# A New Analytical Model for the Effective Thermal Conductivity of Nanofluids

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Dispersions of nanometer-sized particles in liquids, usually called nanofluids, have been reported to possess substantially higher thermal conductivities than anticipated from Maxwell's classical theory. A large number of experimental results have claimed an anomalous increase in the thermal conductivity of nanoparticle suspensions, which would make them attractive as potential heat transfer fluids for many applications. However, results from other experiments have not shown any anomalous increase in thermal conductivity. This has triggered controversy regarding the actual value of the thermal conductivity of nanofluids and the reliability of the experimental methods. In the present study, a new analytical model for the effective thermal conductivity of liquids containing dispersed spherical and non-spherical nanometer particles is developed. In addition to heat conduction in the base fluid and the nanoparticles, also the convective heat transfer caused by the Brownian motion of the particles is considered. For nanoparticle suspensions, the latter mechanism has significant influence on the effective thermal conductivity, which is reduced compared to a system in which only conduction is considered. The developed model allows for the prediction of the effective thermal conductivity of nanofluids as a function of volume fraction, diameter, and shape of the nanoparticles as well as temperature. Due to the inconsistency of experimental literature data, the model is compared with the well-established Hamilton-Crosser model and other empirical models for different nanofluid systems commonly studied in literature. The theoretical estimates show no anomalous enhancement of the effective thermal conductivity and agree very well with the Hamilton-Crosser model within relative deviations of less than 8 % for volume fractions of spherical particles up to 0.25. In accordance with the Hamilton-Crosser model for non-spherical particles, our model reveals that a more distinct increase in the enhancement of the effective thermal conductivity can be achieved using non-spherical nanoparticles having a larger volume-specific surface area.