

The Study of Thermal Diffusivity Measurement Based on Frequency Scan Photothermal Reflectance Technique

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A frequency scan photothermal reflectance technique to measure thermal diffusivity of bulk samples is studied. Similar to general photothermal reflectance methods, an intensity-modulated heating laser and a constant intensity probe laser are used to determine the surface temperature response under sinusoidal heating. The approach involves fixing the distance between the heating and probe laser spots, recording the phase lag of reflected probe laser intensity with respect to the heating laser frequency modulation, and extracting thermal diffusivity using the phase lag – (frequency)^{1/2} relation. The measurement recipe is given with the discussion of deciding the proper measurement frequency range and the distance between laser spots. The experimental validation is performed on three samples (SiO₂, CaF₂ and Ge), which have a wide range of thermal diffusivity. The measurement results agree well to thermal diffusivity values reported in the literature. Comparing to the commonly used spatial scan photothermal reflectance method, the experimental setup and operation of the frequency scan method are simplified, and the uncertainty level is equal to or smaller than that of the spatial scan method. It is also found that the frequency scan method works particularly well on measuring the thermal diffusivity of the substrate material with a thin film coating.