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Fluctuation conductivity and pseudogap in $YBa_2Cu_3O_{7-\delta}$ nanolayers

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After thirty years since the high-temperature superconductors (HTSC's or cuprates) discovery the physics behind the pairing mechanism which allows the Cooper pairs formation at T>100K still remains unknown. Importantly, apart from the high T_c's, cuprates possess the so-called pseudogap (PG) which opens below PG temperature $T^* >> T_c$ [1-3]. It is believed at present that the proper understanding of the PG phenomenon has to account for the pairing mechanism both in cuprates and new FeAs-based high-T_c superconductors, which is important in view of the search for the room-temperature superconductivity.

We believe the PG to be due to preformed pairs (local pairs) formation [1, 2] but the pairing mechanism is very likely of a magnetic type [1, 3]. Thus, the comprehension of the interplay between superconductivity and magnetism is widely considered to be one of the great challenges of the condensed-matter physics [1-3].

To clarify the issue, we studied the fluctuation conductivity (FLC) and PG in $YBa_2Cu_3O_{7-\delta}$ - $PrBa_2Cu_3O_{7-\delta}$ (YBCO-PrBCO) superlattices (SL's) and YBCO-PrBCO double-layer films (so-called "sandwiches", SD's) with different layer composition, prepared by pulsed laser deposition. Pr^{+3} atoms are known to have an intrinsic magnetic moment, $\mu_{eff} \approx 3.58\mu_B$ and $\mu_{eff} \approx 2\mu_B$ in the PrBCO compound. Thus, such compounds are considered to be very promising in studying the change of interplay between superconductivity and magnetism in HTSC's which is expected to increase with an increase of the number of PrBCO layers N_{Pr}.

Simultaneously pronounced maximum of $\Delta^*(T)$ appears at high T and gradually increases along with N_{Pr}. The maximum becomes more pronounced for SL3 and SD2. For the first time such $\Delta^*(T)$ with a descending linear region below T_{max} was observed for magnetic $SmFeAsO_{0.85}$ between the structural transition temperature T_s=150K and T_{SDW}=130 K which corresponds to the antiferromagnetic ordering of Fe spins density wave. It is believed to be the most noticeable feature of the magnetic influence in the HTSCs [2, 3]. To confirm the conclusion we have compared the results obtained for SL3 and SD2 with those found for $SmFeAsO_{0.85}$ and $EuFeAsO_{0.85}F_{0.15}$ [3]. Thus, one may conclude that it is very likely in YBCO-PrBCO compounds with enhanced Pr content, as well as in FeAs superconductors, the transition into the SDW state with decrease of temperature seems to be very possible. Thus we can say that the basic mechanism of the interplay between the superconductivity and magnetism could be the same in different kinds of magnetic superconductors.

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