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CHARACTERIZATION OF FILM EVAPORATING MICROCAPILLARIES FOR MICRONEWTON THRUSTERS

Abstract

Low power micronewton thrusters can provide attitude control for SmallSats to increase mission utility and enable constellation flying. Micronewton thrust control can also enhance missions that require precision pointing such as space telescopes, laser interferometers, and laser communication relays. Film Evaporating MEMS Tunable Arrays (FEMTA) is a novel micropropulsion device that was developed at Purdue University in partnership with NASA Goddard under the SmallSat Partnership program. FEMTA generates thrust by heating microcapillaries to induce controlled film boiling in vacuum. Thrust stand tests under high vacuum have shown that FEMTA can produce controllable thrust in the range of 60-100 N at ¡ 1 W input power with ultrapure deionized water as propellant. To increase the TRL of FEMTA, improvements in reliability, robustness, and ease of manufacturing must be made. We present the design and fabrication of a FEMTA device that addresses limitations of the current design and enables direct observation of the evaporating microcapillaries. The effects of nozzle dimensions, capillary temperature, and propellant feed pressure on microcapillary behavior and thruster performance were studied. A numerical model of the microcapillary was developed based on findings of the experiment. Lastly, we use the insights of this study to explore FEMTA designs that are optimized for spaceflight missions. Device fabrication was performed using standard lithography processes at Purdue's Nanotechnology Center and thrust stand testing was performed at Purdue's High Vacuum Lab.