High-Field Magnetotransport in Complex Oxide Heterostructures

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Introduction

Magnetotransport phenomena in the quantum limit have traditionally been explored in two-dimensional electron gases (2DEG) and quantum wells (QW) in semiconductor heterostructures, such as GaAs/AlGaAs and Si/SiO_2. 2DEGs in complex oxides, whose conduction band is derived from *d* orbitals (e.g. in $SrTiO_3$), have been explored to a much lesser extent.

In this report, we discuss data obtained from magnetotransport measurements at the NHMFL of 2DEGs in modulation doped $La:SrTi_{1-x}Zr_xO_3/SrTiO_3$ heterostructures. We also investigated 2DEGs in $GdTiO_3/SrTiO_3$ and $SmTiO_3/SrTiO_3$ heterostructures in which the 2DEG arises due to a polar discontinuity at the interface between polar $RTiO_3$ (R = Gd or Sm) and nonpolar $SrTiO_3$.

Experimental

Electrical transport measurements were performed using a standard AC lock-in technique. The longitudinal magnetoresistance [$R_{xx}(B)$] of each sample was measured at temperatures down to 350 mK and at various tilt angles in magnetic fields up to 31 T (NHMFL Cell 9).

Results and Discussion

The tilt angle and temperature dependences of the longitudinal magnetoresistance of the $SrTi_{1-x}Zr_xO_3/SrTiO_3$ heterostructure are shown in Fig. 1. The shift of oscillations to higher fields at higher tilt angles, with no obvious oscillations at 90°, is characteristic of a 2D system where the oscillations depend only on the magnitude of the perpendicular component of the magnetic field, rather than the magnitude of the total field. The $RTiO_3/SrTiO_3$ structures showed qualitatively similar behavior consistent with an interfacial two-dimensional system. We are currently working on the interpretation of the data. In particular, we are using models to determine the number of occupied subbands, and the influence of spin splitting.

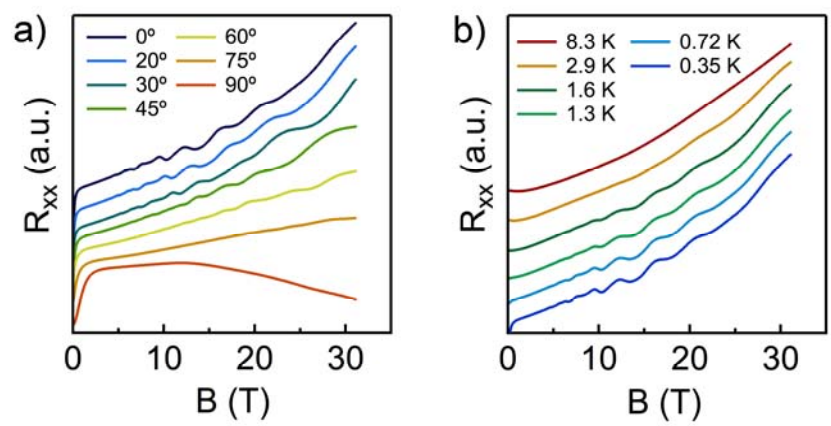

Fig. 1: Longitudinal magnetoresistance (offset for clarity) of a $La:SrTi_{1-x}Zr_xO_3/SrTiO_3$ heterostructure at (a) various tilt angles (i.e. the angle between the magnetic field and the sample interface normal) and (b) various temperatures. The data in (a) was taken at a temperature of 350 mK, and the data in (b) was taken at a 0° tilt angle.

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