GOLD PLATING FOR LUNAR SOLAR PROTECTION AND TEMPERATURE CONTROL G. Zhou[1] and A. A. Mardon[2], [1]The University of British Columbia (Department of Civil Engineering, Vancouver, British Columbia, Canada, gordonz@interchange.ubc.ca) [2]Antarctic Institute of Canada (PO Box 1223, Station Main, Edmonton, Alberta, Canada T5B 2W4, aamardon@yahoo.ca).

Introduction: Gold plating can be used in space technology against radiation and for temperature control. On the lunar surface, astronauts will be exposed primarily to solar radiation from the sun. The sun has a peak radiation at shorter wavelengths at approximately 0.5 microns. In order to protect astronauts, scientists use gold plating to act as a reflector against temperature due to this radiation. Compared to 3 other feasible metals: aluminum, silver, and copper; gold is the better alternative in terms of protection. Although silver and aluminum would offer a superior reflective quality to visible light, these metals would chemically react to form sulphides and lose their reflective qualities. [1] Although being the most expensive material out of the rest, gold is still preferred for many space applications because of its versatility to be applied to many substrate materials. Unlike aluminum, it can only be applied to thermal evaporation or sputtering to substrate materials decreasing its feasibility by its lack of workability.

Two major techniques for the application of thin gold coating to organic and inorganic substrates have been heavily researched. The 'Liquid bright gold" method use complex gold compounds applied to organic solvents. The solution is sprayed through heavily controlled heating operations to ensure that the compound will decompose the organic material to form a film like reflector. An extension of this method is to add with an aliphatic amine with salt gold to form an aqueous solution. The advantage of this method is that it can be applied to a larger array of substrates and does not require heat treatment during the process. [2]

The cost of golden reflector film production must be cost feasible. Scientists have employed a method to achieve film thickness at minimal cost while giving the full reflective properties. It has been found that the effective thickness must be 1000 Angstroms consisting of approximately 2 grams of gold. This amount will cover one square meter costing about $2.50. [3] For the reflector of astronauts' space helmets, the film is about 500 Angstroms. The optical coating will reduce glare from sunlight while offering sufficient vision for space missions.

By acting as a reflector, the gold coating also acts as a passive temperature control application. This will contain heat, along with its low emission of radiant energy governed by this formula:

$$\mathbf{W = \varepsilon\sigma(T^4 - T_O^4)}$$

where:

W = Radiant flux
$\boldsymbol{\varepsilon}$ = Emissivity of the surface
$\boldsymbol{\sigma}$ = Stefan-Boltzman constant
T = absolute temperature of the surface
T_o = absolute temperature of the surroundings

Compared with oxidized Inconel that has a emissivity of 0.8, the value for gold is only at 0.05 which is comparatively lower. [4] This property can effectively control temperature such as in the fuel capsules at design temperature. During the Apollo mission, low emissivity gold coating was used for the pressure vessels of fuel cells to maintain constant temperature to keep hydrogen and oxygen at constant pressure. This is important as this is needed to have stable chemical reactions within these tanks.

Conclusion: The low emissivity and ability to be applied to many different substrates are properties of gold that enables it to be a good application for useful and feasible temperature control in space. Future manned missions should focus on further developments and research to develop a composite gold film with similar properties at a more effective and lower cost.

References:

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3. 4. Langley, R.C. (1975). Gold Films for the Control and Utilization of Radiant Energy. Newark, New Jersey: Engelhard Industries.

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