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# Scalable growth of atomically thin $MoS_2$ by sulfurization of molybdenum thin films

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Molybdenum disulfide ($MoS_2$) is an emerging two-dimensional (2D) crystal that has attracted considerable attention due to its promising application in the field of nanoelectronics, optoelectronics, and valley-related physics.[1] For example, monolayer $MoS_2$, which is a direct band gap semiconductor, has the potential to surpass graphene in the next generation low-power electronic devices.[2] To realize this, large-area production of $MoS_2$ must be developed.

Here, we demonstrate the growth of large-area, atomic layers of $MoS_2$ via sulfurization of thin molybdenum films in a chemical vapor deposition (CVD) set-up. The molybdenum (Mo) films (0.5 – 3 nm), deposited via magnetron sputtering, were sputtered on several substrates like $SiO_2$, $Al_2O_3$, and MgO. After introducing sulfur to the Mo films, a thin layer of $MoS_2$ is formed on the surface as confirmed by Raman (Figure 1B). Further, the grown film can be transferred onto arbitrary substrates by following the same transfer method as other 2D materials, such as graphene and hexagonal boron nitride (Figure 1A).[3]

Moreover, the controllability of the sputtering process allows for a more convenient way of controlling the number of $MoS_2$ layers. For example, the number of $MoS_2$ layers could be controlled by the thickness of the Mo film and the CVD parameters. Our method of growing $MoS_2$ films is a step forward towards realizing $MoS_2$-based devices for several potential applications.

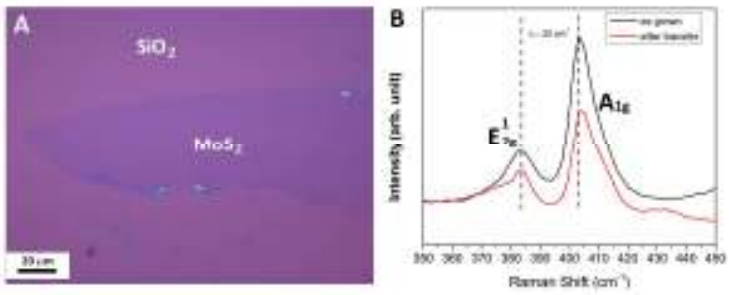


**Figure 1**. Characterization of the grown $MoS_2$ film. (A) Optical image of the $MoS_2$ film after transfer on $SiO_2$/Si and its (B) Raman signature. The Raman signature of the as-grown film is also shown. The Raman peaks are coming from the $E^1_{2g}$ and $A_{1g}$ phonon modes of the $MoS_2$ film (as labeled). The difference of the modes can be used to assess the thickness of the film, which in this case, represents a few layer.

References:

1. Wang, Q. H.; *et. al*. *Nature Nanotech*. **2012**, 7, 699−712.
2. Radisavljevic, B.; *et. al*. *Nature Nanotech*. **2011**, 6, 147−150.
3. Orofeo, C. M.; *et. al*. *Nano Res*. **2013**, 6, 335–347.