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Proximity Effects and crossed Andreev reflections in Perovskite Superconductor-Ferromagnet Bilayers[1]

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Since the ferromagnetic side of a superconductor-ferromagnet (S-F) junction is spin polarized, Andreev reflections are suppressed. Consequently, the induced S order parameter in the F is expected to decay rapidly, on a nm scale. Our scanning tunneling spectroscopy measurements of thin epitaxial (100)$YBa_2Cu_3O_{7-\delta}$-$SrRuO_3$ (YBCO-SRO, S-F) bilayers indeed show that on most of the junction area the S order parameter vanishes in the SRO over a distance less than 8 nm. However, we find localized regions, arranged along narrow strips, where a superconductor-like gap penetrates the SRO more than 25 nm. This is attributed to "crossed Andreev reflections" taking place at domain boundaries, where an electron from one magnetic domain is retro reflected as a hole with opposite spin in an adjacent domain. Another intriguing finding was the reduction in the F ordering temperature of the SRO layer when T_{Curie} was in the pseudogap temperature regime of the (underdoped) YBCO film. This can be due to injection of correlated electron pairs into the SRO, thus supporting the preformed pairs scenario for the pseudogap. With that regard, I will discuss T_c enhancement in cuprate bilayers. We have also studied (110)YBCO-SRO bilayers, where, surprisingly, a clear penetration of the Andreev bound states (residing on the (110) YBCO surface) into the F layer was revealed. The penetration is manifested in the density of states as a split zero bias conductance peak with an imbalance between peak heights. Our data indicate that the splitting occurs at the S side, possibly as a consequence of induced magnetization, consistent with recent theoretical predictions. The imbalance is attributed to the spin polarization in SRO.

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