Low speed/low rarefaction flow simulation in micro/nano cavity using DSMC method with small number of particle per cells

Ali Amiri-Jaghargh[1], Ehsan Roohi[1], Hamid Niazmand[1], Stefan Stefanov[2]
[1] Department of Mechanical Engineering, Faculty of Engineering, Ferdowsi University of Mashhad, Mashhad, Iran.
[2] nstitute of Mechanics, Bulgarian Academy of Science, Acad. G. Bontchev Str., 1113, Sofia, Bulgaria.

Abstract
The aim of this study is to extend the validity of the simplified Bernoulli-trials (SBT)/dual grid algorithm, newly proposed by Stefanov [1], as a suitable alternative of the standard collision scheme in the direct simulation Monte Carlo (DSMC) method, for solving low speed/low Knudsen number rarefied micro/nano flows. The main advantage of the SBT algorithm is to provide accurate calculations using much smaller number of particles per cell, i.e., $< N > \approx 1$. Compared to the original development of SBT [1], we extend the application of the SBT scheme to the near continuum rarefied flows, i.e., Kn = 0.005, where NTC scheme requires a relatively large sample size. Comparing the results of the SBT/dual grid scheme with NTC, it is shown that the SBT/dual grid scheme could successfully predict the thermal pattern and hydrodynamics field as well as surface parameters such as velocity slip and temperature jump. Nonlinear flux-corrected transport algorithm (FCT) is also employed as a filter to extract the smooth solution from the noisy DSMC calculation for low-speed/low-Knudsen number DSMC calculations. The results indicate that combination of SBT/dual grid and FTC filtering not only provides accurate smooth solutions but also reduces the computational time compared to the original SBT/staggered grid as well as the NTC scheme.