Scaling up the synthesis of single layer MoS_2 crystals

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Among the family of 2D TMDCs, MoS_2 is an exceptional member due to its thickness-dependent optical and electronic properties. MoS_2 crystals have been fabricated via the Atmospheric Pressure Chemical Vapor Deposition (APCVD) method, using elemental Mo, MoO_2, and MoO_3 as a molybdenum source under continuous sulfur vapors carried by N_2 gas flow. In most cases, samples produced with those precursors suffer by inhomogeneous nucleation and low substrate coverage. Furthermore, after process refinement, the quality and the size of the 2D crystals have increased from a few microns to single crystals with lateral dimensions of hundreds of μm [1]. In this work, we have successfully employed a novel vapor - liquid APCVD method [2], that uses Na_2MoO_4 as a Mo precursor. First, the growth parameters (growth temperature and precursor concentration) were optimized to achieve almost 100% substrate coverage with 50% monolayer crystals. By fine tuning of other parameters of the fabrication process, such as the spin coating time and acceleration, the monolayer coverage can be increased from 50% to almost 80% (Figure 1). To extract useful metrics from optical microscope images of the grown MoS_2 films, an image processing software specialized in 2D materials was developed. The program utilises several techniques such as k-means clustering method to perform proper image segmentation leading to identification of single-layer, few layer and bulk domains.

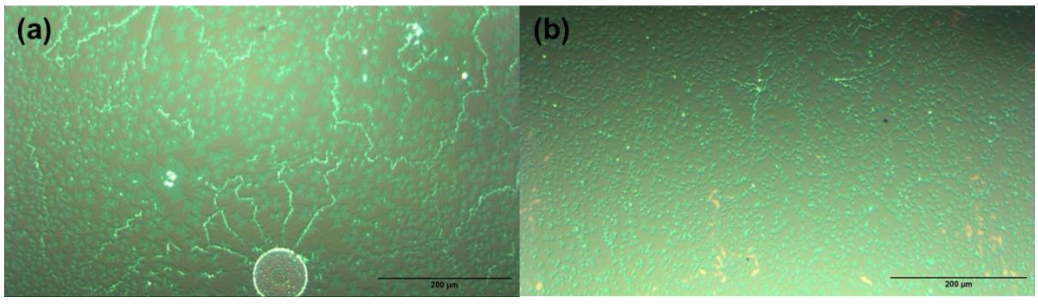

Figure 1: Optical images of MoS_2 grown on Si/SiO_2 after: (a) 2 min and (b) 6 min precursor of spin-coating.

References

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[2] Michail A. *et al.* 2D Materials **5**, 035035 (2018)

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