Photothermal lens and photothermal mirror techniques: effects and applications

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The photothermal lens (PTL) and photothermal mirror (PTM) techniques detect a broad range of phenomena arising from the interaction of tightly focused laser beams and matter at different time scales. In these techniques, a continuous or pulsed laser beam may induce a thermal perturbation and momentum transfer from the light to the sample. The effect is probed by monitoring the probe beam phase shift caused by the bulging of the heated area, the photoelastic effects, and the spatial distribution of the refractive index within the sample and in the fluid surrounding it. The transient signal is monitored at the far-field detector by analyzing the wavefront distortion of the probe beam. The mode-mismatched dual-beam PTL and PTM have been widely applied in the characterization of solid and liquid samples due to their remote, sensitive, and non-destructive characteristics. Thermal diffusivity, thermo-optical and mechanical properties can be quantitatively determined for solids and liquids materials. The applications involve material characterization of optical glasses, polymers, metals, alloys, semiconductors, and liquids. Here we show applications of Photothermal Lens and Photothermal Mirror methods under continuous or pulsed Gaussian laser excitations and the advances in its theoretical description over the past few years. The advances comprise investigating the effects of radiation forces in liquids and solids, generation and detection of pressure transients in liquids and thermoelastic waves in metals using photothermal techniques with pulsed excitation, and analytical description of sample–fluid heat coupling effect in photothermal techniques.