1H-1T’ phase transition and heterojunction formation in CVD-grown monolayer $Mo_{1-x}Re_xS_2$

○Shohei Mori[1], Shogo Sasaki[1], Yu Kobayashi[1], Liu Zheng[2], Shoji Yoshida[3], Takahiro Takeuchi[3], Hidemi Shigekawa[3], Kazutomo Suenaga[2], Yutaka Maniwa[1], Yasumitsu Miyata[1,4]

[1]Department of Physics, Tokyo Metropolitan University, Hachioji, 192-0397, Japan
[2]Nanomaterials Research Institute, AIST, Tsukuba 305-8565, Japan
[3] Faculty of Pure and Applied Sciences, University of Tsukuba, Tsukuba 305-8573, Japan
[4]JST, PRESTO, Kawaguchi, 332-0012, Japan

Semiconductor heterojunctions based on atomic layers have attracted much attention because of their potential applications in electronics and optoelectronic. So far, such heterojunctions have been fabricated by using chemical vapor deposition (CVD) of various transition metal dichalcogenides (TMDCs) such as monolayer MoS_2, WS_2 and $Mo_{1-x}W_xS_2$ alloys [1-3]. In contrast, the junctions with different polytypes have been also observed for exfoliated MoS_2 flakes [4], and for the laser- and electron-beam-irradiated samples [5,6]. However, the direct growth of polytype-based heterojunctions still remain as an unsolved issue. In this study, we report the growth and characterization of heterojunction of 1H and 1T’ phase monolayer $Mo_{1-x}W_xS_2$ alloys grown by CVD.

Monolayer $Mo_{1-x}Re_xS_2$ alloys were formed on graphite and quartz substrate substrates by CVD of sulfur, molybdenum oxide, and rhenium oxide. Growth of hexagonal-shaped monolayer grains was confirmed from atomic force microscope (AFM) observation (Fig.1a). Interestingly, the coexistence of 1H and 1T' phases was found within a single grain through scanning transmission electron microscope (STEM) image (Fig.1b), Raman spectrum (Fig.1c), and scanning tunneling microscope (STM) observations. In particular, the STEM image indicates that the 1T’ phase has higher Re concentrations than the 1H phase. In the presentation, we will report the details of their phase-transition conditions and electronic state.

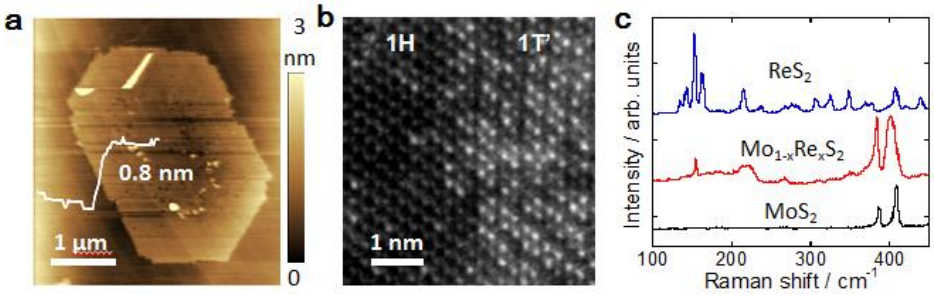

Fig.1 (a) AFM and (b) STEM images of $Mo_{1-x}Re_xS_2$. (c) Raman spectra of MoS_2, ReS_2, and $Mo_{1-x}Re_xS_2$.

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