Epitaxial High-T_c SNS Weak Links on Silicon-on-Sapphire Substrates

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High-T_c SNS weak links are expected to prove useful as high frequency sources and detectors. Recent studies with low-T_c Josephson mixers using shunted tunnel junctions at 100 GHz show good initial performance, and modeling suggests that these results should extrapolate to higher frequencies if larger I_cR_n products can be achieved[1]. High T_c weak links possess the nonhysteretic I-V characteristics required for Josephson mixers and may allow fabrication of devices with higher I_cR_n products. However, high frequency detector applications require device fabrication on medium-to-low-dielectric constant substrates ($\varepsilon<12$) to maximize coupling to the weak link. Silicon-on-sapphire (SOS) substrates have acceptably low dielectric constants (sapphire $\varepsilon \approx 9$-11, Si $\varepsilon \approx 12$), and provide other important advantages, including the possibility of monolithic integration of silicon and superconducting circuitry. We have fabricated $YBa_2Cu_3O_{7-x}$ (YBCO) edge-geometry weak links with $PrBa_2Cu_3O_{7-x}$ normal metal layers on r-plane SOS substrates using cubic zirconia (YSZ) buffer layers and our previously developed edge junction process[2]. Preliminary device results show good-quality RSJ-like I-V characteristics with clean ac Josephson steps. However, the electrical characteristics also indicate the presence of a second weak link in series with the edge-defined weak link, probably due to the nucleation of a grain boundary in the counterelectrode at the YSZ/base-YBCO interface. Current efforts are focused on alternate buffer layer combinations that prevent nucleation of counterelectrode grain boundaries, as well as other normal metal barriers. Progress cm this work will be reported.

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SUBMITTED TO: Devices and Processes for Superconductive Circuits (Randy Simon) at OE/LASE '94

PRESENTATION: Prefer Oral Presentation