IAF SPACE PROPULSION SYMPOSIUM (C4)
Solid and Hybrid Propulsion (2) (4)

Author: Mr. Yu Liao
Northwestern Polytechnical University, China, leo_yu97@foxmail.com

Prof. Peijin Liu
Northwestern Polytechnical University, China, liupj@nwpu.edu.cn
Ms. Jiang Yuan
Northwestern Polytechnical University, China, yuanjiang_xust@163.com
Mr. XU Geng
Northwestern Polytechnical University, China, another_one_ne_c@yeah.net
Ms. Lu Liu
Northwestern Polytechnical University, China, 775622673@qq.com
Mr. Yuanhua Wang
Northwestern Polytechnical University, China, yuanhuaw@mail.nwpu.edu.cn
Dr. Bingning JIN
Northwestern Polytechnical University, China, xuelang-8655@163.com

STUDY ON COMBUSTION WAVE CHARACTERISTICS OF SOLID PROPELLANT UNDER NONLINEAR OSCILLATION

Abstract

The nonlinear combustion response of solid propellant is the most important driving mechanism for the nonlinear combustion instability of solid rocket motors. To obtain the combustion response characteristics of solid propellant under nonlinear oscillation, a high-pressure oscillation combustion experimental device is established by using pulse trigger excitation devices and loudspeakers. The fluctuation and heat release characteristics of 100 μm micro flame of AP / HTPB composite propellant are studied by using combustion diagnosis methods such as tomography, double-wavelength temperature measurement and heat flux measurement under pressure oscillation frequency 0 – 500 Hz and equilibrium pressure 5 MPa. The mesoscopic AP flame structure is obtained, including the flame-centerline, flame-front, flame-bending of the AP decomposition flame and the final diffusion flame, and coupling between adjacent flames. The preliminary results show that the flame fluctuation characteristics under nonlinear pressure oscillation are quite different from those under steady state. Without oscillation, the fluctuates of AP flame is not obvious; under oscillation, the AP flame periodically swings around the centerline, and the swing frequency is basically consistent with the pressure oscillation frequency, with a certain degree of time lag. When the pressure oscillation amplitude is small, the flame basically maintains the overall tilt swing mode, namely 'straight-line' swing; when the amplitude is large enough or the oscillation stops, the flame presents a 'bending' swing because of the partial 'inertia' of the flame front. After the oscillation stopped for a period of time, the propellant returns to steady state combustion. In the following research, the experimental data of flame temperature and heat release will be analyzed to obtain flame heat release characteristics under non-linear oscillation conditions, so as to provide key parameters for in-depth analysis of the mechanism of nonlinear combustion response and to improve the non-linear combustion response model.