Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information:

Processable 2D materials beyond graphene: MoS_2 liquid crystals and fibres

Rouhollah Jalili*[a], Sima Aminorroaya-Yamini *[b], Tania M. Benedetti [a], Seyed Hamed Aboutalebi [c], Yunfeng Chao [a], Gordon G. Wallace [a], and David L. Officer [a]

Email: rjalili@uow.edu.au, sima@uow.edu.au

a. Intelligent Polymer Research Institute, ARC Centre of Excellence for Electromaterials Science, AIIM Faculty, Innovation Campus, University of Wollongong, North Wollongong, NSW 2522, Australia

b. Institute for Superconducting and Electronic Materials, AIIM Faculty, Innovation Campus, University of Wollongong, North Wollongong, NSW 2522, Australia

c. Condensed Matter National Laboratory, Institute for Research in Fundamental Sciences (IPM), Tehran 19395-5531, Iran

Experimental:

A stoichiometric ratio of molybdenum (99.9975%, Alfa Aesar) and sulfur powders (99.9995%, Alfa Aesar) were sealed in a quartz tube and heated to 1100°C in a furnace slowly and was kept at that temperature for a week. 0.1 mg of the achieved crystals or a large natural crystal (Manchester Nanomaterials) were mixed with 10 ml n-butyllithium solution (2.5 M in hexanes, Sigma Aldrich), sealed in an argon-filled Teflon round bottle and stirred slowly for 48 h. The mixture was dispersed in a bath sonicator for 1 h, and then 100 ml water was added slowly to react and exfoliate the lithium intercalated compound. The dispersion was centrifuged at 11 krpm for 15 min to remove non-exfoliated particles as sediment. The dispersion was placed in a dialysis bag and kept for 2 weeks.

SEM analyses were carried out by first depositing MoS_2 sheets from their dispersions on pre-cleaned and silanized silicon wafers (300 nm SiO2 layer). As deposited MoS_2 sheets were directly examined by scanning electron microscopy (JEOL JSM-7500FA) and optical microscopy. X-ray diffraction studies were performed using a powder XRD system (Philips1825) with Cu KR radiation (λ = 0.154 nm) operating at 40 keV and with a cathode current of 20 mA. The birefringence of the MoS_2 dispersion at 0.5 mg ml^{-1} was examined by

polarized optical microscopy (Leica DM EP) operated in transmission mode. Raman and polarized Raman spectra were recorded on a Jobin Yvon Horiba HR800 Raman microscope using a 632 nm laser line. The rheological properties of the MoS_2 dispersion was investigated using a rheometer (AR-G2 TA Instruments) with a conical shaped spindle (angle: 2°, diameter: 60 mm): approximately 2.3 ml of the MoS_2 dispersion at a concentration of 0.5 mg ml^{-1} was loaded into the rheometer with great care taken not to shear or stretch the sample. Shear stress and viscosity were measured at shear rates from 0.01 to 10 s^{-1} using logarithmic steps for a complete (ascending and descending) cycle.

In order to prepare a wet-spinnable dispersion of MoS_2 nanosheets, 50 ml of the original dispersion (0.5 mg ml^{-1}) was filtered through a cellulose membrane then redispersed in 2.5 ml of water to make up a concentration of 10 mg ml^{-1}. Wet-spinning was carried out using a technique we developed previously [1]. Briefly, the dispersion was loaded on a 10 ml syringe then was injected using a gauge 21 needle into a coagulation bath containing 1 wt% $CaCl_2$ in a mixture of water and acetone (30:70 vol%). The coagulated fibers were collected and dried after washing with ethanol and water.

Supporting Figures:

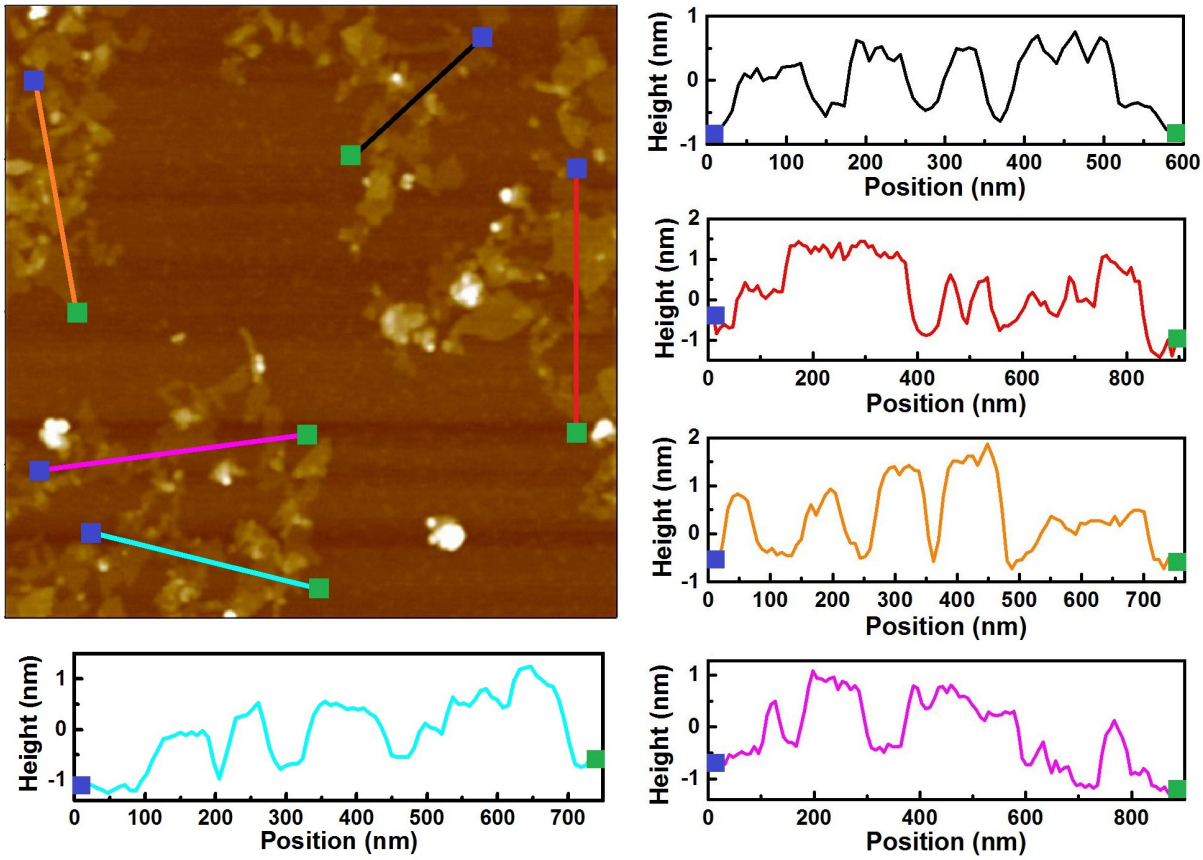

Figure S1. AFM analysis of MoS_2 nanoplatelet deposited on a silicon wafer along with the height profile of different nanosheets confirming thickness of ~ 1 nm.

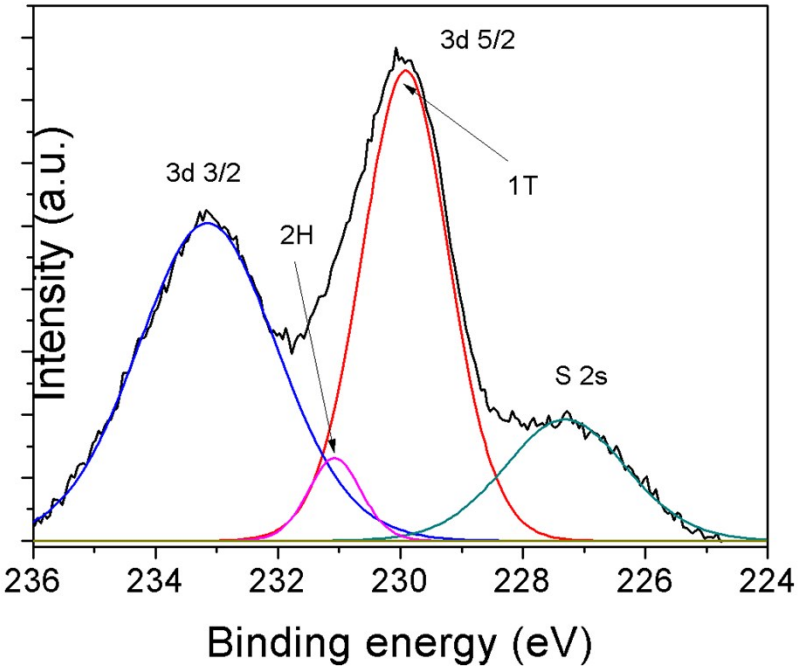

Figure S2, X-ray photoelectron spectrum from the Mo 3d region of exfoliated MoS_2 nanosheets. The contributions of the 1T and 2H phase components in the Mo 3d spectrum are indicated. The as exfoliated MoS_2 nanosheets comprise the predominantly metallic, 1T phase.

References:

1- R. Jalili, S. H. Aboutalebi, D. Esrafilzadeh, R. L. Shepherd, J. Chen, S. Aminorroaya-Yamini, K. Konstantinov, A. I. Minett, J. M. Razal and G. G. Wallace, *Adv. Funct. Mater.*, 2013, **23**, 5345-5354.