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3-D printed propulsion systems for small spacecraft

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The Propulsion Laboratory at Utah State University has recently developed a promising "green" alternative to hydrazine-based space propulsion systems. Additive manufacturing is an essential feature of this technology. Multiple vendors using well-developed commercial technologies can produce identical pieces simultaneously, resulting in a "virtual assembly line." This approach is ideal for supporting the small-to-intermediate volume production rates required for most Aerospace applications, and offers potential of improving component quality, consistency, and performance, while reducing development and production costs. Because additive manufacturing builds specimens one layer at a time, 3D-printed ABS possesses unique electrical breakdown properties that have been exploited to allow for rapid on-demand system ignition. The electrical breakdown property of 3-D printed acrylonitrile butadiene styrene (ABS) was discovered serendipitously while investigating the thermodynamic performance of ABS as a hybrid rocket fuel. On demand ignition has been demonstrated using nitrous oxide, gaseous oxygen, and hydrogen peroxide as oxidizers. This concept has been developed into a power-efficient system that can be started and restarted with a high degree of reliability. Multiple prototype devices based on this concept with thrust values ranging from 4.5 to 900 N have been developed and tested. All units are capable of multiple restarts and can be operated in either continuous or pulse modes. The GOX/ABS thruster has achieved specific impulse (I_{sp}) values in excess of 220 seconds under ambient operating conditions, and greater than 280 seconds under soft-vacuum conditions. This Isp value exceeds the hydrazine performance level by more than 20%.

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