Wafer-scale transfer of MoS_2: characterization protocol

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The large-scale growth of 2D materials has reached maturity [1]. However high temperatures are required for high quality materials which makes transfer a key step of the integration process. Nevertheless, the transfer of these materials presents a considerable challenge, given the necessity to preserve their optical, mechanical, and electrical properties for integration into 2D material-based devices [2]. Typically, only localized characterizations are conducted, and the data do not precisely represent the overall quality of the transferred 2D layer. Thus, a comprehensive wafer-scale characterization is essential to monitor the quality and uniformity of the transferred 2D material.

This study is focused on the extensive characterization of a transferred MoS_2, grown on a 200 mm SiO_2 wafer by Atomic Layer Deposition [3]. The material is transferred onto a target substrate by direct bonding. The transfer rate is, at its lowest, around 50% (Fig. 1) and, in the best case, higher than 95%. Raman spectroscopy, photoluminescence, Wavelength Dispersive X-Ray Fluorescence (WDXRF), and Atomic Force Microscopy are systematically performed both before and after the transfer. 2D thickness is measured by means of WDXRF. Wafer-scale Raman and photoluminescence measurements are used for statistical analysis and provide information on the crystalline quality of the transferred MoS_2.

Overall, this protocol allows for the assessment of the impact of the transfer method on 2D materials after transfer. The results exhibit the good quality of the transferred MoS2 with no damage and no contamination.

References

[1] Z. Ye *et al.* *Nano-Micro Lett.* **15**, 38 (2023).
[2] Watson *et al.* *2D Mater.* **8** (2021) 032001
[3] Cadot S *et al.* Nanoscale. 9(2) (2017) 538-46.

Figures

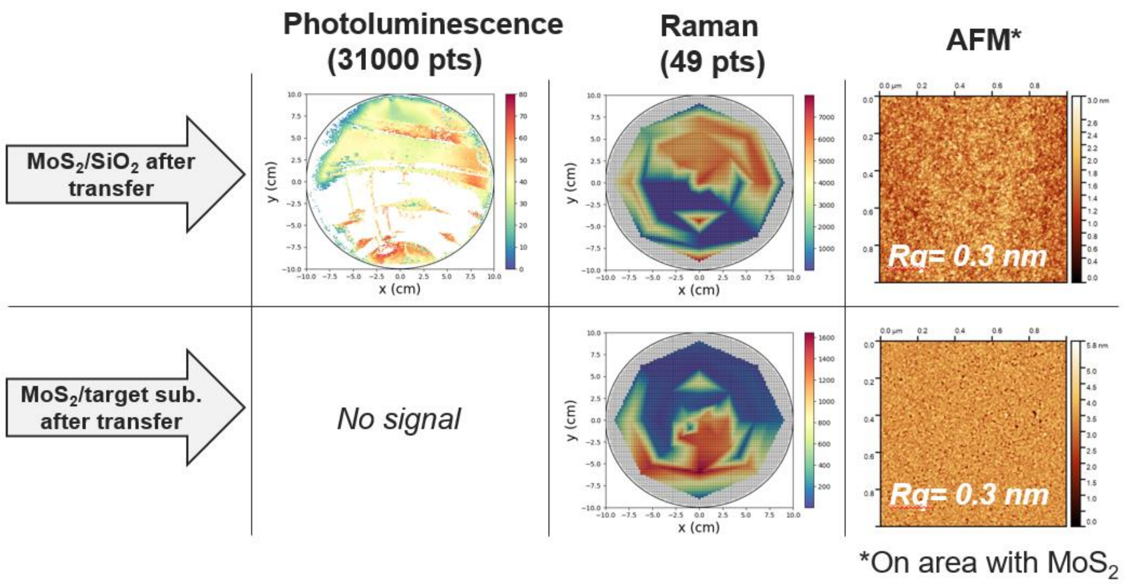

Figure 1: Characterization of monolayer ALD MoS_2 transferred on target substrate. (Left: Photoluminescence; Middle: Raman; Right: Atomic Force Microscopy)