Effective Thermal Conductivity of Dispersions with a Continuous Liquid Phase

Francisco E. Berger Bioucas[1, S], Michael H. Rausch[1], Thomas M. Koller[1, C] and Andreas P. Fröba[1]

[1]*Institute of Advanced Optical Technologies – Thermophysical Properties (AOT-TP), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany*
thomas.m.koller@fau.de

Dispersions with a continuous liquid phase like nanofluids and microemulsions are of importance in various fields of process and energy technology. The processing and application of such systems requires knowledge of their thermophysical properties, including the effective thermal conductivity (ETC). To date, there is an ongoing controversy about the ETC of suspensions and especially nanofluids which have attracted attention as heat transfer fluids because of their enhanced ETC compared to the thermal conductivity (TC) of the corresponding base fluid. This situation is not only related to the lack of reliable experimental data from appropriate methods, but also to a limited understanding of the physical mechanisms affecting thermal conduction in dispersions.

This contribution presents current research activities at AOT-TP in connection with the ETC of dispersions with a continuous liquid phase. The main objective is to understand how different relevant parameters and phenomena affect the ETC by performing systematic experimental investigations. Objects of investigation are nanofluids with the dispersed phase consisting of CuO, TiO_2, SiO_2, or polystyrene nanoparticles and the continuous liquid phase based on water, ethylene glycol, glycerol, or 1-pentanol as well as microemulsions containing water, *n*-decane, and a surfactant. For their study, a newly developed steady-state guarded parallel-plate instrument was used which enables an absolute determination of the TC with expanded uncertainties below 3% at ambient pressure over a temperature range from (283 to 358) K. The experimental investigations involve variations of material, concentration, and morphology of the solid or liquid particles. Findings like the trend of increasing changes in the ETC of nanofluids with increasing size of spherical particles at constant particle volume fraction deepen the fundamental understanding of the ETC of dispersions. All obtained experimental results contribute to the current development of a generalized prediction method for the ETC of dispersions with a continuous liquid phase.