P-type field-effect transistors based on liquid phase exfoliated MoS_2

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Abstract

Two-dimensional (2D) materials are a new class of materials with interesting physical properties and applications. The most studied 2D semiconducting dichalcogenide MoS_2 is gaining importance as a promising channel material for field-effect transistors (FETs) [1]. Liquid phase exfoliation (LPE) is a promising route for large-scale production of 2D materials [2]. However, the MoS_2 films produced with LPE showed low carrier mobility [3]. The assembly of nanomaterials in thin films directly affects their morphology and electronic properties with ordered packing usually resulting in superior film quality and device performance. Integrating nanomaterials into FETs requires reliable assembly methods to fabricate relatively uniform thin films. In our work, we describe controlled deposition of few-layer MoS_2 films using a modified Langmuir-Schaefer (LS) method and perform mobility measurements on few-layer MoS_2 FETs (Fig. 1). Our films showed p-type conduction and mobility larger than 60 cm2 $V^{-1}s^{-1}$ at room temperature in air (Fig. 2). This is the largest ever achieved mobility for FET devices from LPE MoS_2, comparable to the previously reported p-type MoS_2 FET from chemically doped CVD samples [4]. Our facile and reproducible method results in high-quality films that seriously compete with CVD films as materials of choise for applications in electronics.

References

[1] Radisavljevic B. *et al*., Nature Materials 12, (2013) 815-820.
[2] Coleman J. et al., Science, 331(2011)568
[3] Li J. Advanced Functional Materials, 24 (2014) 6524-6531
[4] Liu X. et al., Advanced Materials, 28 (2016) 2345-51

Figures

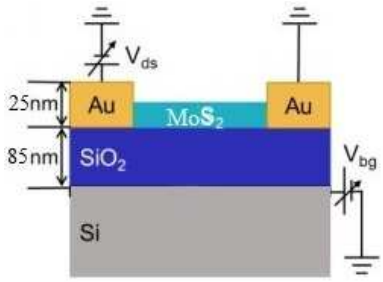

Figure 1: Schematic "cross-sectional" view of the device

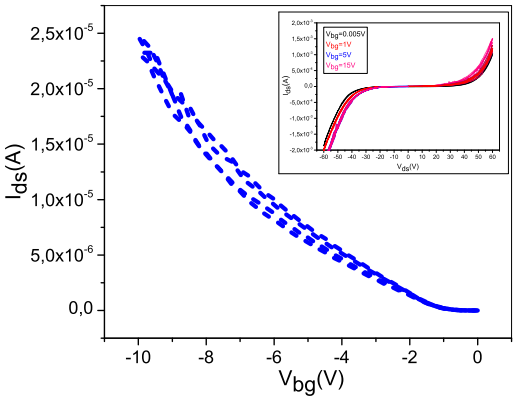

Figure 2: Room-temperature transfer characteristics with 100 mV applied bias voltage, and output characteristics Ids-Vds measured for different gate voltages (inset).