

Nobarrier to applications for a remarkable 2-D material

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Two-dimensional monolayer MoS₂ was grown on sapphire (left). The optical microscope image on the right shows isolated monolayer MoS₂ crystals at the periphery of the film. Adapted with permission from Ref 1. Copyright (2018) American Chemical Society.

Mass production of large, uniform sheets of single-layer molybdenum disulfide, MoS₂, is difficult, which limits its commercial application. A*STAR researchers have modified an existing manufacturing technique to enable the use of MoS₂ in a range of technologies from photodevices to flexible, transparent sensors.

The [two-dimensional material](#) has attracted considerable attention because of its extraordinary physical, electronic and [optoelectronic properties](#), including flexibility, transparency and semiconducting characteristics. But fabricating large-scale, defect-free single layers of MoS₂ is highly challenging.

Dongzhi Chi and his team from the A*STAR Institute of Materials Research and Engineering, in collaboration with colleagues from the National University of Singapore and the Indian Institute of Science Education and Research, has modified a current technique, known as [chemical vapor deposition](#) (CVD), so that it can now produce uniform, centimeter-sized sheets of MoS₂ crystals with large grain sizes.

"The physical properties of MoS₂ vary greatly with its thickness," explains Chi, "to maintain its remarkable electronic and [physical properties](#) we need a method that can uniformly deposit MoS₂ films over a large area with high crystallinity."

Although CVD is an effective technique for fabricating large-area, uniform sheets of MoS₂ of varying thickness on different substrates, and significant progress has been made in improving the quality of MoS₂ monolayers produced by the technique, little attention has been paid to controlling the chemical vapors using physical barriers during the growth of MoS₂ crystals.

By introducing a nickel oxide (NiO) barrier, the researchers were able to control the concentration and distribution of chemical vapors during the growth of MoS₂ crystals. Because NiO reacts with molybdenum trioxide (MoO₃), one of the chemical reactants used in the growth process, it traps and lowers the MoO₃ concentration, allowing the uniform deposition of monolayers of MoS₂ over a large area.

"The advantage of this approach is the ease of implementation as well as a reduction in contamination, and it allows for control of the chemical exposure during the [growth process](#)," says Chi.

The work has led to further advances in the fabrication of uniform and large-area MoS₂ monolayers, and could also be applied to other two-dimensional materials.

"We are now looking to scale up our fabrication process for producing even larger sheets, which could pave the way for next-generation optoelectronic and sensor technologies," says Chi.

More information: Yee-Fun Lim et al. Modification of Vapor Phase Concentrations in MoS₂ Growth Using a NiO Foam Barrier, ACS

Nano (2018). [DOI: 10.1021/acsnano.7b07682](https://doi.org/10.1021/acsnano.7b07682)

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