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Fluctuations and the Maki - Thompson model in $YBa_2Cu_3O_7$ thin films.

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The fluctuation conductivity is analysed for different epitaxial thin films of YBaCuO grown on various substrates such as $LaAlO_3$ KTO_3 and MgO. The findings, without fitting parameters, are explicitly consistent with the paraconductivity model proposed by Maki and Thompson for thin films

1. INTRODUCTION

In the high temperature superconductors, fluctuations have much more influence on the conductivity than in the conventional ones. So fluctuations may be the main reason for a broader transition behaviour above Tc. In this temperature region the observed excess conductivity or paraconductivity can be expressed by different theoretical models from where the dimensionality of the system can be deduced.

Aslamasou and Larkin [A-L] proposed a model [1] according to which the excess conductivity $\Delta\sigma$ can be generally expressed through the relation $\Delta\sigma=\varepsilon^{-\lambda}$; where A is a parameter, $\varepsilon=(T-Tc)/Tc$ and λ an exponent related to the dimensionality D of the system through the relation $\lambda=2-D/2$

Maki and Thompson [2] on the other hand proposed their own model in order to justify the paraconductivity observed in thin films They consider a weak pair breaking mechanism decay of the fluctuations pairs into pairs of quasiparticles, which continue to be much accelerated, leading to a contribution larger than that of A-L for 3D For 2D they give a logarithmic term as follows

$$\Delta\sigma_{2D} = \frac{e^2}{8khd}\,\frac{1}{\varepsilon-\delta_T}\,\ln(\varepsilon/\delta_T)$$

with $\delta_T = 2\xi^2(O) / d^2\delta$, δ a pair breaking parameter varying with temperature and $\xi(O)$ the coherence length at T=O A similar logarithmic

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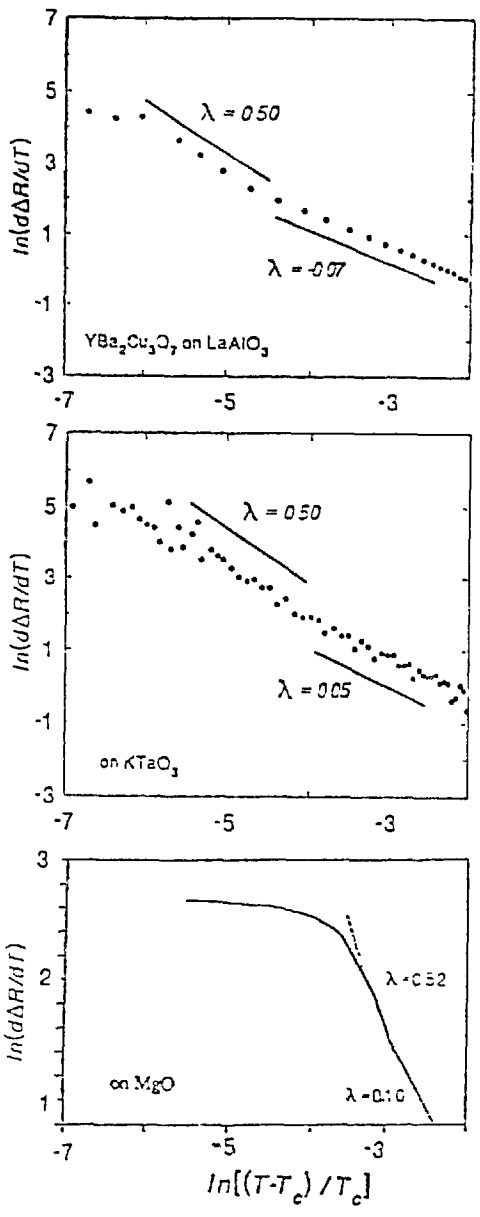
relation has been recently derived by Maki and Thompson [3] Through the above relation it is clear that such a contribution increases logarithmically for $\varepsilon \gg \delta_T$, i.e. at T away from Tc. Indeed as it has been shown by Hikite and Suzuki [4] the influence of M-T term is greater from the transition temperature while A-L contribution dominates closer to Tc.

2. EXPERIMENTAL

In this report fluctuation behaviour was studied in three thin films grown epitaxially on three different substrates : $LaAlO_3$, $KTaO_3$ and MgO.

The experimental method was that of d.c four probes technique. Data around the transition temperature were taken with a temperature sweeping rate of about 9 K/h so that quasistatic conditions may be assumed. For the fluctuation analysis the temperature Tc is used as that inferred from the maximum of dR/dT [5,6]. For the data analysis $\Delta\rho$ is used instead of $\Delta\sigma$ and, in fact, d ΔR/dT in relation to ε, is analysed in a log d ΔR/dT - logε plot where from the slope of the fitted line λ and consequently D is deduced. The plots for the three films are shown in the figures shown. On these figures, the values of λ are noted for different parts of the plots. The λ crosses over from $\lambda \sim 0$ further from Tc to λ=0.5 closer to Tc. The λ=0 according to singular function analysis corresponds to a logarithmic behaviour in accordance with the M-T 2D model

Closer to Tc, for all the films, the λ=0.5 leads to a higher 3D dimensionality This is expected [4] due to an increase in the coherence length. As long as the coherence length along c reaches the interlayer distance the superconductor is viewed as homogeneous and a 3D dimensionality results



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