread in I_c is as small as ±1.5% for a series array of 200 junctions with a critical current density (J_c) of 4.4 kA/cm^2. This small spread indicates that the junction is applicable to digital application. The quality parameter, R_{sg}/R_n, where respective R_{sg} and R_n are sub-gap resistance at 3 mV and junction resistance at 10 mV, is 19 at this J_c value. The specific capacitance estimated by measuring resonant steps in dc-SQUIDs is in the range of 50-80 fF/mm^2 for a J_c range of 0.05-5 kA/cm^2. The V_g is as small as 4.3 mV because of poor initial growth of a counter NbN layer on an AlN_x barrier, whereas elevated substrate temperature during deposition of a counter NbN layer increases V_g up to 5.0 mV.

Keywords - Josephson junction fabrication, NbN Josephson tunnel junctions, tunnel barrier formarion, radical nitridation

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