Eliminating Self-heating from the Interlayer Tunneling Spectroscopy in $Bi_2Sr_2CaCu_2O_{8+x}$ Intrinsic Josephson Junctions

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The interlayer tunneling spectroscopy in $Bi_2Sr_2CaCu_2O_{8+x}$ (Bi-2212) intrinsic Josephson junctions reveals the low-lying quasiparticle excitation spectrum in this non-conventional superconducting material. Tunneling measurements in a high-bias region are, however, often susceptible to the self-heating effect due to the bias-induced dissipated power. In this study we monitored the temperature variation of a stack ("sample stack") of intrinsic junctions by measuring the resistance change 5of a nearby stack ("thermometer stack") of intrinsic junctions, which was strongly thermal-coupled to the sample stack through a common Au electrode. We then adopted a proportional-integral-derivative (PID) computer-control scheme incorporated with a substrate-holder heater to compensate the temperature variation. This in-situ temperature monitoring and controlling technique allows one to get rid of spurious tunneling effects arising from the self-heating in a high bias range. Although the overall shape of the temperature dependencies of the superconducting gap and pseudogap using the PID control turns out to be similar to that without the PID control, this constant-temperature tunneling spectroscopy give the most accurate information on the spectral weight in the superconducting and pseudogap states and the interplay between them.

Keywords : interlayer tunneling spectroscopy, constant-temperature tunneling spectroscopy, pseudogap, superconducting gap