SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (2) (2)

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REGRESSION RATE MEASUREMENTS FOR HYBRID ROCKET ENGINES BASED ON GOX AND HTPB

Abstract

Within the DLR research program AHRES a new test bed up to 10kN of thrust has been constructed to enable the investigation of internal ballistic properties of high pressure hybrid rocket combustion chambers. In this work the test bed itself with the applied measurement techniques, the design features of combustion chamber and the preliminary test results are presented.

The tests are conducted at a chamber pressure up to 7 Mpa with gaseous oxygen as oxidizer and hydroxyl terminated polybutadiene (HTPB) as fuel. The HTPB solid fuel is used as pure substance and with metallic additives. The overall mass flow of the engine is in the order of 0.5-1.0 kg/s.

To identify the local regression rate an ultrasonic measurement system is applied with a sampling rate of 100 Hz. In order to obtain good results a telescope fuel grain configuration is chosen. This involves a geometrically linear surface change, and therefore only slight changes in O/F ratio. The regression rate is calculated by the decrease of the outer cylinder web thickness. The oxygen as gaseous oxidizer has the advantage that no droplet atomizing process will influence the combustion process or the measurement procedure.

Other important parameters being measured are the oxygen mass flow by a coriolis flowmeter, the engine thrust in 3 axes, the chamber pressure and the temperature in the vortex chamber. The completion of the combustion process is analyzed by a gas sensor for the components oxygen, carbon monoxide and carbon dioxide. The exhaust flame temperature is measured by thermal radiation.

The achieved preliminary data are used to set up a regression rate law for applied propellants and the time dependent changes of interior ballistic parameters. The results are compared with a developed engineering model for chamber process description.