Raman spectroscopy as a tool for thermal properties characterization of 2D materials

A. P. Gertych, K. Czerniak-Łosiewicz, M. Świniarski, J. Sitek and M. Zdrojek

Faculty of Physics, Warsaw University of Technology, Koszykowa 75, 00-662 Warsaw, Poland

Determining the thermal properties of 2D materials is an essential step in correctly assessing the suitability of new materials for many applications, including, for example, electronic components and systems. One of the methods of studying thermal properties is the Raman-based optothermal method, in which a Raman laser is used as a heat source, and the change of phonon energy is used as a temperature indicator. [1] This method has many advantages which make it suitable for 2D material characterization: it uses a widely available experimental setup, is contactless, and does not require complicated sample preparation.

In this short communication, we present the usage of the opto-thermal Raman method for thermal conductivity (κ) and thermal interface conductance determination (g) of the 2D materials in the form of atomically thin flakes (~1 nm, CVD, mechanical exfoliation) and thin films composed of atomically thin flakes (~50 nm, vacuum filtration), deposited on SiO_2/Si substrate. [2,3] We focused on MoS_2 and WS_2 and found that values of thermal properties (κ and g) of thin film composed of flakes are at least one order of magnitude lower than corresponding values for a single flake.

This study shows how the sample architecture influences the thermal properties of materials and could be useful for thermal management in future 2D material applications.

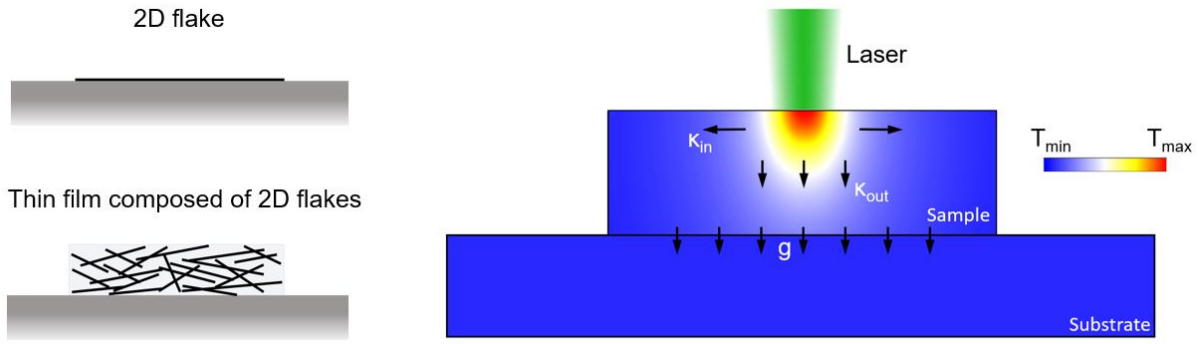

Figure 1 Schematic representation of 2D flake and thin film composed of 2D flakes. Example of temperature distribution of the sample under laser illumination.

[1] Balandin, A. A., et al. Nano letters 8.3 (2008): 902-907.
[2] Gertych, A. P., et al. Scientific reports 9.1 (2019): 1-7.
[3] Gertych, A. P., et al. The Journal of Physical Chemistry C (2021)