2013

Time-Resolved Optical Response of All-Oxide,Proximitized Bilayers

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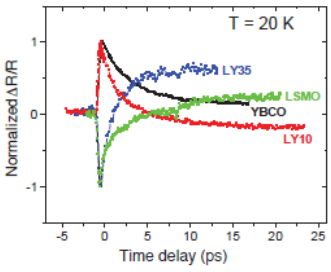
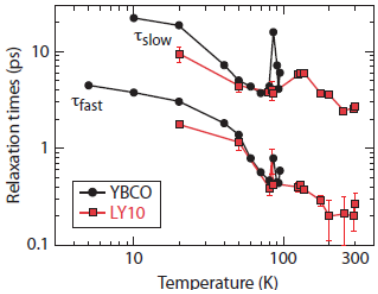
Phys. Rev. B vol. 87, 134514 (2013)

We present femtosecond pump–probe spectroscopy studies of time-resolved optical reflectivity of all-oxide, $YBa_2Cu_3O_7/La_{0.7}Sr_{0.3}Mn_{O3}$(YBCO/LSMO) superconductor/ferromagnet (*S*/*F*) bilayers consisting of a 100-nm-thick YBCO base layer and either 10-nm or 35-nm LSMO cap thickness, in the temperature range from 4 K to room temperature. At temperatures far below the YBCO superconducting transition T_C, samples with a 10-nm *F* overlayer show a photoresponse that is similar to, but faster than, pure-YBCO, 100-nm-thick reference samples, while close to T_C and above (up to 160 K), we observe a signature of both the electronic and spin response that cannot be interpreted as an incoherent sum of contributions from the two layers. The photoresponse of the *S*/*F* structures with the 35-nm LSMO layer always follows that of the pure LSMO. In all cases, the YBCO/LSMO nonequilibrium dynamics can be modeled using a generalized multi-temperature model, which is a superposition of the dynamics of the three-temperature models used to describe the superconductor and ferromagnet subsystems, respectively. The long-term of the photoresponse signal can be well fitted with the two characteristic relaxation times. Finally, the LSMO/YBCO bilayers with 10-nm-thick LSMO caps were characterized by quasiparticle relaxation times substantially shorter than those of the pure YBCO, making them interesting for possible applications of *S*/*F* bilayers in the field of ultrafast superconducting optoelectronics.

a)



b)



a) Normalized Δ*R*/*R* transients versus time delay measured at 20 K for our LY10 and LY35 bilayers, as well as the pure YBCO and LSMO reference samples. b) Characteristic fast and slow relaxation times (τ_{fast} and τ_{slow}) extracted from the experimental Δ*R*/*R*(*t*) plots for our LY10 and pure YBCO samples as a function of temperature.