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Author: Dr. Daeban Seo
KARI, Korea, Republic of

Prof. jongkwang Lee
Hanbat National University, Korea, Republic of
Mr. Juyeong Jung
Hanbat National University, Korea, Republic of
Dr. Youngmin Han
Korea Aerospace Research Institute (KARI), Korea, Republic of

THE GLASS-MEMBRANE MEMS IGNITER WITH IMPROVED PERFORMANCE FOR CUBE-SAT APPLICATION

Abstract

The design, performance prediction, fabrication and firing test of the glass-membrane MEMS igniter for Cube-sat application were described in this study. A photosensitive glass wafer was used as substrate for fabrication of a thick glass membrane like the previous glass-ceramic igniter. The thick glass membrane assured its structural reliability, however, in glass-ceramic igniter, an ignition delay and reproducibility deteriorated owing to characteristics of the thick glass membrane. Hence, the novel MEMS igniter with glass membrane was designed to improve the reproducibility and the ignition delay compared with the previous glass-ceramic igniter. In this design, the uniform thickness and the flat surface of membrane were devised to improve the reproducibility, and heater was designed at the under surface of the membrane to improve the ignition delay. A CFD calculation was carried out to predict the ignition delay of the designed igniter after the design process. A performance comparison of the glass-membrane igniter with the glass-ceramic igniter was also carried out to evaluate the performance improvement of the glass-membrane igniter. The designed igniter was then realized by the MEMS fabrication process using the glass wafer. After all of each layer was separately fabricated, the igniter was formed by integration of the membrane layer and chamber layer. The upper layer and bottom layer were integrated with the igniter after the propellant filling. In the firing test, measured ignition delay of the glass-membrane igniter was 17 ms at the input voltage of 15.37 V. The minimum ignition delay was 15.4 ms at the input voltage of 18.02V. At the input voltage of 15 V, it is conventional operating voltage of Cube-sats, the measured ignition delay was almost same as the CFD calculation result. The measured ignition delay was 34.45% shorter than the measured ignition delay of the glass-ceramic igniter at the input voltage of about 15V. Based on these results, the improvement of ignition delay in the glass-membrane igniter was verified from the firing test at the operating voltage of Cube-sats. The reproducibility was also evaluated by consecutively igniting 5 igniters at the input voltage of 15 V. All igniters successfully ignited, and the ignition delay and energy were measured. A calculated coefficient of variation of the ignition delay and energy were below 12%. This value have not yet been reported on the research of the micro igniters, hence the improvement of the reproducibility of developed glass-membrane igniter was verified.