TUNNELING INTO OVER-DOPED YBCO FILMS AT HIGH MAGNETIC FIELDS

R. Beck, G. Leibovitch, G. Deutscher (Tel-Aviv University-Israel, Physics); Y. Dagan (University of Maryland, Superconductivity Center)

Introduction

High temperature superconductors (HTS) order parameter (OP) are considered to have *d-wave* symmetry. This symmetry has been the key motivation for many theoretical works trying to explain the physical nature of HTS. Yet, this symmetry has a direction, known as the nodes directions, where the strength of superconductivity, measured in terms of an OP, is zero. We investigated the superconductor response for strong currents forced along the node direction. Using high magnetic fields up to 32.4T at NHMFL we induced such currents on properly oriented samples.

Previously, [1] we found that in optimally doped samples, at a certain magnetic field, the gap-like feature bias value, seen in tunneling spectra, undergoes a transition into a new smaller bias value. We interpreted it as a first-order phase transition to the OP where at high magnetic fields/current it is reduced in value but has no nodes. In this project we studied over-doped samples, with the same technique. Here, we did not find any transition in the gap-like feature up to 32.4 T. However, the low bias high magnetic field spectra resembled the optimally doped one.

Experimental

We investigated the tunneling conductance of *In/insulator/YBCO* junctions when a magnetic field is applied parallel to the film and perpendicular to the CuO_2 planes The indium planar junction was set on differently oxygen doped YBCO films. The junction has been shown in numerous publications to exhibit reproducible and clear results under many thermal cycles and over time scales of weeks. We measured the tunneling conductance (dI/dV vs. V) of optimally doped and over-doped (110) YBCO films at the 33 T DC magnet facility at the NHMFL, Tallahassee Florida. The findings from the optimally doped measurements are elaborated in Ref. 1.

Results and Discussion

The tunneling spectrum shows a gap-like feature at the energy scale of the superconducting gap value (see Fig 1. in Ref. 1). Upon increasing the magnetic field, for the optimally doped samples, the gap-like feature is slightly reduced down to 15 meV, until at 6 teslas it can not be detected any more. Further increasing the magnetic field results in the appearance of a new gap-like feature, at 11 meV, where its amplitude grows with increasing magnetic fields. We repeated the experiment with over-doped films. In this case, the gap-like feature is hardly modified with fields up to 32.4 teslas. In contrast to the high bias differences, the low bias region exhibits similar behaviors for the various doping levels.

The differences at the high bias region could be due to different OP symmetry at the different doped samples. It has been already suggested [2], that the over-doped samples may not have nodes and therefore and therefore allows stronger currents along the [110] directions. The low bias spectral resembles could be due to the effect of vortices on the tunneling conductance nearby the surface at high magnetic fields [3].

Conclusions

We measured the tunneling conductance of optimally and over-doped YBCO samples. The tunneling spectra at high magnetic fields show different behaviors for the different doping. It could be explained by different OP symmetry and its reaction to strong nodal current induced by the strong applied magnetic fields. Further insights on the symmetry of the superconducting OP in different doping could be reveled by ultra low temperature phase sensitive measurements.

References

[1] Beck, R., *et al*., Phys. Rev. B., **72**, 10, 4505 (2005).
[2] Dagan, Y., *et al*., Phys. Rev. Lett., **87**, 177004 (2001).
[3] Grader, S., *et al*., Phys. Rev. Lett., **93**, 247001 (2004).