

## EDP1-13

### Design and fabrication of Programmable Josephson Voltage Standard Circuit for 100 V ac-voltage standard

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The Programmable Voltage Standard (PJVS) Circuit having the output voltage of 32 V has been designed and fabricated for ac voltage standard. While our PJVS chip for primary dc voltage standard at NMIJ has the maximum output voltage of about 16 V, the voltage for commercial power in Japan is 100 V<sub>rms</sub> and 141 V<sub>pp</sub>.

We plan to generate 141 V<sub>pp</sub> by combining 5 chips of 32 V PJVS circuit.

Thus, twice higher integration density of Josephson junction and the uniform power distribution for them are necessary to generate such high output voltage with practical operating margin.

To integrate a million of Josephson junctions on the 15 mm x 15 mm chip, the junction size has been changed from 3.4 μm x 3.4 μm to 1.2 μm x 4.0 μm.

Although vertically stacked double barrier Josephson junctions are used to integrate such large number of Josephson junctions, the poor uniformity of the critical current between the upper and lower junction significantly decreased the Shapiro step height. We have found that the grain sizes of the barrier layer of TiN film for the upper junction is larger than that for the lower junction. The surface flatness of the NbN film nearly proportional to the thickness.

We experimentally confirmed that the critical current of the NbN/TiN/NbN Josephson junction depends on the thickness of the base electrode.

This suggests that the difference of the critical current between the upper and lower junction caused from the difference of the crystalline nature such as grain size of the barrier TiN. The lower Josephson junction has smaller critical current and the upper Josephson junction has higher one. And this provides a clue to improve the uniformity of the critical currents between the lower and upper junction, which may significantly increase integration density for Josephson junctions.

Keywords: ac voltage standard, double barrier Josephson junction, NbN, grain size