

# Strain-induced modulation of photoluminescence in layered semiconductor SnS

Atsuhiko Mori<sup>1</sup>, Kazuki Koyama<sup>1</sup>, Jun Ishihara<sup>1</sup>, Sota Yamamoto<sup>1</sup>, Makoto Kohda<sup>1-4</sup>

<sup>1</sup>, Graduate School of Engineering, Tohoku University, Japan,

<sup>2</sup>, Center for Science and Innovation in Spintronics, Tohoku University, Japan

<sup>3</sup>, Division for the Establishment of Frontier Science, Tohoku University, Japan

<sup>4</sup>, Quantum Materials and Applications Research Center, National Institute for Quantum Science and Technology, Japan

atsuhiko.mori.s7@dc.tohoku.ac.jp

SnS (tin sulfide) is a two-dimensional layered semiconductor classified as a group IV monochalcogenide. Characteristics, such as in-plane ferroelectricity and abundant resources make SnS an attractive material. Furthermore, monolayer SnS exhibits interesting phenomena such as bulk photovoltaics arising from the low crystalline symmetry and is expected to be applied to solar cells [1]. The theoretical study predicts that the band structure changes from an indirect transition to a direct transition when strain is applied in monolayer SnS [2]. This is also expected to improve the absorption efficiency near the band edge. In this study, we investigate the strain effect on the band structure of bulk SnS from the photoluminescence property.

Bulk SnS is grown on SiO<sub>2</sub> substrate by chemical vapor deposition (CVD). The growth temperature is 850°C and the growth time is 120 minutes. As shown in Fig. 1, large SnS flake exceeding 100 μm × 50 μm is obtained. Prior to applying the strain, the SnS is transferred onto polymer film. This enables us to apply the percent-order strain to the SnS by bending the film. Figure 2 shows an image of a home-made vise device with the bended film, between two edges. This device is assembled into a photoluminescence apparatus to measure the optical property by changing the strain at room temperature. For the light source, a CW laser with a wavelength of 561 nm is employed for the excitation.

Figure 3 shows the photoluminescence spectra with 0% and 2.04% strain. The Γ-X peak intensity decreases to about half of the Γ-Y peak intensity due to the application of tensile strain along the armchair direction. We will also discuss the effect of tensile strain on band structure from the Raman spectra.

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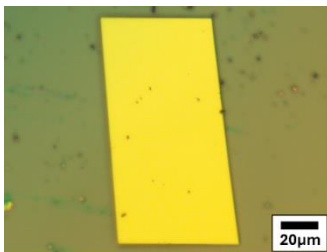


Fig.1 SnS grown by CVD.

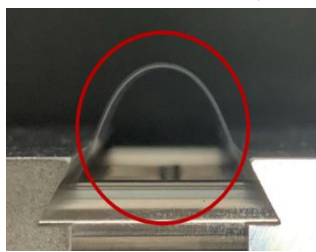


Fig.2 Strain applying device.

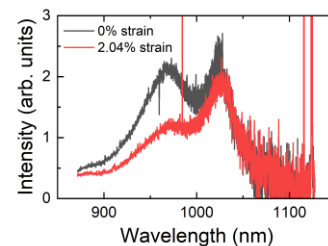


Fig.3 Luminescence spectra at 0% and 2.04% strain.

## References

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