Spin Dependence of Pair Tunneling Properties of $Bi_2Sr_2CaCu_2O_{8+x}$ Intrinsic Josephson Junctions

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We studied the tunneling conduction properties of intrinsic Josephson junctions (IJJs) formed in $Bi_2Sr_2CaCu_2O_{8+x}$ (Bi-2212) single crystals for the injection of spin-polarized bias currents. Spin-polarized current is supposed to induce pair breaking in 0.3-nm-thick superconducting CuO_2 layers, thus suppresses the in-plane superconducting strength and the interlayer Josephson coupling as well (revealed as the gap voltage and the tunneling critical current, respectively). Properties of an identical stack ($3\times2\times0.065$ $\square m^3$) of IJJs were compared for the bias current injected through Au and Co electrodes. Clear quasiparticle branches in tunneling current-voltage (I-V) curves from the IJJs in the stack were observed for an unpolarized bias current through the Au electrode. On the other hand, spin injection through the Co electrode to the same stack caused pair breaking in the CuO_2 double layers, which led to reduction of the Josephson critical current and the superconducting gap revealed in the tunneling I-V curves. This study gives information on the spin-diffusion characteristics in Bi-2212 material along the c axis which can be utilized to develop spin-dependent high-Tc active devices. It may also give valuable information on the role of spin-degrees of freedom in bringing about the high-Tc superconductivity in the material.

keywords : spin-dependent tunneling properties, interlayer Josepshon coupling, pair breaking, intrinsic Josephson junctions