NEWS | NOVEMBER 29 2019

A simpler way to thermally characterize 2D materials

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Scilight 2019, 481102 (2019)
https://doi.org/10.1063/10.0000300

Scilight

25 November 2019

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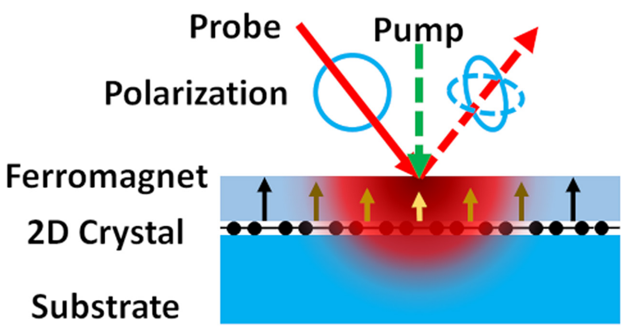
New method simultaneously measures in-plane and out-of-plane thermal transport of anisotropic 2D materials that have device-enhancing potential.



New and existing 2-dimensional (2D) materials could add and improve device functionalities. The optical and electrical properties of 2D materials have been the focus of many studies, but their thermal properties — while relevant to the thermal management of devices — are not as well characterized.

Thermal characterization is more challenging because 2D materials are thermally anisotropic, which makes it difficult to confine heat currents. Today's state-of-the-art techniques are limited, so Rahman et al. developed a new method for quantifying thermal properties.

The authors' method, called frequency domain magneto-optical Kerr effect (FD-MOKE), measures both in-plane and out-of-plane thermal transport simultaneously. They used their method to measure the thermal conductivity and thermal boundary conductance of a range of 2D materials, including single-layer graphene and few-layer hexagonal boron nitride.

"This [technique] is remarkable in that it accomplishes what two of the most popular techniques can each do separately: measuring in-plane transport as in the optothermal Raman technique, and out-of-plane transport as in thermoreflectance techniques," said author Simone Pisana.

Preexisting thermoreflectance-based techniques use a thick metal film as a transducer that can spread heat and limit the measurements of in-plane thermal properties. FD-MOKE avoids this limitation through the use of a thin magnetic film.

Alternatively, Raman thermometry measures in-plane transport, but can be error prone and often requires a suspended sample. FD-MOKE allowed the authors to accurately measure the thermal properties of 2D materials in a geometry similar to that of an electronic device: on an insulating substrate and under a metallic film. This experimental environment makes it easier for researchers to study the heat transport limitations of 2D materials and, in turn, design devices without heat dissipation issues.

Source: "Simultaneous measurement of anisotropic thermal conductivity and thermal boundary conductance of 2-dimensional materials," by Mizanur Rahman, Mohammadreza Shahzadeh, and Simone Pisana, *Journal of Applied Physics* (2019). The article can be accessed at https://doi.org/10.1063/1.5118315.