Nanostructured surfaces

Tunneling into a superconductor with a normal nanoscale near-surface layer

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One of the most exciting events in modern physics has been the discovery of high-temperature superconductivity (HTSC) thirty years ago. Despite enormous efforts, the origin of the phenomenon is one of the most debated problems in condensed matter physics. Many puzzling characteristics have been observed in the novel superconductors, often without any consent about their nature. In this work, we discuss one of such features found in differential conductance spectra $G(V)$ of HTSC hole-doped copper oxides known as a "peak-dip-hump" structure. We briefly review the up-to-date status of unconventional low-energy excitations in HTSC cuprates [1,2] followed by a critical analysis of experimental factors influencing the measured transport characteristics, in particular, the presence of a nanoscale degraded layer at the surface of the HTSC materials. The layer is shown to arise due to the space-charge effects in cuprate films with a free surface. We have calculated differential-conductance and shot-noise spectra of tunnel junctions formed by a normal counter-electrode and an *s*- or *d*-wave superconductor with a normal nanometer-thick sheet at the interface. It is shown that combined measurements of the two characteristics can provide new information on the kinetics of transport processes in such heterostructures.

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