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NANO-CELLULOSE APPLICATION IN THE RADIATION SHIELDING ARCHITECTURE

Abstract

This paper is based on the ongoing work that is being done as a Master Thesis from Architecture with a specialisation of Spatial Experiments on the faculty of Engineering at Lund University.

The study is motivated by the need to develop a novel system of protection against radiation for the 'surface' Lunar base, which would allow for more freedom in shaping the base structure. This paper discusses multiple approaches which were taken under consideration to achieve that, passive radiation shielding being one of them. For it's purpose the use of nano-cellulose is proposed. Together with the lunar regolith, In-Situ grown nano-cellulose membranes would create a composite system, based on the soil reinforcement principles. By the inclusion of short fibres, continuous strips or sheets within the soil mass it stabilises unstable slopes and helps to retain the soil on steep slopes and under crest loads. With the use of nano-cellulose to reinforce the lunar regolith mass it would be possible to build stable structure without using as much material.

Nano-cellulose is a light solid substance and has exceptional strength characteristics. It possesses the property of specific kinds of fluids or gels that are generally thick in normal conditions. It is lightweight, stiffer than Kevlar®, electrically conductive and non-toxic. It has very high tensile strength - 8 times that of steel. It might be translucent, which is a big asset when considering the introduction of the natural light to the habitat. Also, it has better radiation protection properties than regolith. It was already tested on Kombucha Multimicrobial Cellulose-Forming, on the surface of the ISS, with a conclusion that biofilm-forming microbial communities can survive in harsh environments. They display greatly increased resistance to physical and chemical adverse conditions. It is considered as an alternative to carbon fibre and glass fibre for some applications.

The other, parallel approach, is configuration optimisation. The paper discusses how to combine the ergonomy of the habitat with the protection against the radiation. Compromise is needed to achieve desired uniform shielding thickness. Utilisation of higher in density and in hydrogen content subsystems, as well as logistics around shelter can further reduce the parasitic mass.

Pressurized parts of the habitat, together with the 'cellulose production module' would be self-deployable, using the Miura-Ori origami fold. The whole system of constructing the base would only need robotic operations to be fully settled (to gather and assemble regolith layers).