Thermal conductivity of suspended $MoSe_2$ 2D crystals with thickness control via Raman Thermometry

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Despite being highly relevant for enabling thermoelectric, photodetection and medical applications, thermal properties of 2D materials have received less atterntion than their electrical and optical counterparts. Currently, there is no consensus on how the thermal conductivity (κ) of 2D materials depends on thickness, in particular for TMDs [1, 2, 3, 4]. Here, we use 1- and 2-laser Raman thermometry as a tool to extract the in-plane κ of suspended $MoSe_2$ crystals as a function of thickness, down to the monolayer limit. The $MoSe_2$ flakes are directly exfoliated on a PDMS stamp which is readily used for dry-transferring onto Au-coated chips with large (15 µm), circular apertures (see Figure 1). A temperature-calibrated Raman mode (A_{1g}), with χ = 0.008 ± 0.001 cm^{-1}/K, allows us to correlate a given Raman shift (with spectral resolution of 0.05 cm^{-1}) to a lattice temperature within ± 2 K. The power-dependence of a CW laser (532 nm) enables its use as both a thermometer and a heat source. A second CW laser (405 nm) allows for locally heating the center of the suspended region while scanning the probe laser (see Figure 1). Our results suggest a subtle trend in κ, ranging from 10 – 30 W/m/K for the different studied flakes. We measured >15 samples, including 2 suspended monolayers and 4 suspended bilayers, in an attemp to unravel the effects of thickness on the thermal transport properties of $MoSe_2$.

References

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Figures

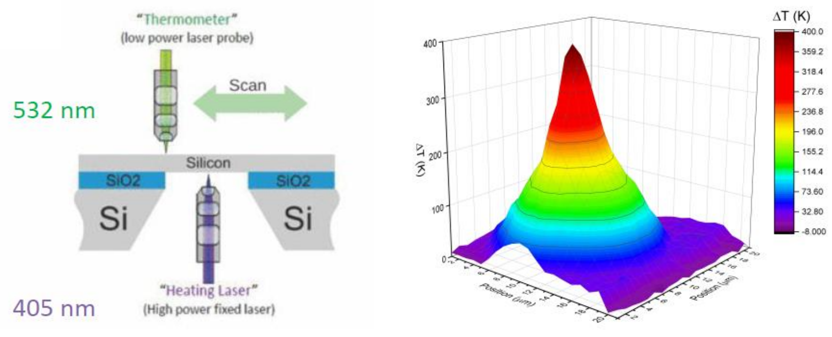

Figure 1: Measurement scheme (left) and heat profile of a $MoSe_2$ flake (right).