# Development of transition metal dichalcogenides for modern photodetector devices

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**Abstract**
Transition metal dichalcogenides (TMDs) are layered material with strong in-plane chemical bonds but weak out of plane van der Waals bonds. Among all TMDs, $MoS_2$ nanostructures show exceptional electronics and optoelectronics properties. The bandgap of $MoS_2$ is reported around 1.23eV in its bulk form while 1.8eV in monolayer form. The production of extremely thin sheets of direct semiconductor $MoS_2$ with 1.80eV bandgap from bulk material is achieved by the process called exfoliation. Owing to its low cost, scalability and high yield production, liquid exfoliation is emerging as an excellent strategy for the synthesis of thin sheets of $MoS_2$. The chemical exfoliation of layered bulk Molybdenum (IV) sulfide ($MoS_2$) is carried out to obtain few layers which are semiconducting in nature. Among all the solvents for chemical exfoliation, N-methyl Pyrrolidone (NMP) is the most efficient one. The process involves ultra-sonication for 4 hours followed by centrifugation to separate the few layers from bulk $MoS_2$. The interdigital electrodes (IDE) fingers were obtained by lithography technique on $SiO_2$/Si substrate. The morphological, structural and opto-electronic properties of as-fabricatedMoS2 nanostructure have been analyzed by utilizing SEM, Raman spectroscopy and UV- Visible spectrophotometer. The sensitive films of active materials were deposited on the IDE by using airbrush technology.

**Keywords**
MoS2, TMDs, Exfoliation, Photodetection

## 1. Introduction

After the successful exfoliation of graphene [1], immense efforts have been explored to the synthesis, characterization, and application of other two-dimensional (2D) materials [2], such as black phosphorus [3], TMDs [4,5], and antimonene [6], and so on. Owing to the various distinct properties such as adjustable band gap, the unique quantum confinement effect, and excellent compatibility with device fabrication [7,8]. Recently, 2D materials have been extensively sed in sensors, catalysis, in electronic devices and energy conversion [9,10,11]. Particularly their electronic properties are extremely sensitive to adsorption of gas molecules, owing to their ultrathin thickness and high surface to volume ratio [12]. Therefore, 2D materials hold great promise for gas sensor to detect toxic gases via changing the carrier concentration and shifting the fermi level.

## 2. Result and Discussion

The chemical exfoliation process involves ultra-sonication for 4 hours followed by centrifugation to separate the few layered articles from bulk $MoS_2$. The interdigital electrodes (IDE) fingers were obtained by lithography technique on $SiO_2$/Si substrate. The sensitive films of active materials were deposited on the IDE by using airbrush technology. The deposited exfoliated $MoS_2$ particles on IDE can be seen in SEM images as shown in Figure 1.

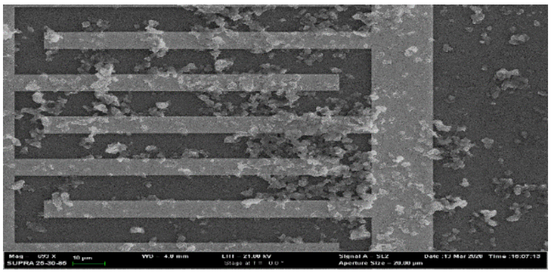

**Figure 1:** SEM image of $MoS_2$ deposited on IDE

## 3. Conclusion

The successful chemical exfoliation of bulk $MoS_2$ in N-methyl Pyrrolidone (NMP) solvent helped in obtaining few layered $MoS_2$. The exfoliated $MoS_2$ are direct band gap semiconductor which are suitable for sensing applications. The SEM images of the exfoliated $MoS_2$ was also obtained.

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