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Investigation of proximity effects in a YBa2Cu3O7-x/SrRuO3 bilayer heterostructure by magnetotransport measurements and neutron scattering techniques

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Heterostructures (HS) composed of conventional superconductors (SC) and ferromagnets (FM) reveal intriguing effects resulting from the interaction and proximity of these two opposing phases of matter. Our interest is focused on proximity effects in HS based on high critical temperature (T_c) SC and FM with perpendicular magnetic anisotropy, particularly oxides. $SrRuO_3$ (SRO) emerges as a suitable FM candidate due to its strong PMA with narrow domain walls and excellent lattice match with the high-T_c SC $YBa_2Cu_3O_{7-x}$ (YBCO). Moreover, SRO exhibits interesting quantum properties, such as high spin-orbit coupling, anomalous Hall effect, and Berry effects. Such properties in combination with conventional and unconventional superconductors motivate the exploration of topological superconductivity [1]. We have observed indicators of proximity effects in an epitaxial YBCO/SRO bilayer HS characterized by (i) a reduction in the SC T_c and (ii) an inversion of the magnetoresistance signal at the superconductivity onset. These global features invite a more detailed microscopic understanding. Polarized Neutron Scattering (PNR) provides insights into the structural and magnetic properties of the high-T_c SC/FM bilayer HS with depth resolution, elucidating the spatial distribution of SC and FM regions and identifying interfacial effects. Off-Specular Neutron Scattering (OSS) offers additional depth- and lateral-resolved characterization of magnetic properties, allowing a more detailed understanding of the magnetic domain structures and interfacial interactions within the YBCO/SRO bilayer HS. In this work, we report magnetotransport results of YBCO/SRO bilayer HS prepared on low miscut $SrTiO_3$ (001) single crystals by high oxygen pressure sputtering. Additionally, through simulations, we present how PNR and OSS can be useful to investigate whether the formation of an interfacial magnetic dead or depleted layer contributes to the reduction of the SC T_c, and to characterize the formation of magnetic domain structures in this YBCO/SRO bilayer HS. This work contributes to a deeper understanding of the complex interplay between magnetism and superconductivity in the high-T_c SC/FM systems and sheds light on future materials for quantum electronics.

[1] M. Cuoco; A. Di Bernado, APL Materials, v. 10, n. 9, p. 090902 (2022).

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Sitzung Einordnung: Mounting Posters, Beer and light Dinner

Track Klassifizierung: Magnetism & Superconductivity