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PORTABLE LUNAR SURFACE SHELTERS OF LIQUID METAL-TEXTILE COMPOSITES;
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Lunar surface exploration or manufacturing operations will require portable or temporary shelters which can easily be set up and disassembled by unmanned devices and which are adaptable to permanent use, if required. We suggest that liquid metal-textile composites (LMTC)[1] be further developed as construction materials for such shelters. LMTC consist of flexible, high strength, thermally durable, radiation-resistant metallic textiles[2] impregnated with low melting alloys, such as those of lead, tin, bismuth and indium. These composites in the liquid state are capable of being folded, packaged, and subsequently deployed by unmanned devices. They are also totally impermeable to gases[1], would self-seal to micrometeorite impact, would resist most high energy radiation and would not degrade in the vacuum and radiation lunar surface environment.

Consider as an example, an inflatable structure (Fig. 1) in the form of a Goldberg Prism[3], which has the minimal number of folds per unit volume of any polyhedron. It will have double walls comprised of two layers of LMTC sewn to a thin, thermally insulating layer of an organic elastomer, such as a silicone or fluorocarbon rubber. At the time of inflation both metal skins would be in the liquid state as delivered from the warmed interior of a lander, but after inflation (as from an integral pressurized air vessel in the base of the structure), the outer skin will solidify in the cold lunar environment and provide the structure with "sheet metal" rigidity. The inner metal skin would be kept liquid as a micrometeorite barrier through heat supplied by photovoltaic roof panels which would also provide storage energy to chemical batteries for use in heating and lighting the interior structure during the lunar night. The structure would readily refold under gravity for portability once its air was released and sufficient power supplied to "melt" the outer skin.

An equilateral Goldberg prism 9 feet on an edge would weigh about 68 lb.[4] if constructed of an alloy textile, such as Chromel R impregnated with Bi (41%), Pb (22%), Sn (11%), Cd (8%) and Ga (1%). Textiles, such as Chromel R maintain their high tensile properties through a temperature range of from -320°F to 500°F. Single small shelters of this type could be used as emergency accessories to mining or manufacturing operations on the planetary surface or they could be ganged to form a large modular colony.

It is apparent that foldable forms other than the Goldberg Prism would also be useful, as for example, large domes to be erected over craters. These structures would be man-erected and suitably braced, as major operations centers. If a crater were first smoothed mechanically and its interior sealed (as with silicone or epoxy resin) an LMTC canopy would make it habitable, without the large energy requirement needed for underground works.

References

(1) U. S. Patent 3,579,412 (1971), Fluid impervious barrier, including liquid metal alloy and method of making same, A. J. Bauman, NASA.

(2) Freeston, W. D. (1965), Flexible fibrous structural materials, Technical Report AFML-TR-65-118, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio.

(3) Goldberg, Michael (1966), personal communication.

(4) Weight, approximately 12 lb. on the lunar surface.

FIGURE 1 Goldberg Prism, open (A) and folded (B)