Electrical and magnetic properties of semi-metallic WTe$_2$

Jeehoon Jeon$^{1,2,*}$, Tae-Eon Park$^1$, Sangsu Kim$^2$, Taeyueb Kim$^3$, Chaun Jang$^1$, Hyoun Tae Kim$^6$, Hyun Cheol Koo$^{1,4}$, Jinki Hong$^2$, Joonyeon Chang$^5$

$^1$Spin Convergence Research Center, Korea Institute of Science and Technology, Seoul, Korea
$^2$Department of Applied Physics, Korea University, Sejong, Korea
$^3$Center of Electricity and Magnetism, Korea Research Institute of Standards and Science, Daejeon, Korea
$^4$KU-KIST Graduate School of Converging Science and Technology, Korea University, Seoul, Korea
$^5$Post Silicon semiconductor Institute, Korea Institute of Science and Technology, Seoul, Korea

Spintronics device is one of alternative ways to realize next generation electric device beyond modern electronic device. The generation, manipulation and detection of spins in materials are an important issue for the development of spin-based electronics. In an aspect of overcoming these challenges, refers to ohmic junction and suitable spin transport channel with long spin relaxation time in terms of propagating spin polarized current injected from source to drain without spin dephasing. Recent studies have shown generation of pure spin current, efficient propagation, spin manipulation in low-dimensional materials. Among them, Van der Waals materials representing atomic ultra-thin layers isolated from layered single crystals have been researched. Transition-metal dichalcogenide (TMD), which is one of Van der Waals materials have been known for large spin—orbit interaction (SOI) and object of opto-valleytronics research, thus TMD has recently attracted attention.

In this research, we introduce 1T'-WTe$_2$ crystals as a material for spintronic device. We fabricated Hall bar structure using an exfoliated WTe$_2$ layers. This device is used for electrical and magnetic measurement. We obtained ohmic contacts between metal electrodes and WTe$_2$ by chemical and physical surface treatment, and then observed the extremely large magnetoresistance (XMR), transverse resistivity contributed by both electron and hole transport, and the quantum oscillation by the Shubnikov–de Haas effect at low temperature. In a transport measurement, we observed non-saturating magnetoresistance (MR) which illustrates a high-mobility and semi-metallic property of 1T'-WTe$_2$ crystal. Therefore, these study imply that WTe$_2$ is one of the excellent candidates for spin transport devices.