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Impact of MOCVD growth parameters on nucleation density in MoS_2 epitaxial layers.

As MoS_2 is considered most promising 2D semiconducting material it is in great interest to variety of applications. For the operation and design of MoS_2 based devices, the reliable production technology and the knowledge of the properties of this materials is essential. At the moment the most important challenge seems to be mastering the technology of high quality two dimensional MoS_2 synthesis. Widely used in semiconductors industry, MOCVD (Metalorganic Chemical Vapor Deposition) epitaxy [1] appears to be most likely the main method for wafer scale synthesis of monlayer MoS_2. In contrast to powder precursors growth [2] it enables precise and independent control of gaseous precursors flows (partial pressures). Different molybdenum and Sulphur precursors have been used so far [1-3].

When considering obtained MoS_2 devices [4] it becomes clear that for most applications the main issue that has to be tackled is not high enough carrier mobility. In order to improve mobility in obtained layers crystal quality has to be improved. Most likely crystal grain boundaries causes significant reduction of carrier mobility. In principle the bigger crystal grains the less grain boundaries for carriers to scatter thus higher mobility can be expected. Large crystal grains require low nucleation density. The less seeds the less number of grains and bigger dimensions (ideally one seed to form monocrystalic structure).

Here we discuss the control of (crucial for high quality layers) nucleation density, by growth parameters. We perform MOCVD growth of MoS_2 using molybdenum hexacarbonyl as Mo precursor and sulphur hydride as S precursor in range of process parameters. We discuss how nucleation density by SEM and AFM and Raman spectroscopy

References

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[2] Yi-Hsien Lee et al. , Adv. Mater.,Vol 24, Issue 17 (2012) page 2320
[3] Yifei Yu et al., Sci. Rep. 3, 1866 (2013)
[4] B. Radisavljevic et al., Nature Nanotechnology 6, (2011) 147–150

Figures

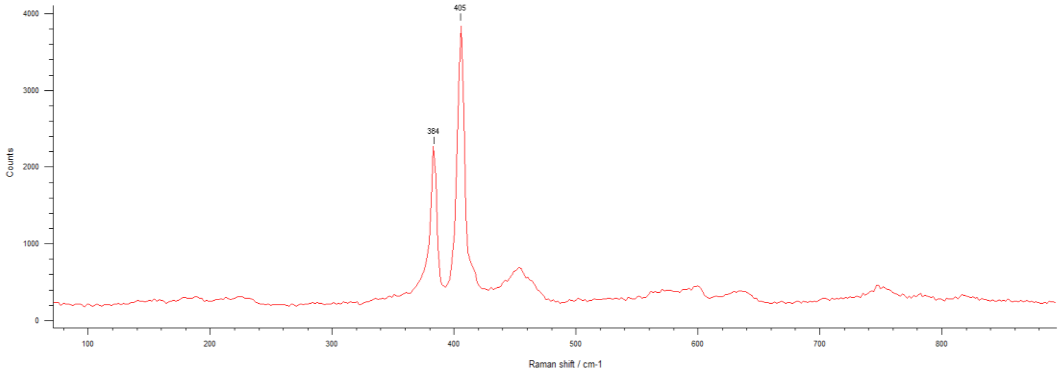

Figure 1: Raman spectrum of MoS_2 grown using MOCVD on Al_2O_3 substrate

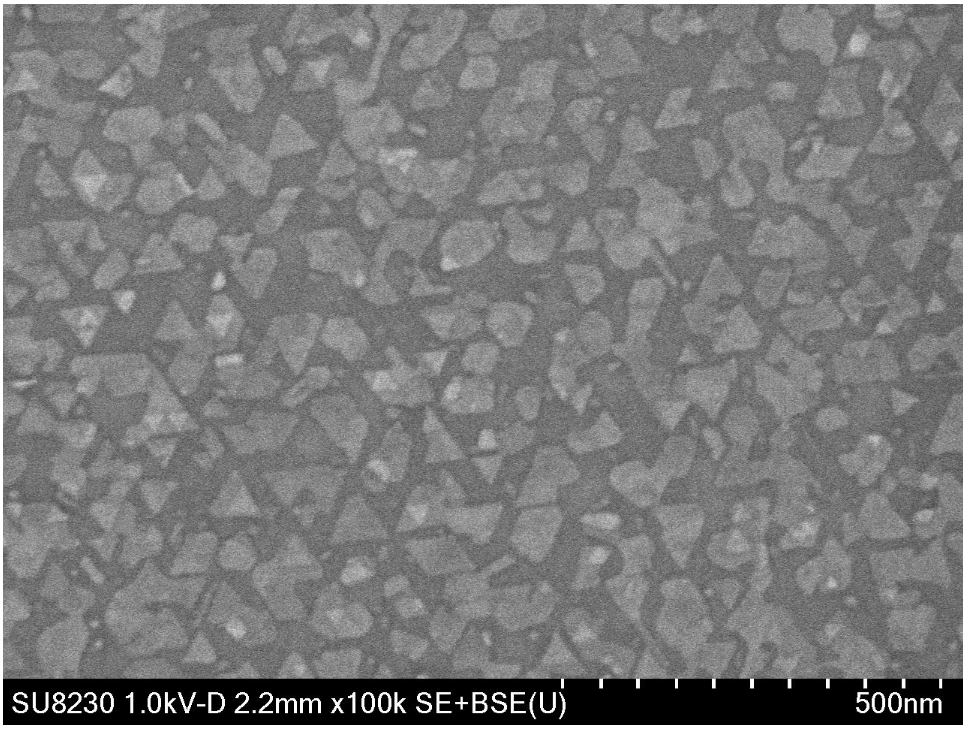

Figure 2: SEM image MoS_2 domains of high nucleation density on Al_2O_3 substrate

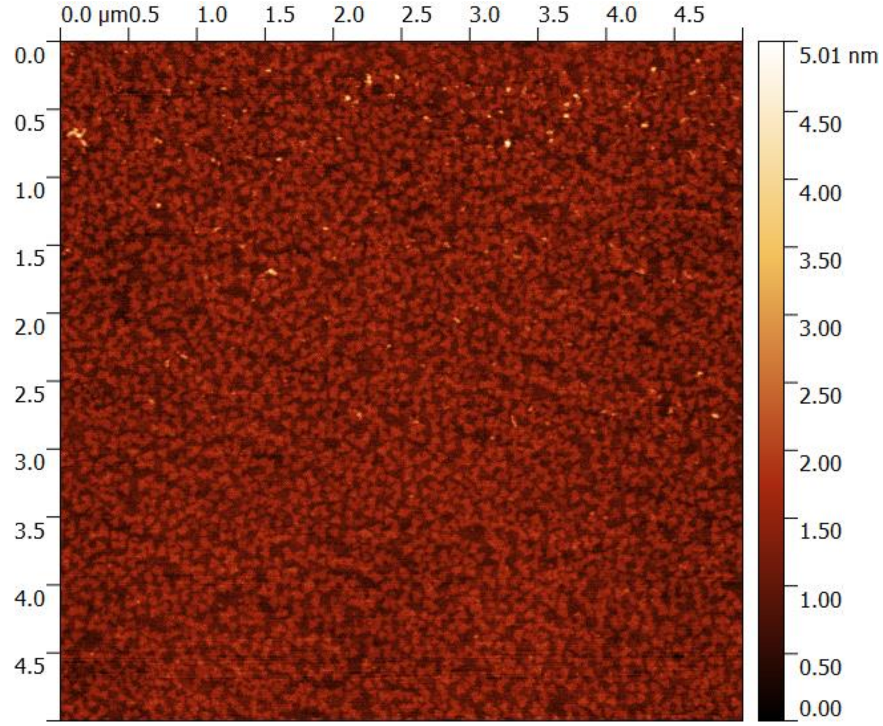

Figure 3: AFM topography of MoS_2 domains of high nucleation density on Al_2O_3 substrate