LNCMI-Toulouse

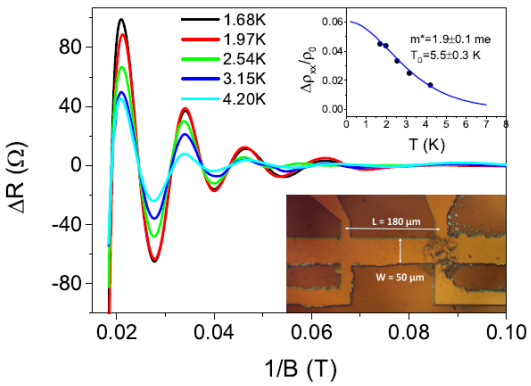
Electronic properties of 2D electron gas at the interface between complex oxides

Summary

In collaboration with the National University of Singapore, this project aims at studying the magneto-transport properties of 2DEG at the interface between complex oxides such as $LaAlO_3/SrTiO_3$ in extreme conditions of very high magnetic field (80T) and low temperature (350mK). In particular, the prominent role of spin-orbit coupling and the presence of several low-energy conduction sub-bands will be investigated by varying the magnetic field tilt angle, the temperature and the sample's carrier density.

Detailed subject

The discovery of a high-mobility two-dimensional electron gas (2DEG) at the interface between two insulating complex oxides ABO_3 (the most prominent examples are $LaAl0_3$ and $SrTi0_3$, but other oxides may exhibit similar properties with A=Sr, La, Ba and B=Al, Ti, Mn) has triggered extensive researches aiming at understanding its peculiar electronic properties [1]. The origin of such a 2DEG is often ascribed to the polar discontinuity arising at the interface between a polar oxide overlayer and a nonpolar oxide substrate. For the case of $LaAl0_3$ / $SrTi0_3$, an internal electric potential builds up in the alternating stacks of polar AlO^{2-}/LaO^{+} layers on the $TiO_2{}^0$-terminated nonpolar $SrTiO_3$. As a consequence, electrons can be transferred from the $LaAlO_3$ valence band to the $SrTiO_3$ conduction band, giving rise to the conducting 2DEG at the interface between the two insulating materials. Contrary to conventional 2DEG, unexpected properties including two-dimensional superconductivity [2], magnetic interactions [3], and electronic phase separation [4] have been reported, pointing towards the rich physics and complexity of electronic states at the oxide interfaces. Making advantage of a long-standing collaboration between the Multifunctional (Oxide) Materials & Devices group at the National University of Singapore specialized in device fabrication engineering and characterization, this project aims at studying the magneto-transport properties of such 2DEG in extreme conditions of very high magnetic field (80T) and low temperature (350mK). To date, only one study above 30T has been published [6], despite the incontestable interest of the experimental method. In particular, the prominent role of spin-orbit coupling and the presence of several low-energy conduction sub-bands are likely to be investigated using high field magneto-transport, where the magnetic field tilt angle, the temperature and the sample's carrier density will be varied *in situ*.



Publications linked to the theme

1. M. Yang *et al.*, APL **109**, 122106 (2016).
2. A. Ohtomo and H. Y. Hwang, Nature **427**, 423 (2004).
3. N. Reyren *et al*., Science **317**, 1196-1199 (2007).
4. Ariando *et al*., Nat. Commun. **2**, 188 (2011).

Background and skills expected

Advanced condensed matter physics and quantum mechanics, skills for experimentation

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