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NANOFLUIDS BY QUANTUM MECHANICS

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ABSTRACT

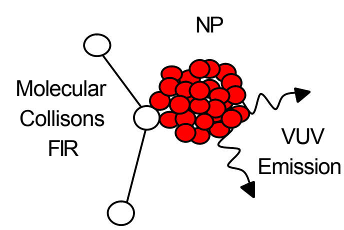
The enhanced heat transfer of nanofluids is shown not to be caused by the increase in thermal conductivity based on the concentration of nanoparticles (NPs) given by the long-standing Hamilton and Crosser (HC) mixing rules. Instead, heat transfer is enhanced because quantum mechanics (QM) restricts the specific heat of NPs to vanish, the consequence of which is that thermal kT energy absorbed from collisions of solvent molecules cannot be conserved by an increase in temperature. Conservation may only proceed by the QED induced up-conversion of the low frequency absorbed kT energy to the EM frequency of the NP, typically in the VUV. Here EM stands for electrodynamics, QED for quantum electrodynamics, and VUV for vacuum ultraviolet. The EM confinement is quasi-bound so that the VUV radiation promptly leaks from the NPs. Classically, collisions increase the NP temperature with EM emission occurring in the far infrared (FIR) that is absorbed with little penetration at the NP surface. But the VUV is absorbed at large penetrations, thereby enhancing heat transfer in proportion to the number of NPs without increasing the nanofluid conductivity - the process called QED induced heat transfer. Nanofluid conductivity given by the HC mixing rules for NPs in solvents is still valid and need not be modified.

INTRODUCTION

Over the past few decades, nanofluids comprising NPs in common solvents are generally thought to significantly enhance thermal conductivity. The transient hot wire method (THWM) test used to infer thermal conductivity from the temperature response of a thermocouple near an electrically heated wire generally shows enhancements in conductivity far greater than that given by HC mixing rules.

The HC rules for thermal conductivity were derived by extending Maxwell's treatment of electrical conductivity for macroscopic particles. Nevertheless, NPs in solvents still should obey HC mixing rules, but do not if the enhanced heat transfer is interpreted as an increase in conductivity. What this means is that at the nanoscale, the NPs are enhancing heat transfer of the solvent by a heat transfer mechanism that is independent of thermal conductivity.

Indeed, conductive heat transfer in solutions need not be enhanced by increased thermal conductivity [1] provided the FIR heat absorbed by the NPs is converted to penetrating VUV radiation by QED. Heat as VUV emission is absorbed at a greater distance from the NPs while the FIR is absorbed with virtually no penetration at the NP surface as shown below.



By QED theory, enhanced efficiencies found for nanofluids in THWM tests are the consequence of QED induced heat transfer, and not by any enhancement of conductivity itself.

PRESENTATION

The background of enhanced conductivity in nanofluids is contrasted with HC nixing rules. QED induced heat transfer is presented as a result of QM restrictions that require the heat content and specific heat of NP atoms to vanish. See www.nanoqed.org Classical heat transfer based on the conservation of absorbed collisional heat therefore cannot occur by an increase in NP temperature, the conservation proceeding by QED induced VUV emission. QED induced heat transfer increases with NP concentration but the conductivity of the nanofluid given by HC mixing rules is not modified.

REFERENCES

[1] T. Prevenslik, "Nanofluids by QED Induced Heat Transfer," IASME/WSEAS 6th Int. Conf. Heat Transfer, HTE-08, 20-22 August, Rhodes, 2008.