Advantages and disadvantages of photothermal measurement methods estimating thermal transport properties (such as thermal conductivity, diffusivity and boundary resistance) of multilayered samples

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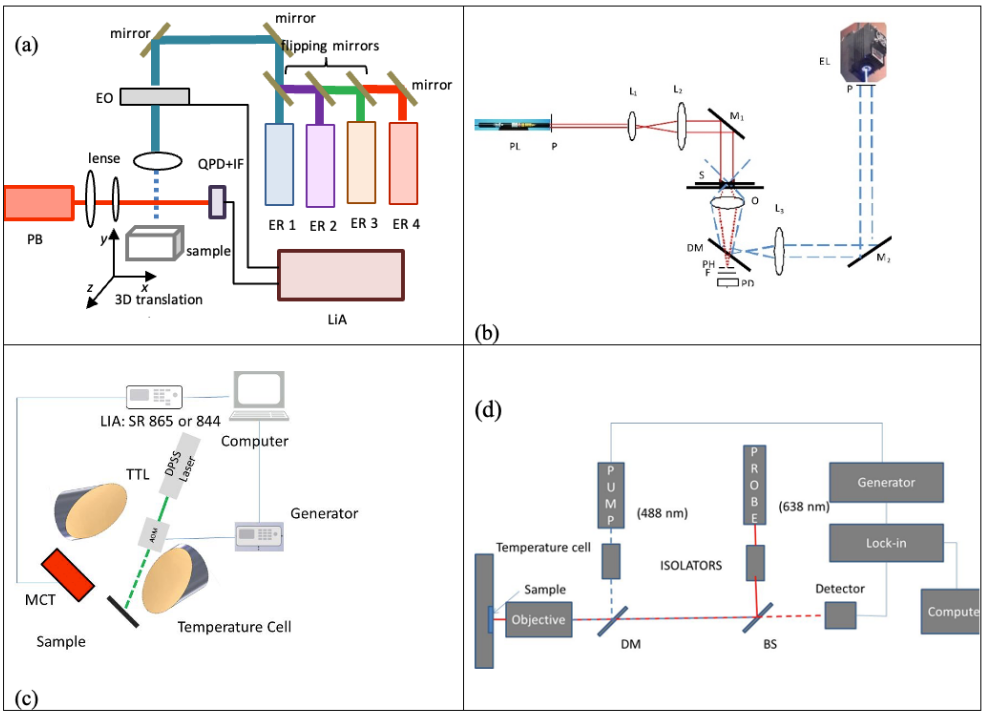
Since thermal conductivity plays a significant role in applications focused on accurately measuring the amount of energy dissipation, investigating this parameter will pave the way for fundamental research related to thin film characterization. Thermal conductivity can be measured using frequency domain (FD) methods. Compared to time domain (TD) methods, FD methods can also measure thermal diffusivity. In this paper we compare four FD thermal methods for measuring thermal transport properties as shown in figure 1.



Figs. 1a) to d) present the most used important methods for measuring the thermal transport properties [1-4]. Table 1 summarizes the degree of difficulty of studying thermal transport properties of thin layers superlattices and few layers graphene using frequency-domain photothermal radiometry (PTR) [1,2], frequency-domain thermoreflectance [2], beam deflection spectrometry (BDS) [3], and photothermal lens microscopy (PTM) [4].

Table 1. Summary of frequency-domain thermal wave methods.

Feature	PTR	TR	PTM	BDS
Measurement of cross-plane thermal transport properties	Applicable	Difficult but Applicable	Difficult	Applicable
Measurement of in-plane thermal transport properties	Difficult but Applicable	Applicable	Applicable	Possible
Complexity of optical system	Relatively easy	Relatively difficult	Relatively easy	Relatively easy
Temperature-measurements at low temperatures	Difficult, due to physical limitations	Applicable	Difficult	Difficult
Temperature measurements at high temperatures	Applicable	Applicable	Difficult	Difficult
Photoluminescence measurements	Applicable	Not Applicable	Not Applicable	Not Applicable

References

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