Proceedings of the 8th World Congress on Mechanical, Chemical, and Material Engineering (MCM'22)
Prague, Czech Republic – July 31, 2022 - August 02, 2022
Paper No. HTFF 185
DOI: 10.11159/htff22.185

Thermal Resistance of a Liquid-Solid Interface on Curved Smooth and Rough Walls

Semran Ipek[1], Kiril Shterev[2], Stefan K. Stefanov[2], Ali Dinler[3*]
[1]Istanbul Medeniyet University, Department of Physics Engineering, Uskudar Istanbul, Turkey
[2]Bulgarian Academy of Sciences, Institute of Mechanics, Academic Georgi Bonchev Street, Sofia 1113, Bulgaria
[3]Istanbul Medeniyet University, Department of Mathematics, Uskudar Istanbul, Turkey
semran.ipek@medeniyet.edu.tr; kshterev@imbm.bas.bg; stefanov@imbm.bas.bg; ali_dinler@yahoo.com

Extended Abstract

The breakdown of the momentum transfer at a fluid-solid contact has been known in micro/nanofluidics for many years. Influence of the surface shape (i.e. convex/concave) has been investigated in gas-phase flows [1-2]. On the other hand, thermal boundary resistance is a known phenomenon, which reduces the heat transfer between heterogeneous materials and affects overall thermal performance, has not been investigated sufficiently well at curved interfaces. The present study runs non-equilibrium molecular dynamics (NEMD) simulations and considers a thin heated cylindrical shell, which is located in the middle of the gap between two coaxial stationary cylinders, in order to investigate the thermal boundary resistance. In contrast to previous molecular dynamics simulations [3-4], realistic walls are created to examine the interfacial heat transfer related to the surface curvature over rough and smooth surfaces.

The results show the existence of the opposing effect of curvature. This effect demonstrates itself by increasing heat transfer from a hot concave surface to the fluid with curvature, while, in contrast, by decreasing heat transfer from a hot convex surface. At identical curvature and surface area, the present results show that the thermal resistance between a hot convex silver surface and liquid argon is larger than the thermal resistance between a hot concave silver surface and liquid argon. In addition, the interfacial resistance of an equivalent flat case defines the upper and lower limits for these concave and convex interfaces, respectively.

The research leading to these results has been funded under 2502 joint program between the Scientific and Technological Research Council of Turkey (TUBITAK) and the Bulgarian Academy of Sciences (BAS) with a grant number of 119F279.

References

[1] A. Dinler, R. W. Barber, S. K. Stefanov, and D. R. Emerson, K. Orucoglu. "Role of surface shape on boundary slip and velocity defect." *Physical Review E*, 86.1, 016314, 2012.
[2] A. Dinler, R. W. Barber, S. K. Stefanov, and D. R. Emerson, K. Orucoglu. "On the degree of boundary slip over nonplanar surfaces." *Microfluidics and nanofluidics*, vol. 15, no. 6, pp. 807-816, 2013.
[3] A. Dinler, "Heat transfer at the convex fluid-solid interface," *Journal of Applied Physics*, vol. 121, p. 124302, 2017
[4] A. Dinler, R. W. Barber, S. K. Stefanov, and D. R. Emerson, "Curvature dependence of heat transfer at a fluid-solid interface," *Physical Review E*, vol. 98, no. 3, p.033104, 2018.