Terahertz Time-Domain Magneto-spectroscopy of $LaMnO_3$ and $La_{0.875}Sr_{0.125}MnO_3$

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Doped perovskite manganites (e.g., $La_{1-x}Sr_xMnO_3$ or LSMO) have attracted considerable interest over the last few decades due to their complex phase diagrams and the discovery of the colossal magnetoresistance (CMR) effect [1]. To date, the origin of the CMR effect and some unusual states, for instance, the ferromagnetic insulator (FI) phase in $La_{0.875}Sr_{0.125}MnO_3$ at low temperatures, are still not well understood [2]. It is challenging to extract the full picture from time-integrated spectroscopy measurements due to the strong interplay among the charge, spin, orbital, and lattice degrees of freedom in the manganites. Ultrafast pump-probe spectroscopy has been suggested as a powerful tool for providing insight into such complex materials by investigating their dynamics after optical excitation [3]. Terahertz (THz) spectroscopy is particularly important to probe low-energy collective excitations such as phonons, magnons, and charge density wave (CDW) condensate [4]. Here, we studied the temperature and magnetic field dependence of THz transmission in $LaMnO_3$ (LMO) and LSMO (x = 0.125) single crystals. The temperature dependence of conductivity spectra showed well agreement with the known phase diagram. In addition, a few resonance modes in the THz regime were observed.

The LMO and LSMO (x = 0.125) single crystals were grown by the floating zone method. THz time-domain spectroscopy (THz-TDS) was used to measure the complex conductivity of the crystals. Near-infrared pulses at 775 nm were used to generate THz pulses with a ZnTe crystal. The THz beam transmitted through the sample mounted in a superconducting magnet, and then was detected by the electro-optic sampling method using another ZnTe crystal.

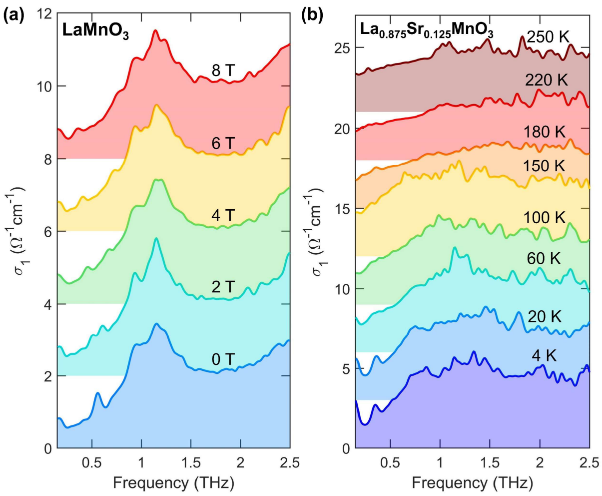

Fig. 1 (a) Magnetic field dependence of the real part of the optical conductivity, σ_1, measured for LMO at 4 K and (b) temperature dependence of σ_1 measured for LSMO (x = 0.125) at zero magnetic field.

In summary, THz-TDS measurements of $LaMnO_3$ and $La_{0.875}Sr_{0.125}MnO_3$ were conducted at different temperatures and magnetic fields. The optical conductivity spectra showed basic agreement with expectations based on the known phase diagram but revealed new resonance modes in the THz regime in both crystals. Future work will include optical-pump/THz-probe experiments of both crystals to study light-induced phase transitions.

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