



Shubnikov de Haas oscillation in electron gases based on KTaO_3 (001) interface

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Introduction

In transition metal oxides, the interplay between the active lattice, spin, charge and orbital degrees of freedom leads to extremely rich ground states such as multiferroicity, high- T_C superconductivity, colossal magnetoresistance, and metal-to-insulator transitions. Recently, 5d TMO compounds have attracted much attention due to their strong spin-orbit coupling (SOC) from heavy elements, which can lead to exotic properties. In this project, we created electron gases in a 5d electron perovskite metal oxide system KTaO_3 (001) to explore these effects.

Experimental

Shubnikov de Haas oscillations were measured up to 35 T magnetic field.

Results and Discussion

In this project year, we have conducted one week high magnetic field measurement at National High Magnetic Field Lab. We focused on measurements of Shubnikov-de Haas oscillations in high magnetic fields and low temperatures in electron gases created based on KTaO_3 (001) surfaces. By using band engineering at the interface, we have confirmed that the electron gases can be tuned from three-dimensional to two-dimensional as demonstrated from the angular dependence of the oscillations. In mixed dimensionality samples, when the magnetic field is applied parallel and perpendicular to the film plane, SdH oscillations were observed in both directions. When the sample is near two-dimension, only in the perpendicular magnetic field direction, the oscillation is present. The quantum confinement of the sample in two dimension also causes various changes in the oscillation peak frequency which correspond to the surface band structure change due to quantum confinement effect. The details of the band structure change and the effect of the strong spin-orbit coupling on the modification of the surface electron bands through Rashba effect is being analyzed.

Conclusions

We have succeeded in engineering the dimensionality of the electron gases and observed quantum confinement effect and strong spin-orbit coupling on the surface band structure.

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