Deposition of MoS_2 nanoworms on silicon & glass substrate and its Structural, Optical & electrical characterizations.

Samridhi and Prof. Davinder Kaur

FUNCTIONAL NANOMATERIALS RESEARCH LAB

Department of Physics and Centre of Nanotechnology, Indian Institute of Technology Roorkee, Roorkee-247667, India

Introduction

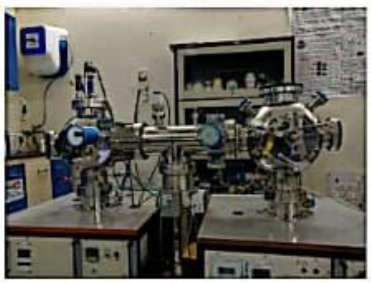
Two-dimensional (2D) transition metal dichalcogenides (TMDCs) are promising candidates for next generation nanoelectronics because of their atomically thin structure and high surface to volume ratio. Optical bandgap of MoS_2 vary from 1.1 eV to 1.88 eV depending on number of layers. It can absorb up to 5 - 10% of incident sunlight in a thickness of less than 1nm (1 order of magnitude higher sunlight absorption than GaAs and Si). It is n - type semiconductor with mobility of 100 $cm^2V^{-1}sec^{-1}$.

Objective

- The basic objective of the project is to deposit MoS_2 thin films with different thickness (<200 nm) using DC sputtering technique.
- **Structural** characteristics were studied using X Ray diffraction and FESEM techniques.
- **Optical** characterization was performed using Raman spectroscopy and UV -Visible spectrum.
- **Electrical** properties of deposited films will be studied using current – voltage measurements.

Deposition method: DC Sputtering

Sputtering is a vacuum technology which is used to deposit coatings of pure materials (target) on the surface of various objects (substrate). Coatings in thickness range of angstroms to microns can be deposited in a layered structure which can be a single material, or multiple materials. This involves introducing a controlled gas, usually chemically inert argon, into a vacuum chamber, and electrically energizing a cathode to establish a self sustaining plasma. The exposed surface of the cathode, called the target, is a slab of the material to be coated onto the substrates.



a.)

b.)

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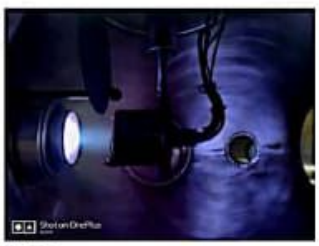


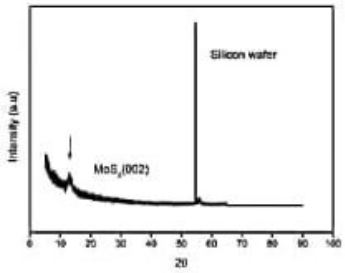
Overall Methodology

Deposition Parameters

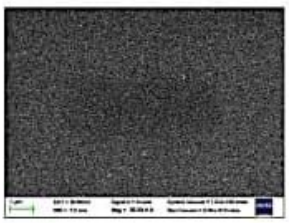
	Sample 1	Sample 2	Sample 3
Power	40 W	40 W	40 W
Gas used	Argon	Argon	Argon
Working Pressure	9.8E-3 Torr	9.8E-3 Torr	9.8E-3 Torr
Time of deposition	20 sec	40 sec	3 min
Temperature	400^0 C	400^0 C	400^0 C

Characterization Results

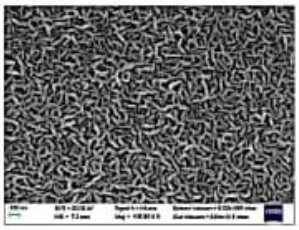
A) XRD pattern of film deposited on silicon substrate (100)



B) FESEM Images



a.)



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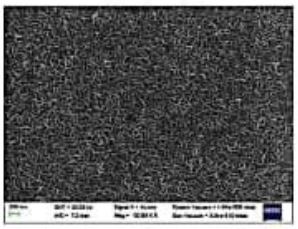
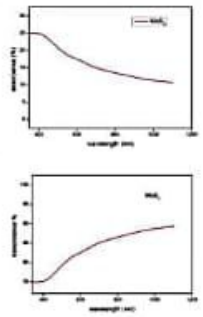


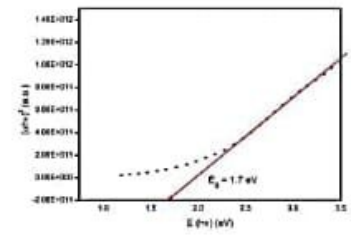
c.)

C) UV Visible spectrum



Tauc relation

$\alpha h\nu = A(h\nu - Eg)^{1/n}$



Concluding Remarks

- **XRD analysis showed 2H phase growth of MoS_2 layer with (002) orientation and crystallite size of 2.4 nm.**
- **SEM images show the uniform density growth in nanoworms of MoS_2 thin films.**
- **UV Visible spectrum shows the band gap of film is 1.7 eV.**

References:

- A. J. Cheah et al, AIP Conference Proceedings 1669, 020030 (2015)
- M.I.Serna et al, ACS Nano, 10, 6054 (2016).

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