Controlling of 2D MoS_2 nucleation density by growth parameters in MOCVD epitaxy

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As MoS_2 is considered a 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. When considering obtained MoS_2 devices [2] 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

[1] Kibum Kang et al. , Nature, Vol 520 (2015) page 656

[2] B. Radisavljevic et al., Nature Nanotechnology 6, (2011) page 147

Figures

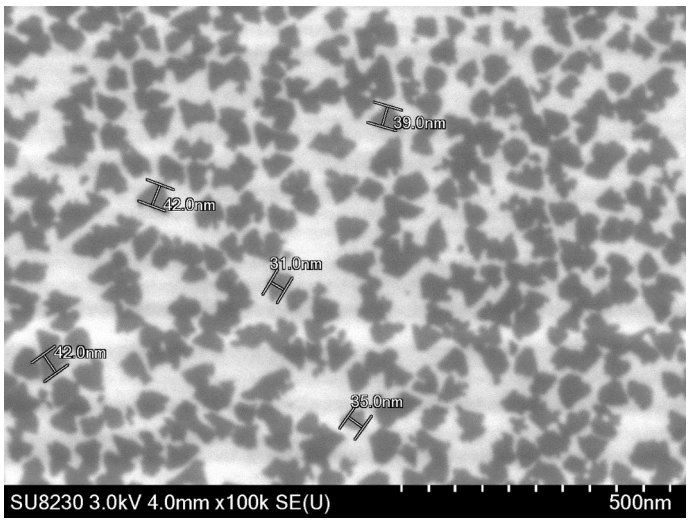

Figure 1: SEM image of MoS_2 monocrystaline seeds in form of triangular islands, with relatively high surface density.

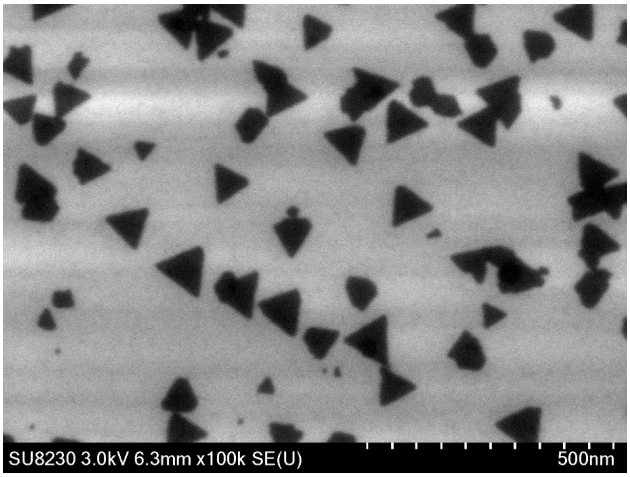

Figure 2: Surface of the MoS_2 sample obtained with lower surface density of seeds shown by clearly seen on SEM image