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 LaAlO$_3$ and SrTiO$_3$, 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 LaAlO$_3$/SrTiO$_3$, an internal electric potential builds up in the alternating stacks of polar AlO$_2$-/LaO$^+$ layers on the TiO$_2$-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

Background and skills expected
Advanced condensed matter physics and quantum mechanics, skills for experimentation

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