On the superconducting critical temperature in multiband disordered $LaAlO_3/SrTiO_3$ interfaces

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Abstract

$LaAlO_3/SrTiO_3$ interfaces are a nice example of a two-dimensional electron gas whose carrier density can be varied by top- and back-gating techniques. The interplay of two-dimensionality, multi-band character and disorder affects the superconducting critical temperature T_c of these heavily disordered multi-band superconductors.
We propose a realistic two band disordered model (Fig. 1) based on experimentally determined parameters [2] to study such interplay.
While confirming that a repulsive inter-band coupling favors the T_c suppression, we show that disorder alone can mix the two bands [2], generating a more pronounced suppression of the critical temperature in the vicinity of the Lifshitz transition. Finally, this study allowed us to disentangle microscopic from mesoscopic disorder effects, since the global behavior of T_c is well captured only if the strongly inhomogeneous nature of such compounds is considered.

References

[1] T. V. Trevisan, M. Schütt, R. M. Fernandes, Phys. Rev. Lett. (2018) **121**, 127002
[2] G. Singh, G. Venditti, G. Saiz, G. Herranz, F. Sánchez, A. Jouan, C. Feuillet-Palma, J. Lesueur, M. Grilli, S. Caprara, and N. Bergeal, Phys. Rev. B (2022) **105**, 064512
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Figures

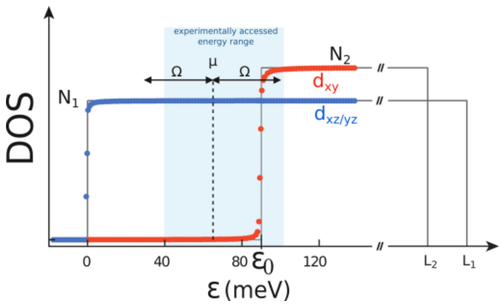

Figure 1: Sketch figure of the density of states (DOS) N_1 and N_2 as functions of the energy ε . The solid grey lines show the clean case (no disorder), while the blue and red symbols show the dirty case for both bands, with an inverse scattering time τ^{-1}= 0.4 meV. The shaded blue area corresponds to the experimental accessible chemical potential window.

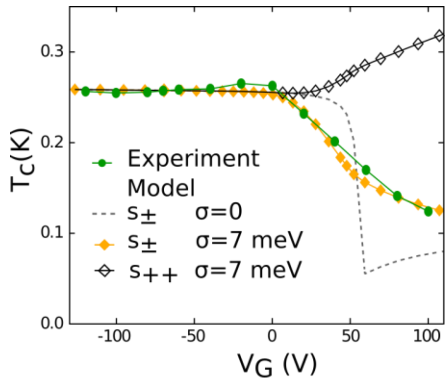

Figure 2: Experimental (green circles) and calculated superconducting T_c as a function of the gate voltage V_G both in the case of attractive (black diamonds) and repulsive (orange diamonds) interband coupling, with the variance of the chemical potential disorder σ =7 meV and τ^{-1}=0.4 meV. Dashed line shows the computed curve in absence of mesoscale disorder in the $s_{\pm}$ scenario (σ =0 meV).