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Exchange Driven Spin Relaxation in Ferromagnet/Oxide/Semiconductor Heterostructures[1] YU-SHENG OU, YI-HSIN CHIU, The Ohio State University, Dept of Physics, NICHOLAS HARMON, University of Iowa, Dept of Physics, PATRICK ODENTHAL, University of California, Riverside, Dept of Physics, ROLAND KAWAKAMI, The Ohio State University, Dept of Physics, MICHAEL FLATTÉ, University of Iowa, Dept of Physics, EZEKIEL JOHNSTON-HALPERIN, The Ohio State University, Dept of Physics — Time-resolved Kerr rotation (TRKR) is employed to study the exchange coupling between spin ensembles in GaAs and a neighboring ferromagnet (FM) in an Fe/MgO/GaAs heterostructure. The time-resolved spin dynamics in GaAs provide local magnetometry, revealing the strength and sign of the exchange field as well as its impact on electron and nuclear spins. Consistent with previous studies, we see a hyperpolarization of the nuclei induced by the dynamic exchange at the Fe/MgO/GaAs interface that results in a large effective nuclear field on the electrons (Bn = 0.2 T). Unexpectedly, we observe that the spin relaxation time in GaAs, T2*, depends on the strength of the exchange-driven nuclear field rather than the applied field. In addition, the temperature dependence of T2* shows a crossover of relaxation mechanism from hyperfine dominated to D'yakonov-Perel' (DP) dominated at temperatures above 40 K. These results not only resolve a long-lasting puzzle of the GaAs spin relaxation mechanism, but further demonstrate the ability to detect exchange-driven dissipation in FM/NM heterostructures. We discuss the potential for this work to define a novel detection scheme for exchange-driven spin injection in FM/semiconductor heterostructures, such as ferromagnetic resonance driven spin pumping.

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