Heat Transfer in a Rarified Air Chamber Using a Thermal Wave Resonant Cavity

Cindy Lorena Gomez Heredia [C, S] and Juan Daniel Macias
Department of Applied Physics, CINVESTAV-IPN, Mérida, Yucatán, México
cindygomez@mda.cinvestav.mx

Jose Ordoñez Miranda
Nanoscience, Nanotechnology, Nanoscale Heat Transfer, Ecole Centrale Paris, Châtenay, Malabry, France

Oscar Eduardo Ares Muzio and Juan José Alvarado-Gil
Department of Applied Physics, CINVESTAV-IPN, Mérida, Yucatán, México

Heat transfer in gases at low pressures is an important subject in several applications, and in particular in solar thermal energy conversion, in which vacuum is used to minimize heat loses due by heat conduction. However heat transfer at low pressure involves phenomena in which the mean free path of the molecules can be very large and the usual concepts for viscous fluids have to be changed to understand transport phenomena. In this work heat transfer, in a rarefied air gas chamber is studied using the thermal wave resonant cavity technique [1]. Our experiments follow a similar methodology previously developed for the viscous regime, which was used to determine the thermal diffusivity of gases and emissivity of thin metallic foils [2]. In contrast in our case, a region of very low pressures values is explored. The thermal wave cavity is an open system, consisting on one side of a flat heat source and on the other by a flat pyroelectric detector separated by a thin layer of air. The thermal wave resonant cavity was introduced into a closed chamber and the air was evacuated using a mechanical pump. The pressure of the chamber was varied from 10^{-4} to 760 Torr. In this way the heat transfer experiments were performed at low modulation frequency of the heat source and the cavity length was scanned until 1×10^{4} micrometers. Our results show that in the viscous regimen to a pressure of about 1 Torr, heat transfer behaves in the usual diffusive way. However, when the pressure is lower, in such a way that the mean free path of the molecules is of the order of the size of the cavity, the experimental data obtained with the thermal wave resonant cavity, show that heat transfer is not diffusive [3,4]. The mechanisms present in all the range of pressures are presented and discussed.

References

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