Polymer Aerogels for Lunar Survivability (PALS). S.L. Vivod[1] and M.R.Deminico[2], [1] NASA Glenn Research Center, 21000 Brookpark Rd, Cleveland OH 44135, Stephanie.L.Vivod@nasa.gov, [2] 1 NASA Glenn Research Center, 21000 Brookpark Rd, Cleveland OH 44135, mathew.r.deminico@nasa.gov

Introduction: Planetary colonization is part of the current mission critical focus within STMD and NASA's Deep Space Exploration Systems, specifically for Exploration Research and Development (ERD). This area is in need of far-reaching, innovative concepts and materials for the development of capabilities needed for human survival, exploration, and habitation of Moon and Mars. One such material would include polymer aerogels; lightweight solids with nano-scale pore size, high internal surface area, low thermal conductivity, and extremely high porosities. Due to these interesting properties, aerogels are ideal as thermal and acoustic insulators but also have the potential to combat issues such as dust and radiation mitigation.

Thermal Management: In order to maintain a sustained human presence on the Moon and eventually Mars, one of the greatest challenges will be protecting against the vast temperature gradient and subzero temperatures experienced during the long lunar night. With this in mind, NASA patented optically transparent polymer aerogels offer a solution to this problem in multiple ways. [1] These materials offer a unique capability to allow for passive radiative transfer to be able to heat a target much like a magnifying glass, while at the same time, the polymer aerogel structure acts as a thermal trap similar to a greenhouse. The unique aerogel properties create a tortuous pathway allowing for extremely low thermal conductivity (15 mW/m-K), in ambient conditions and even lower in a vacuum and at cryogenic temperatures. For the lunar surface, this multifunctional material could not only provide enhanced capability to survive the 2 week lunar night, but could also be utilized for concepts such as Martian terraforming, inflatable habitats, and MLI for lunar/Mars rovers and EVA suits (Fig 1.)

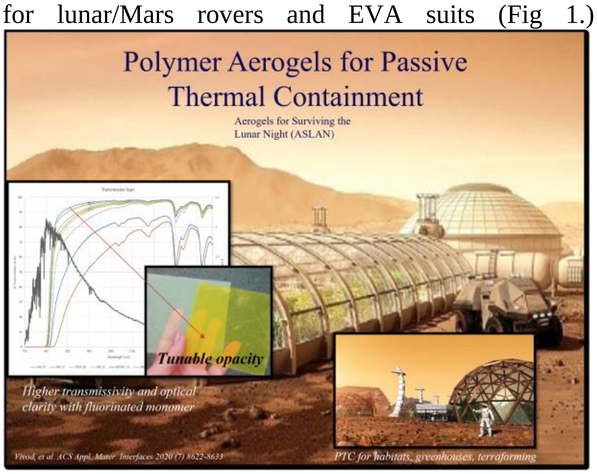

Figure 1. Optically transparent polymer aerogels

Radiation Mitigation: Additional areas of concern are exposure to space radiation which poses acute and chronic risks to crew health and safety, as well as limits the life-span of sensitive test equipment and flight hardware. A major technical challenge for future human exploration is to define the best way to mitigate exposure to unfiltered UVR. The development of a light-weight, low-density, thermally insulating multi-functional material with characteristics such as radiation resistance and robust structural integrity was achieved by creating an aerogel with a conformal coating of a radiation mitigating polymer (melanin) throughout its underlying matrix (Fig 2). [2]

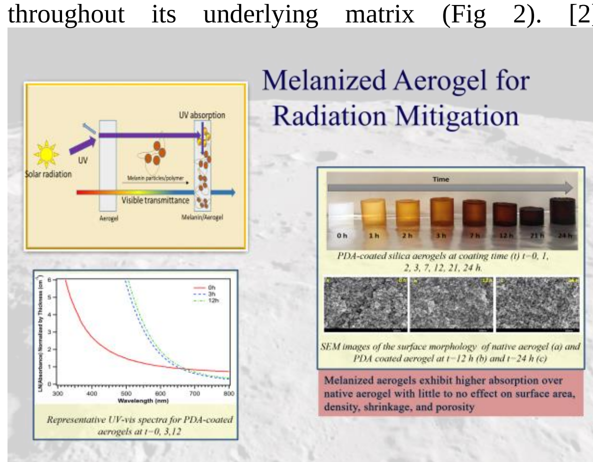

Fig 2. Radiation mitigating polymer aerogels

Robust, lightweight, radiation mitigating, impact resistant, thermally insulating aerogel structures may enable Grand Challenges in Economical Space Access, Space Colonization, Efficient In-Space Transportation and Surviving Extreme Space Environments.

Herein, multiple applications that address Lunar challenges will be discussed including 3D printing and ISRU.

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References:

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