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c-axis Tunneling in Intercalated $Bi_2Sr_2CaCu_2O_{8+x}$ Single Crystals

Minhyea Lee, Hyun-Sik Chang, Yong-Joo Doh, Hu-Jong Lee[*a], Woo Lee, Jin-Ho Choy[b]
a *Pohang University of Science and Technology, Pohang, Korea*
b *Seoul National University, Seoul, Korea*
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Abstract

We compared *c*-axis tunneling characteristics of small stacked intrinsic Josephson junctions prepared on the surface of pristine, I-, and HgI_2-intercalated $Bi_2Sr_2CaCu_2O_{8+x}$ (Bi2212) single crystals. The $R(T)$ curves are almost metallic in I-Bi2212 specimens, but semiconducting in HgI_2-Bi2212 ones. The transition temperatures were 82.0 K, 73.0 K, and 76.8 K for pristine Bi2212, I-Bi2212, and HgI2-Bi2212 specimens, respectively, consistent with p-T_c phase diagram. Current-voltage (IV) characteristics of both kinds of specimens show multiple quasiparticle branches with well developed gap features, indicating Josephson coupling is established between neighboring CuO_2 planes. The critical current I_c of I-Bi2212 is almost the same as of that of pristine crystals, but I_c is much reduced in HgI_2-Bi2212. In spite of expanded interlayer distances, the interlayer coupling is not significantly affected in I-Bi2212 due to holes generated by iodine atoms. The coupling in HgI_2-Bi2212 is, however, weakened due to inertness of HgI_2 molecules and the expansion of interlayer distance. Relation between the superconducting transition temperature T_c and the critical current I_c seems to contradict Anderson's interlayer-pair-tunneling theory but agree with a modified version of it.

Keywords: Intercalation; Interlayer Pair Tunneling; Hole Doping, Intrinsic Josephson Effect;