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## Scalable Growth of 2D VS<sub>2</sub>: Impact of Process Conditions on Crystallinity and Layer Quality

Vanadium disulfide (VS<sub>2</sub>) is a 2D transition metal dichalcogenide with highly tunable electronic, magnetic, and optoelectronic properties. While bulk VS<sub>2</sub> exhibits metallic behavior, monolayer and H-phase forms are p-type semiconductors with a direct bandgap of 0.3-1.3 eV, high structural stability, and room-temperature ferromagnetism. The metallic phase is ideal for ultrathin, low-resistance contacts in field-effect transistors, whereas semiconducting monolayers serve as active channels. Monolayer VS<sub>2</sub> also exhibits strong light-matter interactions, enabling photodetector and phototransistor applications. Various techniques have been employed to synthesize VS<sub>2</sub> layers, among which chemical vapor deposition (CVD) is particularly effective. CVD enables a controllable and reproducible process for producing high-quality crystalline monolayers. Furthermore, its strong compatibility with established industrial fabrication standards makes it well-suited for both fundamental research and scalable production of two-dimensional materials.

This study investigates the optoelectronic properties of VS<sub>2</sub> synthesized via CVD on various substrates, extending beyond conventional growth approaches. Optimal growth conditions, including temperature and carrier gas flow rate, are systematically identified to achieve a high-quality, continuous VS<sub>2</sub> monolayer. Using photoluminescence, Raman spectroscopy, and confocal laser optical microscopy, we examine surface morphology, crystalline quality, phonon modes, and band gap characteristics of the VS<sub>2</sub> layers.

### Academic or Professional Status

Undergraduate Student

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