

Real-Time Sensing of Thermal Diffusivity for Dynamic Control of Anisotropic Heat Conduction of Liquid Crystals

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Anisotropic behavior of heat conduction is characterized by a molecular alignment, and is needed mainly for an advanced thermal design in microelectronics, or bio-related devices. Liquid crystal is widely utilized as an optical material for its anisotropic properties by alignment order of molecules, and has a potential for dynamic anisotropy control in heat conduction. However, it is difficult to quantify the characteristics of anisotropic heat conduction including the transition process in real-time.

In the present study, we have applied a developed real-time sensing system for thermal diffusivity by using the forced Rayleigh scattering method for the anisotropy control of the liquid crystal. In this method, in-plane thermal diffusivity can be measured perpendicular to the transient thermal grating created by interfering pulsed laser beams. Thus, it can be used to evaluate the transient behavior of anisotropy in thermal diffusivity. In addition, the time resolution of the real-time measurements in our experimental system is 10ms. This resolution allows us to trace a transient process of liquid crystalline molecules. We have measured the anisotropy of in-plane thermal diffusivity of 4-4'-pentyl-4-biphenylcarbonitrile (5CB) under the ordering condition by a rubbing glass or by applying an electric field. Also, by adjusting the electric field, the time evolution of the anisotropic thermal diffusivity in real-time was measured. The results obtained demonstrate the capability of dynamic anisotropic control in thermal diffusivity.