

Time Domain Differential Raman for Thermal Diffusivity Measurement

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Raman scattering is not only applicable for structural characterization of molecular configuration and conformation in chemistry, but also relevant to physical properties of materials, such as temperature and stress. Thus information about temperature of specimen can be evaluated from intensity, Raman shift and linewidth of Raman signals. This provides the theoretical foundation for characterizing temperature by Raman scattering. In this work, a brand-new time-domain differential Raman (TD Raman) technology is developed to measure the thermal diffusivity of materials. The TD Raman technology uses a variable pulsed laser to heat the specimen and probe the temperature variation based on the principle of Raman thermometry and transient electrothermal (TET) technique. To evaluate this technique, silicon tipless cantilevers are used to conduct the experiment. A silicon tipless cantilever is heated by laser pulses and then Raman scattering spectrum of the specimen is collected. First of all, we develop a physical model to relate the accumulated Raman signal to the instantaneous Raman emission with temperature-dependent intensity, Raman shift, and linewidth. Then we develop a physical model to determine the thermal diffusivity of the cantilever by fitting curves of normalized Intensity and Raman shift against time. Sound agreement is obtained between the measured thermal diffusivity and the reference value. The TD Raman technology provides a very promising noncontact technique to measure the thermal diffusivity of materials without need of the temperature coefficients of Raman signals.