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A Laser Based Method for Anisotropic Thermal Property Measurement

Laser-based method simultaneously measures 2D in-plane thermal conductivity of anisotropic sheets with wide conductivity/anisotropy ranges.

Researchers at Purdue have developed a novel method to measure the two-dimensional thermal conductivity of anisotropic material sheets (from ~10 microns to a few millimeters thick). The new technique takes inspiration from the Ã…ngstrom method, which is a common technique for measuring the axial thermal conductivity of homogeneous rod-like materials or sheets cut into a long narrow strip. However, this method is only able to measure the thermal conductivity of a material in one dimension (along the axis of the rod or the long dimension of the strip) and requires multiple measurements to characterize anisotropic materials.

The researchers developed a new technique to measure the thermal diffusivity in two dimensions simultaneously, giving the measurement apparatus the ability to characterize the thermal conductivity of anisotropic materials. The measurement apparatus and approach has been validated by measuring the in-plane conductivity of materials from ~0.1 to ~2000 W/m-K with anisotropy ratios up to 225 using a single sample of each material.

Technology Validation:

The apparatus's ability to measure the thermal conductivity of anisotropic materials was validated by characterizing various materials with well documented thermal properties. As an example, Dupont's TemprionÂ® Organic Heat Spreader is a material known to have a high degree of thermal anisotropy. Upon measurement by the apparatus, the thermal conductivity of the material was confirmed to be highly anisotropic, and the values were within the expected range for the material.

Advantages:

- Measures thermal conductivity of isotropic and anisotropic sheets of material with minimal sample preparation for a wide range of sample

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Category

Artificial Intelligence & Machine Learning/Computer Vision & Image Recognition
Materials Science & Nanotechnology/Advanced Functional Materials
Automotive & Mobility Tech/Micromobility & Smart Urban Infrastructure

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thicknesses (from ~10 microns to a few millimeters thick)

- Visualizes and quantifies thermal anisotropy in two in-plane dimensions with only a single sample

- Can measure materials across a wide range of thermal conductivities (from ~0.1 to ~2000 W/m-K) and thermal conductivity anisotropy ratios (demonstrated for ratios from 1 to ~225)

Applications:

- Measuring thermal conductivity of anisotropic materials

Related Publication: Aalok U. Gaitonde, Aaditya A. Candadai, Justin A. Weibel, Amy M. Marconnet; A laser-based Ã…ngstrom method for in-plane thermal characterization of isotropic and anisotropic materials using infrared imaging. Rev. Sci. Instrum. 1 July 2023; 94 (7): 074904. https://doi.org/10.1063/5.0149659

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