NARROW CAVITY CVD FOR MoS_2 FILM FORMATION FROM MoO_x PERCURSOR FILMS

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The future of integrated measuring systems for daily use and industry highly depends on silicon-photonics-based integrated sensors, consisting of a light source, photonic circuits and photodetectors. Typically, current systems operate in the near-infrared range. The extension of the working range into the mid-infrared range is still challenged by issues such as the low efficiency of current methods; however, such expansion would greatly improve the sensitivity of the systems and would create new possibilities for applications in various fields. From the perspective of photodetectors, on-chip 3–5 μm photodetectors and imagers with application-specific sensitivities are projected to be available by 2030 [1].

However, photodetectors functioning in the 3–5 μm range at room temperature with the possibility of integration into the silicon photonic integrated circuits (PIC) remain scarce - further research is required to find suitable materials and a design of the device's structure. In particular, Transition Metal Dichalcogenides (TMDs) are promising candidates as a material base for the infrared photodetectors. This is possible due to properties such as a high absorption coefficient and layer-dependent band gaps. Furthermore, van der Waals heterostructures allow stacking of different materials owing to weak interlayer interactions and the absence of epitaxial constraints, such as lattice constant matching [2].

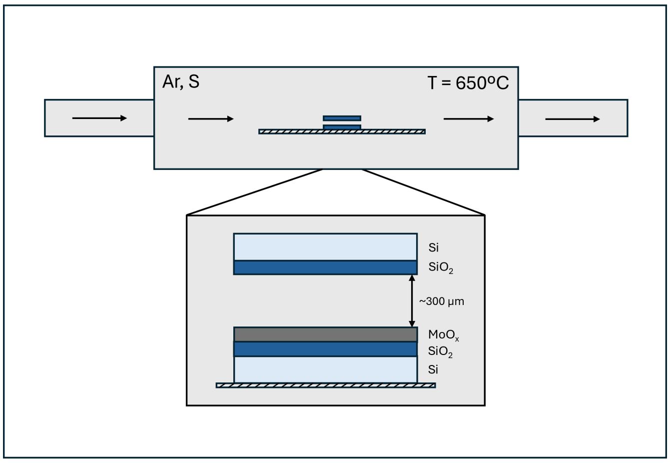

Fig. 1. Schematics of the narrow cavity CVD setup.

In this work, we present a novel narrow-cavity Chemical vapor deposition (CVD) method for the formation of MoS_2 films on SiO_2 dielectric and layer thickness control via a deposited MoO_x precursor layer. The idea is based on the sulfurization of relatively thick (5–50 nm) MoO_x films by formation of a narrow 300 μm cavity with the addition of another substrate (Fig.1).

CVD-grown MoS_2 layers were characterized by Raman scattering measurements. The resulting spectra showed typical MoS_2 layer peaks. Peak analysis showed that by controlling MoO_x precursor thickness, the resulting MoS_2 films can be obtained with a thickness ranging from 2-3 monolayers to more than 8 monolayers, with the film's crystallinity enhanced in comparison to standardized CVD sulfurization process with a single substrate setup.

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[2] V. Selamneni and P. Sahatiya, "Mixed dimensional Transition Metal Dichalcogenides (TMDs) vdW Heterostructure based Photodetectors: A review," Microelectronic Engineering, vol. 269, p. 111926, Dec. 2022, doi: 10.1016/j.mee.2022.111926.