Interface-controlled thermal transport in monolayer molybdenum disulfide

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The role of interfaces in the thermal transport in 2D transition metal dichalcogenides is vital in the context of device miniaturization and heat management. We used the Raman opto-thermal technique combined with finite element simulations to study thermal transport in CVD-grown monolayer MoS_2 on crystalline-Al_2O_3 and amorphous-SiO_2/Si substrates. A comprehensive study reveals that the relative effects of other limiting factors of thermal transport, like defects, strain, and charge transfer, are comparable and low in both systems, making the case for absolute comparison of interfacial effects. Our findings present the dominant contribution of interfaces in modulating the thermal transport in 1L-MoS_2, with the crystalline and amorphous nature of the substrate playing a crucial role. The key observation of our study is a four-fold enhancement in the thermal conductivity of MoS_2 on Al_2O_3 (κ ~ 78 W/mK) compared to that on SiO_2/Si substrate (κ ~ 21 W/mK), in agreement with theoretical predictions. A concomitant reduction in the interface thermal conductance is also observed [1].

References

[1] Aswathi Sampanraj et al., Physical Review B, 111(2025) 075423

Figures

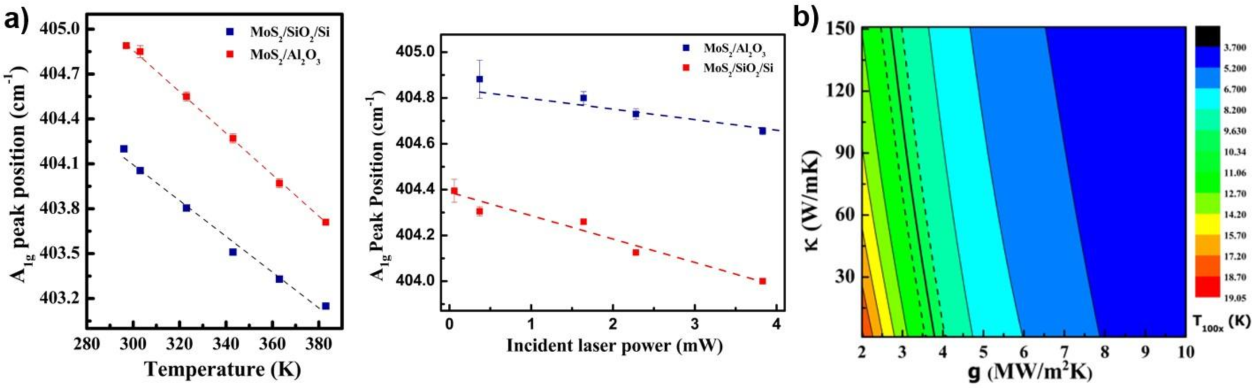

Figure 1: a) Raman opto-thermal measurements in MoS_2/Al_2O_3 and MoS_2/SiO_2/Si: The red shift of the peak position of A_{1g} Raman mode with temperature (left) and with incident laser power (right). b) FEA results: Temperature rise for MoS_2/Al_2O_3 as a function of thermal conductivity (κ) and interface thermal conductance (g) for 100x objective.