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DEVELOPMENT AND TEST OF A FOLDABLE PROTECTION SYSTEM FOR A SMALL LANDING PROBE USING 3D-PRINTED METAL GRIDS AS SHOCK ABSORBER

Abstract

The exploration of our solar system has progressed continuously during the past decades. Here, especially the planets stood in the focus of investigation. Now, since many orbiters and landers were sent to those worlds, the focus has shifted to smaller bodies like comets, asteroids and smaller moons of the planets. All those objects have similarities with regard to their weak gravitational field and their absence of an atmosphere. Small landing probes in the range of less than 20kg therefore face the challenge of landing without the help of a parachute and possibly without propulsion system which would have a large mass impact.

A suitable technique for protecting a lander from the shock of impact is a crushable shell, which absorbs the kinetic energy at touchdown by plastic deformation of its core material. Past studies revealed the effectiveness of this method, which has also been used for the landing probe Schiaparelli of the ESA Trace Gas Orbiter. But landing probes like Schiaparelli rely on an active Guidance, Navigation Control (GNC) system to keep its right orientation, since the shell is only on the bottom side of the lander. A less complex and lightweight solution could be to cover all sides of the lander and omit the GNC and propulsion system completely.

The obvious challenge with this kind of design is the need for an unfolding mechanism which would remove the crushable shell elements from the lander body in order for the instruments and antennas to have a free and unobscured field of view.

Another innovative design concept is the use of 3D-printed metal grids instead of commonly used aluminum honeycombs as the primary shock absorbers. The advantage of the metal grids is the multi-directional energy absorption capability which is not given with the honeycomb. With this feature the lander can land in any inclination without losing crash performance.

In this paper we present and discuss the design, manufacturing process and breadboard testing of a small landing probe encapsulated in a crushable shell made out of 3D-printed metal grids.