Title

A new combustion phenomenon: penetrative combustion of 3D printed fuel grain for hybrid rocket engine

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Abstract

Traditional hybrid rocket fuel can improve fuel combustion efficiency through structural design which is conducive to aerodynamic enhancement of regression rate. However, complex structure increases the difficulty of fuel structure forming, hindering the scientific research and engineering application verification of fuel charge with heterogeneous and topological structure in the hybrid rocket. 3D printing is used to manufacture hybrid rocket fuel grains with a special mesh structure to improve combustion performance. When analyzing the gas-phase and solid-phase combustion characteristics of acrylonitrile-butadiene-styrene (ABS) fuel with a single-hole mesh structure, the penetrative combustion phenomenon of 3D printed structural fuel was first discovered, and the minimum print packing rate of fuel charge axisymmetric ring disintegration caused by penetrative combustion was determined. The results show that penetrative combustion can effectively increase the regression rate, and the lower the packing rate of fuel, the more obvious the penetrative combustion phenomenon, and the shorter the penetration time. When the oxygen mass flux is 100 kg/(m^2·s), the regression rate of the solid ABS fuel grain with 100% and 90% packing rates increased by 20.0% and 30.7%, respectively, compared with the solid ABS fuel grain manufactured by a computerized numerical control (CNC) lathe. ABS fuel grains with packing rates of 80%, 70% and 60% will disintegrate during combustion and the regression rate will rise sharply due to the presence of penetrative combustion.