Synthesis and preliminary study of Diluted magnetic Molybdenite (MoS_2) in bulk morphology

Dehghani, Parnian[1]; Pakmehr, Mehdi[1]

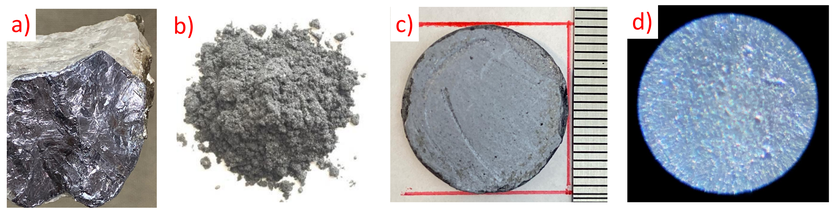
[1] *Shiraz University, Physics Department, Shiraz 71946, Iran*

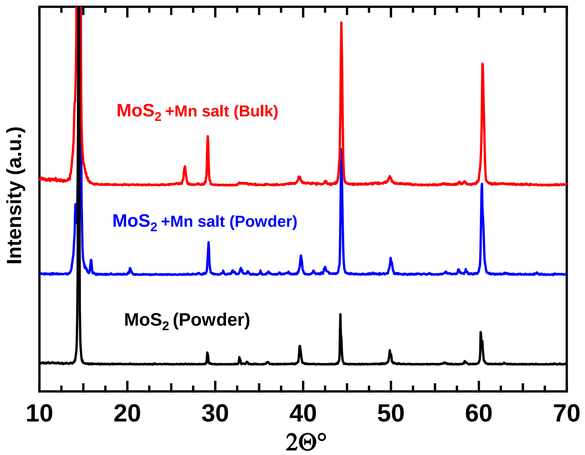
Introduction

- Interests to Study and Probe physical Properties of Novel semiconducting materials for future practical applications within (Opto)electronics technology and other technological applications.
- Molybdenite (MoS_2) Known to be an indirect Gap semiconductor with gap of E_{gap}=1.4 eV in Bulk.
- Doping Molybdenite with Manganese produces diluted magnetic semiconductor (DMS) sample in 3D morphology for possible magnetic based devices & faster electronic devices (Spintronics)
- Processing Molybdenite doped Powder Into the Bulk Sample through Spark Plasma Sintering (SPS) technique by implementing both High Pressure and Temperature

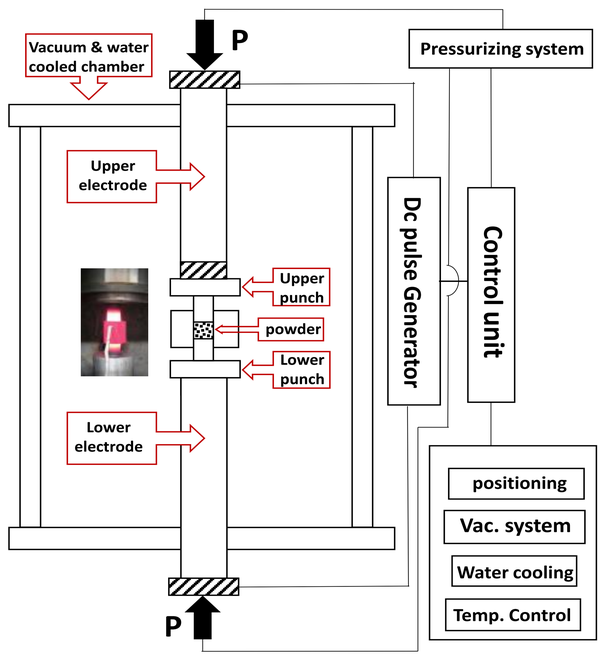
Plasma Sintering technique

- MoS_2 Powder (90%) + Mn (10%) based salt → mixed as shown in **fig. b)** → sintered
- Combination of High Pressure (up to 80 MPascal), High Temperature (up to 2500 K) and High Vacuum (10^{-3} torr) used to synthesize bulk coin shape (2mm thick) conducting sample of **fig. c)** ↓
- Optical micrograph of sample surface shown in **fig. d)**
- Schematic diagram of Plasma Spark Sintering set-up (SPS) shown in opposite figure →



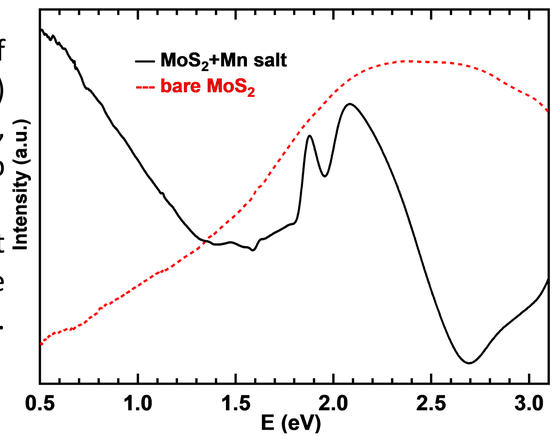


- PXRD pattern of diff. MoS_2 based samples, Mn doped sample (Blue) contain more peaks due to salt addition, Sintered sample (Red) retain the base sample main peaks (polycrystalline structure) conveying no melt down during SPS process



Schematic diagram of SPS set up

- Absorption spectra of bare MoS_2 sample (Red) with shoulder @1.5 eV, signature of Indirect gap nature of bulk sample
- Adding Mn based salt makes spectrum more complicated with abs. valley & peaks @E>1.4 eV



Results

- Mn ions (salt)+ MoS_2 → DMS sample using SPS technique.
- Initial characterization proved Bulk polycrystalline sample with different physical properties than bare MoS_2

Discussion

- One might use SPS technique to fabricate bulk coin shape MoS_2 wafer for possible device fabrication
- Using Manganese as a magnetic dopant might produce DMS sample needs to be studied

References

[1] J. K. Furdyna; "Diluted magnetic semiconductors"; *Applied Physics letters* **64**, No. 4 (1988) 40-46.

[2] Masao Tokita; "*Trends in Advanced SPS Spark Plasma Sintering Systems and Technology*"; *J. of Soc. of Powder Tech. Jpn.* **30**, (1993) 790.

[3] پاک مهر، مهدی، فهندژ، مارال؛ «ساخت و بررسی مقدماتی نمونه بالک مولیبدینیت»؛ *مقاله نامه نهمین کنفرانس ملی خلا ایران*، پاییز 1398، صفحه 47 تا 50.