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Electrodynamics of Hetero-structured High-Temperature Superconductors

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Oxide Interfaces and Superconductivity





Collaborators



Enhancement of J_c in *Pnictide Superlattices*

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SISSI@Elettra S. Lupi P. Di Pietro Superconductivity in CCO/STO Superlattices

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Co-Ba122 single crystalline films

Template engineering growth on 100 u.c. STO

Higher T_c (comparable to bulk single crystals)
Higher crystallinity

•Higher J_c



S. Lee et al., Nature Mat. (2010)





Increasing J_c in Pnictide Superlattices

High-field applications require large J_c and H_{irr} along all crystal directions



Co-Ba122 film Self-assembled nano-rods → Flux pinning centers along the c-axis

STO SL 1.2 nm STO interlayer every 13 nm Co-Ba122 → no c-axis defects O-Ba122 SL 3 nm O-Ba122 interlayers Every 13 nm Co-Ba122 → **3D pinning**



Critical currents and T_c





Normal State Electrodynamics



Two-band model

1) Narrow Drude term ($\gamma \sim 100-200 \text{ cm}^{-1}$)

2) Broad Drude term ($\gamma \sim 4000 \text{ cm}^{-1}$)

Optical conductivity of O-Ba122-SL reminds that of the Co-doped film

On the other hand STO-SL displays larger spectral weight, and less pronounced multi-band character

Is the multiband character preserved in the superconducting state of the SL compounds?

A. Perucchi et al., APL (2014)



Superconducting gap

Zimmermann model with parallel conductivity channels

Normal state parameters $(\omega_p \text{ and } \gamma)$ are extracted from the fits of the 25 K data

*∆*_A is strongly suppressed, but the multigap structure is still preserved



Co-Ba122 film Δ_A =18 cm⁻¹ Δ_B =60 cm⁻¹

> STO-SL Δ_A = 7 cm⁻¹ Δ_B =60 cm⁻¹

O-Ba122-SL Δ_A = 7 cm⁻¹ Δ_B =60 cm⁻¹



HTSC in (CaCuO₂)_n/(SrTiO₃)_m





D. Di Castro et al., PRB (2012)



Layer thickness dependence





D. Di Castro et al., PRB (2012)



Electrodynamics of $(CaCuO_2)_5/(SrTiO_3)_3$

T-dependent conductivity peak Mid-IR band (weakly T-dependent) Charge density ~ 2.10^{21} cm⁻³ (δ ~0.05)







Conclusions

Enhancement of J_c in Pnictide Superlattices

Multigap structure is preserved in SuperLattices **but**

in O-Ba122-SL the normal state electronic structure deviates from that of the pristine Co-Ba122 film

Superconductivity in CCO/STO Superlattices

Electrodynamic properties remind underdoped cuprates

Charge density distribution in the various CuO layers still to be determined



Thank you!

