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Extreme heat and strain gradiants in 2D material measured by Raman spectroscopy and vibrations

2D materials heterostructures are atomically thin materials, sandwiched together, to form new devices and concepts. It is the case in electronic, with subthermionic transistors, neuromorphic or memristive devices, and even transistor integration reaching the Si benchmark. but it also covers many potential topics: water sieving, exciton condensation, chiral quantum source emitters, twistronic, atypical thermal transport, and more recently straintronics. 2D thermal phonons, 2D vibrations or 2D straintronic engineering are important and fascinating emerging topics in the field of 2D materials and 2D heterostructures. **Straintronics in 2D materials** is the modulation and control of the 2D properties through macro- and nanoscale strain engineering. Straintronics is used for optical response tuning or the creation of quantum emission sources. This is especially interesting since 2D materials can withstand more than 16% strain (theory) and the excitonic energy is shifted by 125meV/% of strain. **The engineering of heat transport** remains a key point in miniaturized devices. Integrated circuits and thermal management strategies require materials with high thermal anisotropy, for example, for heat spreaders which can eliminate hot spots along the direction of the fast axis and provide thermal insulation along the slow axis. 2D materials have a record thermal anisotropy of 900, with room for improvement.

Theoretical deformation and heating limits applied to 2D materials are generally well beyond the scope of standard experimental tools . However, closing the gap between such theoretical predictions and experimental limit is crucial to benchmark 2D materials and integrate them optimally in novel devices. This are the activities that we propose to discuss (1,2,3).

References

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Figures

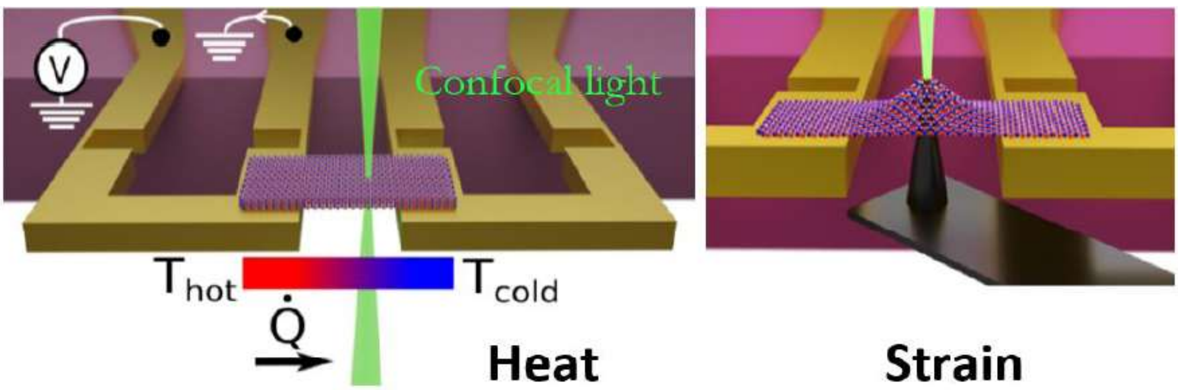

Figure 1: (left) Sketch of the strain/heating platform where two independent Silicon heaters can apply a calibrated heat gradient (>600K) along a suspended 2D nanomaterial. (right) A metallic tip is used to indent locally a 2D membrane by 10%. Optical methods, such as Raman spectroscopy, photoluminescence or optomechanic, are used to perform thermal and strain measurements.