

Wafer-scale single-crystalline MoS₂ realized by Epitaxial phase conversion

Xiangming Xu

Prof. Husam N. Alshareef

Materials Science and Engineering, King Abdullah University of Science and Technology (KAUST),
Thuwal, 23955-6900, Saudi Arabia

xiangming.xu@kaust.edu.sa

2D semiconductors are one of the most promising materials for next generation electronics. Realizing wafer-scale continuous 2D monolayer semiconductor is still a challenge. We developed an epitaxial phase conversion (EPC) process to meet this requirements. The EPC process is a kind of two-step process, where sulfurization process was carried out on pre-deposited Mo-containing films. Traditionally, two-step processes for 2D MoS₂ and other chalcogenides have suffered poor quality film and non-discontinuity at monolayer thickness. The EPC process solves these problems by carefully preparing precursor film and carefully controlling sulfurization process. The precursor film in the EPC process is epitaxial MoO₂ grown on 2" diameter sapphire substrate by pulsed laser deposition. This epitaxial precursor contains significantly fewer defects compared with amorphous precursor films, thus fewer defects are inherited by the EPC MoS₂ film. Thus, the EPC MoS₂ film quality is much better. The EPC MoS₂ devices show field effect mobility between 10 ~ 30 cm²/vs, which is the best among two-step process. The EPC MoS₂ film could be realized with monolayer continuous and uniform at wafer scale, by carefully minimizing the Ar/S flow dynamic fluctuation during sulfurization.

References

- [1] Xiangming Xu, Zhenwei Wang, Sergei Lopatin, Manuel A Quevedo-Lopez, Husam N Alshareef, 2D Materials, 6(2018) 015030
- [2] Xiangming Xu, Gobind Das, Xin He, Mohamed Nejib Hedhili, Enzo Di Fabrizio, Xixiang Zhang, Husam N Alshareef, Advanced Functional Materials, 29(2019) 1901070
- [3] Xiangming Xu, Chenhui Zhang, Mrinal K. Hota, Zhixiong Liu, Xixiang Zhang, Husam N. Alshareef, Advanced Functional Materials, (2019), 1908040

Figures

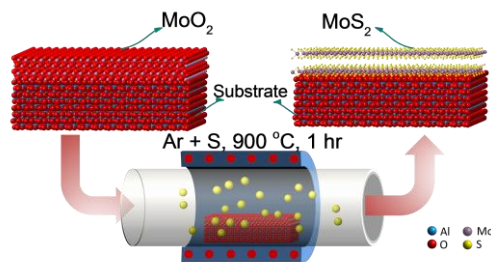


Figure 1: Schematic of epitaxial phase conversion process



Figure 2: wafer-scale single-crystalline MoS₂ films with high electric performance