

AD-A267 006



QUARTERLY REPORT
for
DARPA/ONR
HIGH TEMPERATURE SUPERCONDUCTIVITY
PERIOD ENDING: December 31, 1992

I. PROGRAM INFORMATION

Contract Number: N00014-88-C-0760

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II. PROGRAM SUMMARY

The overall goals of this program are to develop the technology of MBE growth of HTSC material, to optimize the performance of HTSC films with high transition temperatures and critical current densities, and to explore the development of electronic devices based on such material.

III. PROGRAM STATUS

Transport through large n-layer slabs that were modulation doped with holes was studied. Good superconducting transport was observed in these samples and this provides a means of placing a barrier in a more nearly isotropic material.

IV ACCOMPLISHMENTS

A new technique for providing carriers in large slabs of CuCaO_2 was devised that makes it possible to have good high T_c superconductivity present in large n-layer unit cells closely related to layerings like 2278. Previously, unit cells of compounds such as 2278 had been shown to be not good superconductors, and in fact had been utilized as barriers for c-axis transport Josephson devices. Values of critical currents in the neighborhood of 0.1 to 0.5 mA and normal state resistances of 1 Ohm were typical in these c-axis transport samples, and barrier limiting T_c 's of about 25 K were typically seen. This was attributed to there being not enough carriers in the 8 CuO_2 planes to support superconductivity. Indeed, with about 0.5 to 0.75 carriers per formula unit, this would provide only less than 0.1 holes per CuO_2 state in each formula unit. This is not thought to be enough carrier density to support superconductivity. At the same time we considered measures to introduce carriers into the n- CuO_2 layers. We have observed a range of stoichiometries that give rise to single phase films, and have been able to grow occasional single BiO layers, effectively reducing the BiO double layer to a BiO single layer. This should have a large effect of local carrier density since each BiO layer donates one electron to the bands at the Fermi energy. With this in mind, we grew samples that were similar to the trilayer Josephson junctions previously reported, with single 2278 layer barriers, but removed a BiO layer from

either side of the 8-CuO₂ layer slab. This can be considered to be a unit cell of a metastable compound, 0278, where we attribute the single BiO layers on either side of the 0278 layer as belonging to the adjacent 2212 formula units. This had a profound effect on c-axis transport. These samples had c-axis transport transitions that went to zero above 80 K, and showed critical currents at 4.2 K of more than 30 mA. The critical currents observed were not Josephson like, and were more likely flux flow. Apparently, the removal of the two BiO layers introduced an adequate density of holes at the Fermi surface in the 0278 layer to make it a superconductor, at least when surrounded with superconducting 2212. In the next period we plan on embedding c-axis transport barriers within the 0278 layer. This will make the overall junction similar to an "infinite compound" junction.

V PROBLEM AREAS

No significant problem areas exist.

VI CORRECTIVE ACTION

Work will continue to perfect the growth and device fabrication processes

VII GOALS FOR NEXT PERIOD

To continue studying trilayer junctions and vertical transport in them.

VII FISCAL STATUS

The amount currently provided on contract is \$2,158,000 as of January 1, 1993. The expenditures and commitments to this date are \$2,094,289. These funds are sufficient to continue the work as planned.

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