Discrete simulation of multi-phase flow of MEMS-based solid propellant microthruster

†*Wenjing Yang [1], Peijing Liu [1], Qiang Li [1], Guoqiang He [1]

1 Science and Technology on Combustion, Internal Flow and Thermal-structure Laboratory, Northwestern Polytechnical University, PR China

*Presenting author: yangwj@nwpu.edu.cn
†Corresponding author: yangwj@nwpu.edu.cn

Abstract

As a relatively new class of mircothruster, the solid propellant microthruster owns unique advantages, such as compact size, high impulse performance and no leakage concerns. To meet the requirements in the aerospace field, including the precise attitude control, orbit adjust and gravitation compensation etc., the accurate prediction of the thrust of mircothruster is critical important, which is closely correlated to the precise description of the internal flow field inside the motor. The internal flow field is on the microscopic level, mostly hundred microns, and involves multi-phases, *i.e.* gas and particle, and multi-physical fields, *i.e.* flow field, acoustic filed and sometimes gravity field. The numerical simulation based on the discrete element method prohibits irreplaceable merits in simulating the particle related flow, since it can describe the particle behavior on microscopic level, and furthermore it is flexible to consider the forces acted on each individual particle from multi-physical fields. Then, in this work the discrete based numerical model for the internal flow of solid microthruster is successfully established, with consideration the acoustic force, and the interacting force between particles and gas. The gas-particle flow in the microthruster is calculated and the micro-structure of the flow field is analyzed, which is able to provide the quantitatively evaluations of the factors affecting the flow field. Also, the particle behavior is identified in different regions of the motor, such the contacts with walls, particularly the nozzle area, and the space distributions. The particle scale information is important but difficult almost impossible to obtain from other methods, and necessary to precisely predict the thrust of a microthruster.

Keywords: solid propulsion, microthruster, discrete element method, internal flow