Solution Processing Of Transition Metal Dichalcogenide Thin Films

Tech ID: 32651 / UC Case 2014-807-0

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	9,991,390	06/05/2018	2014-807

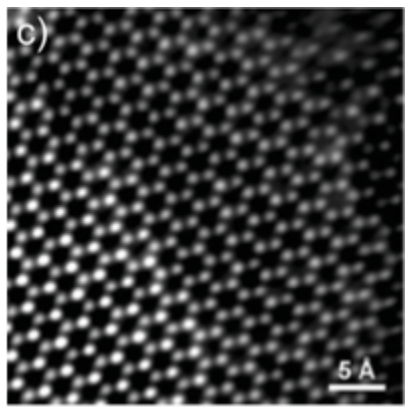
FULL DESCRIPTION

Background

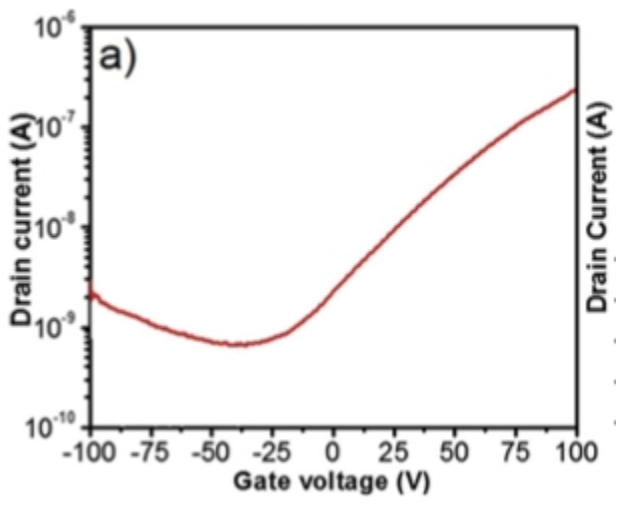
Molybdenum Disulfide (MoS_2) belongs to a class of materials called Transition Metal Dichalcogenides (TMD). TMDs have the chemical formula MX_2 where M is a transition metal such as Molybdenum, Tungsten, etc. and X is from the chalcogen group. After graphene, MoS_2 is the next 2-dimensional material being researched for new device applications given its strong optical and electronic properties. Methods for producing MoS_2 include micromechanical exfoliation, solvent exfoliation and intercalation. The challenge with these top-down approaches is that their size renders them unsuitable for electronic applications. Other processing methods may leave undesirable carbon residue.

Current Invention

Prof. Cengiz Ozkan and his research team at UCR have developed and synthesized atomically thin, large area MoS_2 sheets. The patented technology synthesizes MoS_2 sheets on SiO_2/Si substrates at wafer scale by thermolysis of spin coated, $(NH4_2)_2MoS_4$ films. They have also used this method to prepare WS_2 (Tungsten Disulfide) and hybrid MoS_2-WS_2 thin layers.



High-angle, annular dark-field scanning, Transmission Electron Microscopy image showing tri-, bi- and monolayer MoS_2 (from left to right).



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OTHER INFORMATION

KEYWORDS

Transition Metal Dichalcogenides, Monolayer MoS2, Molybdenum Disulfide, 2 dimensional nanosheets, Photoluminescence, Photodetectors, Semiconductors, Optoelectronics, Chemical sensors, Solar cells, Electrodes, Valleytronics, Logic circuits, High efficiency on/off switches

CATEGORIZED AS

- **Optics and Photonics**
  - All Optics and Photonics
- **Communications**
  - Optical
- **Computer**
  - Hardware
- **Energy**
  - Solar
  - Storage/Battery
- **Materials & Chemicals**
  - Chemicals
  - Electronics Packaging
  - Superconductors
- **Semiconductors**
  - Design and Fabrication
  - Processing and Production
- **Sensors & Instrumentation**
  - Environmental Sensors

RELATED CASES

2014-807-0

Plot of drain current versus gate voltage for fabricated FET showing electron transport. The on/off ratio for this device is 300.

ADVANTAGES

The benefits of their technology are:

- Excellent control of the film thickness by varying the concentration of the solution and spin coating speed.
- Does not need the use of sulfur or high temperatures for preparation.
- Can be used to achieve homogeneous alloys and doping of TMDs.
- Samples can be prepared down to monolayer thickness.

SUGGESTED USES

- Field effect transistors, high-efficiency switching and logic circuits
- Photodetectorrs
- Solar cells
- Chemical sensors
- Supercapacitor electrodes
- Next generation Valleytronics – e.g., quantum computing and qubits.

TESTING

To evaluate, they fabricated Field Effect Transistors (FET) on SiO_2/Si substrate with Ti/Au contacts. FETs show electric mobilities of 0.1 sq. cm per Volt per second.

RELATED MATERIALS

- Wafer Scale Synthesis and High Resolution Structural Characterization of Atomically Thin MoS 2 Layers

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