Heat transport in h-BN

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2D materials have new and intriguing properties, including their thermal properties. Like 3D materials, there is a wide variety of 2D materials with all ranges of thermal conductivity that can be simply assembled on top of each other [1]. Moreover, the thermal conductivity is extremely anisotropic in these materials. It has been demonstrated in the same 2D heterostructures ratios of 3 orders of magnitude between vertical and in-plane thermal conductivity, a record. Moreover, the interest from a fundamental point of view is the appearance at room temperature of a particular regime of phonon scattering, which allows to describe the heat transport as a hydrodynamic flow [2]. Thanks to these characteristics, it is interesting to study their thermal properties. Here, we focus on the thermal conductivity of suspended h-BN. It is an interesting material because it has a very high thermal conductivity but is electrically insulating. Nevertheless, it is difficult to heat it with a laser because of its low absorbance. To overcome this problem and to perform thermal mapping, we have made two heating bridges of Silicon between which a flake of hBN is suspended. One of the bridges is heated by Joule effect while the other one allows us to calibrate the heat flow through the 2D materials. Raman spectroscopy measurements allow to measure the temperature at each point of the system. We were able to extract a thermal conductivity of h-BN at different temperatures.

References

[1] Qian X. et al., Nat. Mater, 20 (2021) 1188-1202
[2] Shi L. et al., Science,364 (2019) 332-333

Figures

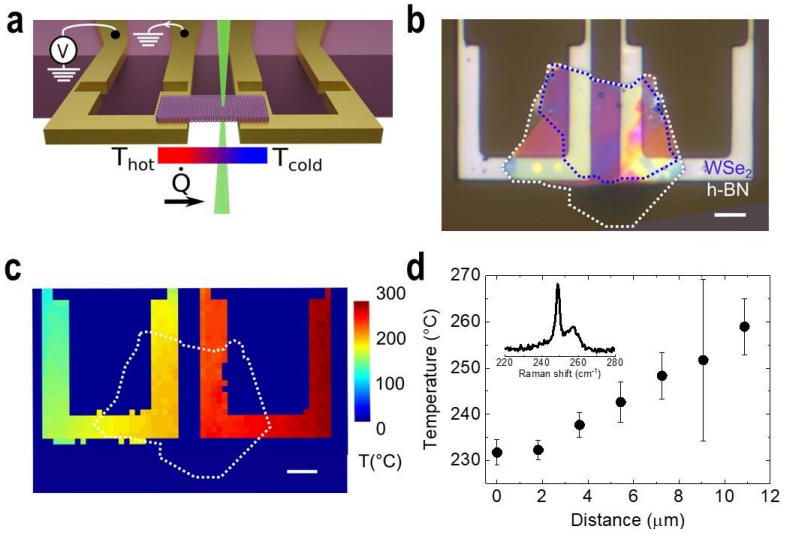

Figure 1: a) b) Schematic sketch (a) and optical image (b) of the device structure with a suspended hBN between two silicon heaters.) c) Temperature map of Si when 6 V are applied on the right electrode. d) Gradient of temperature of WSe_2 along a line from the cold electrode to the hot one (inset: Raman spectrum of WSe_2) All scales bar : 10 microns