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IMPLICATIONS OF LUNAR VEHICLE WHEELS CREATED THROUGH 3D PRINTING OF AMORPHOUS METAL AND HIGH ENTROPY ALLOYS

Abstract

A major factor affecting the lifespan of lunar vehicles is the wear of vehicle structures due to the adhesive and abrasive lunar soil. Lunar regolith is composed of highly abrasive particles that are charged over centuries of exposure to ionic radiation from the sun. Apollo missions have shown that lunar dirt infiltrated sensitive equipment and was resistant to efforts to rid of lunar dirt.

These two factors will significantly degrade lunar vehicle wheels, which see the greatest contact and movement over this hazardous substance. Any coating of lunar wheels will wear off due to both significant solar radiation and accumulated exposure to lunar soil. At the same time, lunar wheels must provide sufficient structure to support the entirety of the vehicle's weight against potentially extreme terrain. This requirement is further exacerbated by the wheels' necessity to be porous to expel lunar dust from accumulating inside the wheel structure.

This paper proposes the use of 3D-printed amorphous metal alloys as the alternate solution for manufacturing lunar wheels. This research investigates a particular amorphous metal alloy "Attometal" as developed by Kolon Industries that are available for 3D printing manufacturing processes in the sizes required for a standard wheel.

Attometal is categorized as a high-entropy alloy (HEA) that has much higher strength performances and resistance against distortion even in extreme temperature profiles. The higher molecular density of HEA allows the lunar wheel to maintain its porous structure while improving its structural integrity and maintaining performance in the extreme temperature contrast of the lunar surface.

3D printing also allows for the building of unique wheel expressions that can operate sufficient traction in the soft lunar environment while minimizing soil buildup within the wheel subcomponents. The entirely 3D printable structure also ensures erosion resistance characteristics to the base material than relying on coating layers.