Grating Excitation Techniques: Creation of Nano/Microscale Transport Properties Sensing Engineering and Its Progress

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Sensing techniques of nano and micro-scale thermophysical properties are very important not only for the fundamental research of thermal engineering but also in broad cross-disciplinary fields on the basis of research and development of leading-edge technology. For example, in nanotechnology fields we need to evaluate thermal conductivity of newly developed nano-materials such as SWNT and graphene in order to design various devices utilizing these materials. In biotechnology fields it is important to control the diffusion and separation of DNA and proteins. In spite of these intense demands, we are often faced with the problems that the widely used conventional techniques to measure thermophysical properties are entirely unsuitable for such materials and conditions owing to their limitation of spatial and temporal resolutions.

The present plenary lecture overviews new frontiers of sensing techniques for transport properties in nano and micro-scale processes using grating excitation techniques developed at Keio. Especially, new optical techniques to measure wide variety of thermophysical properties such as thermal diffusivity (Forced Rayleigh Scattering), viscosity and surface tension (Laser-induced Capillary Wave), mass diffusion coefficient (Soret Forced Rayleigh Scattering) of novel fluids and solids are presented with an emphasis on their engineering applications. These grating excitation techniques have the following features: (1) non-invasive and in situ, (2) high spatial resolution, (3) high temporal resolution, (4) small amount of sample and (5) 2D distribution measurement applicable to anisotropic materials, all of which have never been attained by any conventional measurement tools.