A Model and Calculation of Evolving Tunneling Spectra for the Superconducting Gap and Pseudogap in $Bi_2Sr_2CaCu_2O_{8+\delta}$

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By the short-pulse interlayer tunneling spectroscopy using intrinsic Josephson junctions in $Bi_2Sr_2CaCu_2$-$O_{8+\delta}$ (Bi2212), we have found that, with the increase in doping, the superconducting coherence peak becomes greater and sharper and the pseudogap peak diminishes. It is also found that these changes are accompanied by a significant almost exponential increase in the maximum Josephson current density. In order to explain the experimental results, we propose a model, in which mobile carriers reside only in limited areas in the **k**-space, like a situation as represented by so-called Fermi arcs, and are closely related to the d-wave superconducting order parameter in these directions in the **k**-space. The range of the area in which mobile carriers reside depends on the doping level and outside these areas the density of states is absent and a semiconducting gap is assumed for the carriers to be mobile. Based on this model, the tunneling spectra between a normal metal and Bi2212 are calculated at various doping levels. With appropriate values for the semiconducting gap as a function of doping, we obtain the result that the superconducting peak increases from a cusp at the shoulder of the pseudogap to a dominantly strong peak as the doping increases. The results are in qualitatively good agreement with the experimental tunneling spectra observed.