Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Thermal Boundary Resistance at Ideal Gas Solid-Fluid Interfaces

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We study the thermal boundary resistance at the interface between an ideal gas solid and another ideal gas fluid. In the solid side, heat is mostly carried by phonons, and thermal resistance occurs due to the partial reflection of phonons at the interface. In the fluid side, the sound waves can carry diffusive heat from the interface into the bulk of the liquid. We include both longitudinal and transverse sound modes of the fluid in the theory. The sound modes in the fluid and the reflected phonons in the solid have the same frequency as the phonon incident at the interface from the solid side. The wave vector for the sound modes is then calculated using the knowledge of the fluid pair distribution function in the bulk. The pair distribution function near the interface is modified due to the presence of the solid atoms. We solve coupled equations of motion for the atoms at the interface to obtain the phonon reflection coefficients. The Kapitza resistance is then obtained using the knowledge of these reflection coefficients. The calculation provides a method for extending the Young-Maris theory to the fluid-solid substances.

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Date submitted: 19 Nov 2010