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Novel Interface-engineered Junction Technology for Digital Circuit Applications

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The Josephson characteristics of interface-engineered junctions are extremely sensitive to the substrate temperature for the counter-electrode deposition, and the I_c value appropriate for the fabrication of SFQ circuits can be obtained only at a relatively low substrate temperature range. This temperature range conflicts with the requirement for the complete *c*-axis oriented growth of the counter electrode layer with minimum sheet inductance L_s, when we utilize sputter-deposited YBCO as the counter electrode. This trade-off problem between I_c and L_s could be solved if we adopted YbBCO as the counter electrode, because it can grow with complete *c*-axis orientation in a far wider temperature range than is possible with other 123 compounds. We fabricated interface-engineered junctions on YBCO base electrodes with YbBCO as the counter electrode material. These junctions exhibited excellent Josephson characteristics with a magnetic field modulation of the I_c exceeding 90 % at 4.2 K. The 1-sigma spreads in I_c were around 5% for 16 junctions within a chip, and 9% for a 100-junction array. The sheet inductance of the YbBCO layer on a buried ground plane was confirmed to be less than 0.8 pH below 40 K. We also investigated the current transport processes within the junction. Our *dI/dV* measurements revealed the crossover from a tunneling regime to a mesoscopic SNS regime with increasing J_c values.

keywords : Josephson junction, SFQ circuit, Interface-engineered junction, YbBCO