Fabrication of All-Nb Josephson Junction using the Self-aligned Contact(SAC) Process without the Selective Niobium Anodization Process(SNAP)

Hyun Kwon Hong*, [a], Kyu-Tea Kim+, [b], Se Il Park+, [b], Kie-Young Lee[a]

[a] *Chungbuk National University, Chongju, Korea*

[b] *Korea Research Institute of Standards and Science, Deajeon, Korea*

Josephson junction arrays with an aluminum overlayer on niobium were fabricated by DC magnetron sputter. The Al native oxide, formed by thermal oxidation, was used as the tunneling barrier. In the fabrication of high quality all-refractory Josephson tunnel junctions, we used the self-aligned contact(SAC) and selective niobium etching process(SNEP) after trilayer deposition without the use of selective niobium anodization process(SNAP). The array have 2000 junctions with the area of $A = 14\ \mu m \times 46\ \mu m$. The gap voltages were in the range of 2.5 ~ 2.6 mV and the spread of critical current, $\Delta I_c/I_c$ was ± 10 ~ 14 %. When operated at 70 ~ 94 GHz, the arrays generated zero-crossing steps up to 2.1 ~ 2.4 V. To improve the transmission of microwave power and prevent oxygen diffusion while depositing SiO_2 dielectric using PECVD, we applied a plasma nitridation process to Nb films. We measured the number of Josephson junctions which responds to microwave with 76.4 GHz. The criteria to decide the number of microwave-responded junctions was chosen by the decrease of critical current by 20 %. And the microwave transmission in the arrays with and without nitridation of Nb ground-plane was compared. The microwave power was equally propagated in Josephson junction arrays with and without nitridation. But a difference in microwave transmission at finline antennas was found, which can be interpreted by the difference in impedance matching between waveguide and Josephson arrays.

keywords : Josephson, nitridation, microwave