Assessment of carbon contamination in MoS_2 grown by MOCVD using $Mo(CO)_6$ and $(CH_3\text{-}CH_2)_2S$ precursors

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This work aims at assessing carbon contamination in large-scale deposition of MoS_2 films by metal-organic vapour deposition (MOCVD). This growth method has shown to produce continuous and homogeneous films of high quality transition metal dichalcogenides. [1] In contrast to conventional CVD using chalcogen and metal oxide powders as precursors, MOCVD is superior in terms of controlled supply of volatile precursors and the high potential for process upscaling and wafer-scale deposition. However, carbon contamination has been shown to be a major issue, if organic chalcogen precursors are used. [2] [3]

In this work we demonstrate the growth of MoS_2 films on Si/SiO_2 substrates by MOCVD in a vertical hot-wall reactor using molybdenum hexacarbonyl $Mo(CO)_6$ and diethyl sulfide $(C_2H_5)_2S$. Diethyl sulfide has been identified as the source for undesirable carbon formation. Based on SEM, Raman and XPS data we discuss how carbon incorporation depends on several growth parameters like temperature, growth time, $(C_2H_5)_2S$ and $Mo(CO)_6$ precursor flow. We reveal the effect on MoS_2 synthesis with respect to growth rate and evolution of film morphology. Carbon incorporation inhibits lateral growth of MoS_2 domains and leads to photoluminescence quenching. Finally, we discuss an optimized growth parameter set for monolayer MoS_2 and how the carbon footprint can be mitigated by using hydrogen as a reductive gas.

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References

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Figures

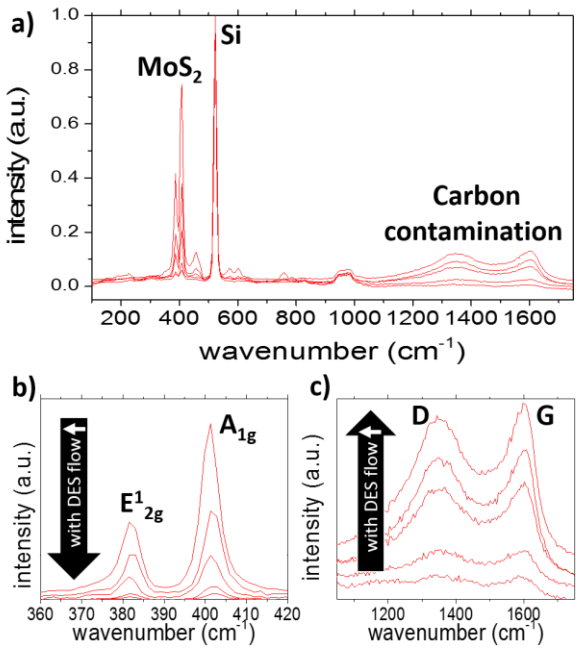

Figure 1: a) Raman overview spectrum of MoS_2 grown on SiO_2 by MOCVD for different diethylsulfide (DES) precursor flows
b) inset of MoS_2 region c) inset of Carbon region