Near-field optical imaging of monolayer MoS_2 grown by chemical vapor deposition: Identification of grain boundaries and line defects

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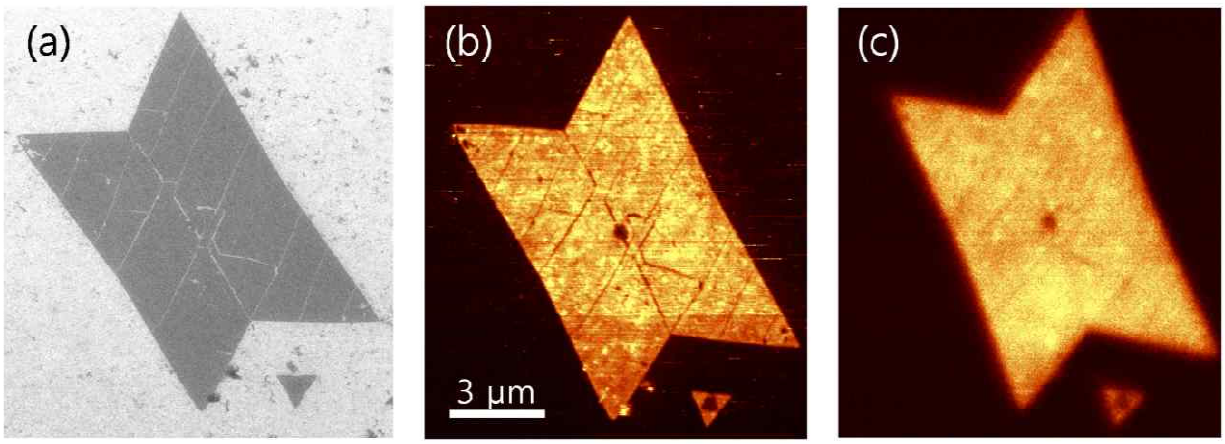
Abstract

Molybdenum disulphide (MoS_2), as known as 2-dimensional transition metal dichalcogenides, has appeared as semiconductor with an indirect/direct band gap in the rage 1.2 - 1.8 eV, which shows the photoluminescence (PL) depending on the thickness of the layers. Moreover, large-area monolayer MoS_2 by the chemical vapor deposition method paves the way to promising optoelectronic applications. However, imperfections such as grain boundaries and line defects in grown MoS_2 induces the lower mobility than the mechanically exfoliated MoS_2 and the degradation of optical properties. Therefore the visualization of such imperfections have been limited to scanning tunneling microscopy, transmission electron microscopy and second harmonic generation.

Here, we used near-field scanning optical microscope (NSOM) PL imaging of monolayer MoS_2 with 100 nm spatial resolution and showed that NSOM PL imaging can identify the nano-scale line defects, as small as ~20 nm in width, developed on grain boundaries of CVD grown monolayer MoS_2, which were not distinguished by conventional confocal PL imaging. We also found that combined with correlated scanning electron microscope (SEM) imaging, grain boundaries without formation of physical line-defects didn't provide the detectable PL contrast even with NSOM imaging.

Figures



Figures. (a) The image of butterfly shaped MoS2 taken by SEM. and The PL images taken by (b) NSOM and (c) Confocal.