Paper ID: 19826
student

SPACE PROPULSION SYMPOSIUM (C4)
Poster Session (P)

Author: Mr. Xin Liu
Northwestern Polytechnical University, China

Prof. Peijin Liu
China
Ms. Shaojuan Wei
Northwestern Polytechnical UniversityNPU, China

EXPERIMENTAL INVESTIGATION ON COMBUSTION OF ALUMINUM IN THE AP/HTPB COMPOSITE PROPLLENT

Abstract

Aluminum is an excellent energetic material. Because of its high combustion temperatures and energy release, aluminum powder has been used as an additive to propellents and explosives in SRM for decades. This application has been the driver for research for the past 60 years. Aluminum powders, typically ranging from 16-18% by mass of the heterogeneous propellent. Parent aluminum powder accumulates on the burning surface of the propellent, melts, and coalesces or agglomerates to form larger particles which, eventually, separate from the surface. The purpose of the experiment is to investigate the combustion process of aluminum of the propellent. It is know that AlO is the intermediate of gas-phase aluminum oxidation, and evidence of the AlO would be an indication that either gas-phase reactions were occurring or that temperatures were high enough such that some AlO was dissociating. The AlO emission is 486nm wavelength. In this paper, a spectrometer was used to measure light emission of the burning propellent in the combustion chamber. The AP/HTPB propellent used in experiment contains 17% mass percent of aluminum. The pressure of the experimental conditions are from 1atm to 35atm. The combustion chamber filled with nitrogen, so as to guarantee a certain pressure and clean the observation window. Experiments were performed both with and without a 486 nm bandpass interference filter in front of the spectrometer to isolate the $\Delta\nu = 0$ band sequence in the transition of AlO. The size of propellent was 8mm*8mm*100mm. Measurements were at 1atm , 10atm ,20atm and 35atm. Only at 35atm, AlO emission was observed. The others were not. And in the atmospheric environment at normal temperature and 1atm, pure aluminum combustion also was not observed in the emission spectrum of AlO. Only in cases with a relatively high pressure environments was any AlO emission observed at all. Pyrometry temperatures increase very significantly with pressure as well. Under similar heat transfer conditions, the reaction rate will control the particle temperature. A faster heat release will lead to higher particle temperatures to drive the heat transfer from the particle. This could explain the observed trends, as the high pressure cases reacted the fastest and also displayed the highest temperatures. In conjunction with the lack of observed AlO light emission,indicates that there is very little gas-phase reactions in the combustion process. It is important to understand the combustion process of aluminium of the propellent.