Heat transfer in soft nanoscale interfaces

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Abstract

Nanoscale interfaces offer tremendous opportunities to design high performance materials, for instance, materials with enhanced thermal properties as in *nanofluids*. A paradigm of a nanoscale interface is a nanoparticle suspension, where the solvent/nanoparticle interface has a typical size of the order of 10^2–10^3 nm^2. There is currently a vigorous research activity on nanoparticle-interface related problems. Due to their small dimensions the nanoparticles' properties depart significantly from those observed in macroscopic materials. The interface between the material, e.g., nanoparticle, and the solution, becomes increasingly important on the nanoscale. Hence, it is expected that for very small particles (few nm diameter) the thermal transport will be strongly dependent on the properties of the interfaces and therefore, it will be different from heat transfer in macroscopic systems, where interfaces become less relevant as compared with bulk effects.

We have investigated [1] the heat-transfer through nanometer-scale interfaces consisting of n-decane (2–12 nm diameter) droplets in water using transient non-equilibrium molecular-dynamics simulations (NEMD). We have obtained the temperature relaxation of heated nanodroplets as a function of time and we have computed the thermal conductivity and the interfacial conductance of the droplet and the droplet/water interface respectively. We find that the thermal conductivity of the n-decane droplets is insensitive to droplet size, whereas the interfacial conductance shows a strong dependence on the droplet radius, and we rationalize this behavior in terms of a modification of the n-decane/water surface-tension with droplet curvature.

References

[1] Anders Lervik, Fernando Bresme, and Signe Kjelstrup. Heat transfer in soft nanoscale interfaces: the influence of interface curvature. *Soft Matter*, 5:2407–2414, 2009.