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INERTIAL MICROFLUIDIC MIXER FOR BIOLOGICAL CUBESATS MISSIONS

Abstract

Given the almost infinite application area of CubeSats while minimizing the cost of space missions, the micro-satellites have become a significant part of the space economy sector [1]. Despite the popularization of this, the cost of space missions is still high compared to ground-based tests. The solution to this problem is to take advantage of the technology of the thriving microsystems market [2]. Thus, it can be assumed that these industries will be inseparable in the coming years. In addition, for environmental reasons and the desire of companies to be environmentally responsible, passive components that do not require electrical power are attracting interest. This paper presents methods for optimizing the fluid mixing system for biological research performed in CubeSats – used among others in the BioSentinel mission [4]. It was assumed that the force generated by the rocket engines during the launch of the satellite into orbit could be used for this purpose. The fully passive mixing system proposed by us not only saves the space occupied by standard pumping equipment, but also reduces the energy requirements of the final satellite - which also makes it possible to reduce the size of the battery modules. The structure of the valves, as well as the mixing system, was made using 3D printing technology with biocompatible materials. The valves use capillary forces to hold the liquid in a dedicated reservoir until the rocket takes off. The force of the rocket launch is also the force that causes the liquid to be released from the valves. Microchannels made with 3D printing technology can take any shape, and the cost of making a single spatial structure does not depend on its complexity. To date, the design was tested using small experimental rockets (up to 3,000 meters), as well as simulations and ground tests, showing appropriate performance. In future works, other microchannels geometries and 3D printing materials will be verified as well. Currently, we are preparing the detection system to control the concentration of mixed liquids, based on optical transmission signal and conductometry. [1] Chantal Cappelletti and Daniel Robson, 2021 CubeSat Handbook. https://doi.org/10.1016/B978-0-12-817884-3.00002-3 [2] N. F. de Rooij et al., MEMS for space, TRANSDUCERS 2009 - 2009 International Solid-State Sensors, Actuators and Microsystems Conference, Denver, CO, USA, 2009, pp. 17-24, doi: 10.1109/SENSOR.2009.5285575. [4] Michael R. Padgen et al., 2021 Astrobiology https://doi.org/10.1089/ast.2020.2305