Magneto-Optical Studies of Layered Antiferromagnet $CrPS_4$

Jongchan Kim[1,2], Kenji Watanabe[3], Takashi Taniguchi[4], Je-Geun Park[1,2], Jieun Lee[1,2]

[1]*Department of Physics and Astronomy, Seoul National University, Seoul 08826, Republic of Korea.*

[2]*Institute of Applied Physics, Seoul National University, Seoul 08826, Republic of Korea.*

[3]*Research Center for Electronic and Optical Materials, National Institute for Materials Science, Tsukuba 305-0044, Japan.*

[4]*Research Center for Materials Nanoarchitectonics, National Institute for Materials Science, Tsukuba 305-0044, Japan.*

Two-dimensional magnetic materials have recently attracted significant attention as promising platforms for studying spin-based devices such as spin filters or valves and investigating exotic spin-dependent phenomena such as the realization of magnetic skyrmions. However, micrometer-scale dimensions of these materials make their direct magnetic characterization challenging. Conventional bulk measurement techniques are often insufficient, therefore, approaches through transport measurements or optical probes must be employed. In this work, we investigate thin-layers of antiferromagnetic semiconductor $CrPS_4$, which is an A-type antiferromagnet in its bulk form, and explore its spin properties through magneto-optical effects and polarization-resolved photoluminescence (PL) measurements.

The few-layer flakes of $CrPS_4$ investigated in our work are obtained by mechanical exfoliation from bulk crystals which are subsequently capped with *h*BN. For probing the spin polarization, we measured the degree of circular polarization of PL emission from $CrPS_4$ in Faraday geometry and confirm the out-of-plane spin orientation which is further supported by the magnetic circular dichroism (MCD) measurements. We further extend our study to the Voigt geometry, performing both MCD and circularly polarized PL measurements to track the evolution of spin orientation under in-plane magnetic fields. Taken together, these optical spectroscopic results demonstrate the potential of two-dimensional antiferromagnets as versatile platforms for exploring spin physics in van der Waals platforms and advancing next-generation spin-based technologies.

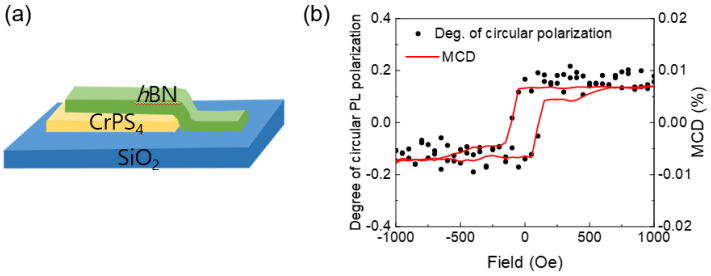

Figure 1. (a) Schematic of *h*BN capped few-layer $CrPS_4$. (b) Degree of circular PL polarization (black dots) and magnetic circular dichroism (MCD, red line) measured as a function of magnetic field. The degree of circular PL polarization is defined as (left circular PL – right circular PL) / (left circular PL + right circular PL).