Nanocomposites and nanomaterials

Influence Pr on pseudogap behavior in $YBa_2Cu_3O_{7-\delta}$ nanolayers

L.V.Omelchenko, A.L.Solovjov

Transfer B.Verkin Institute for Low Temperature Physics and Engineering of NAS of Ukraine, 47 Nauky Ave., Kharkiv, 61103, Ukraine
E-mail: omelchenko@ilt.kharkov.ua

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}.

Totally three SL's with 4YBCO-1PrBCO (4Y-1Pr), 7Y-7Pr and 7Y-14Pr layer periodicity (samples SL1, SL2, SL3) and two SD's: 400Å PrBCO-500Å YBCO (SD1) and 400Å PrBCO-200Å YBCO (SD2) have been studied. The excess conductivity $\sigma'(T)$ and PG, $\Delta^*(T)$, were analyzed within the Local Pairs model [2]. SL1 shows $\Delta^*(T)$ being typical for unadulterated YBCO films with a wide maximum at T_{max}~138 K and $\Delta^*_{max} \approx 250$ K. With increase of N_{Pr}, Δ^*_{max} decreases, whereas T* increases. 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]. 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 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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