Large-Scale Transfer and Thermal Conductivity Study of MBE-Grown $PtSe_2$ Suspended Membranes

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Abstract

In this study, we address the challenge of transferring large-scale epitaxially grown 2D materials, focusing on $PtSe_2$, a promising material for sensor applications [1]. We demonstrate a highly efficient transfer process that enables the fabrication of multiple suspended membranes in a single step while maintaining the high quality of the 2D material.

Molecular Beam Epitaxy (MBE)-grown $PtSe_2$ offers a more reliable and reproducible alternative to mechanical exfoliation, facilitating its integration into devices. To investigate its intrinsic thermal properties, we employ Optothermal Raman Thermometry (ORT) [2] to determine the in-plane thermal conductivity of 13-layers suspended $PtSe_2$ membranes, eliminating substrate interactions. Our approach leverages large-scale transfer to conduct multiple ORT measurements, enabling statistical refinement of the thermal conductivity value.

Comparative ORT measurements in vacuum and air confirm the determination of the intrinsic in-plane thermal conductivity. Additionally, precise control over key experimental parameters such as laser beam radius, cavity size, and 2D material thickness ensures accurate thermal conductivity extraction. Finally, our results are validated through numerical simulations using a COMSOL model.

This work provides critical insights into the thermal transport properties of MBE-grown $PtSe_2$, paving the way for the design of high-performance electronic devices with enhanced thermal management capabilities.

References

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