Rotationally-oriented MoS$_2$ growth by thermal vapour sulfurization of Mo film

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Abstract
Two-dimensional molybdenum disulphide (MoS$_2$) film has been synthesized by thermal vapour sulfurization (TVS) of thin Mo film. Figure 1(a) shows transmission electron microscopy (TEM) image of the MoS$_2$ film transferred on a TEM grid. Selected area electron diffraction (SAED) patterns taken from different spots identified in (a) exhibited nearly identical crystallographic orientations, revealing the rotational alignment of the MoS$_2$ domains in the film. The film was found to consist of 4~5 layers (Figure 1(b)). The MoS$_2$ film was also characterized by Raman spectroscopy. As shown in Figure 2(a), the two Raman modes E$_{12g}$ and A$_{1g}$ are observed at a separation of about 25 cm$^{-1}$, indicating multilayer formation [1]. MoS$_2$-channel field-effect-transistor (FET) fabricated on a SiO$_2$/Si substrate exhibits n-type semiconducting behaviour (Figure 2(c)), which is consistent with previous reports [2, 3]. Two-terminal FETs exhibited electron mobility ranged from 0.1 to 2.9 cm$^2$/V-s at room temperature which is larger than previously reported values of TVS-grown MoS$_2$ [4, 5]. We also tested gas-sensing properties of the FET, and it was found to exhibit resistivity change by an order of magnitude to 7 ppb of NO$_2$ in N$_2$. This research was partly supported by JST CREST Grant Number JPMJCR15F1, Japan.

References