IAF SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems (1)

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ASTROPLASTIC: FROM COLON TO COLONY

Abstract

Governments and private enterprises alike are preparing for exploration and colonization of Mars. Two ecological and economical challenges to interplanetary travel arise: the sustainable management of waste

produced on a Mars base and the astronomical cost of shipping materials to Mars. The purpose of the Astroplastic project is to mitigate these two challenges through a waste management system which can generate bioplastic as a usable end product.

Our team used recombinant *E. coli* (expressing genes from *Ralstonia eutropha* and *Pseudomonas aeruginosa*) to turn human waste into poly(3-hydroxybutyrate) (PHB), a bioplastic. Our engineered *E. coli* have also been modified to secrete the PHB they produce. Secretion makes the PHB production process continuous rather than a batch process, leading to improved efficiency and yields. In addition to engineering the bacteria, we have also designed a start-to-finish integrated system that can be used in space to generate items useful to astronauts during early Mars missions. Our system complies with current standards and best practices for designing space systems. In our design, we have included specifications for bioreactors and fermentation tanks, processes for separating various components of the human waste so that PHB can be isolated, and a method for the final extraction of powdered PHB nanoparticles for use in 3D printing. The byproducts of this system are water and excess organic matter which can be used as a fertilizer.

The preliminary results of our project are promising: we have observed successful PHB production and secretion with our recombinant *E. coli* and have tested our process at the lab scale using synthetic human waste. Further testing and prototyping are needed to confirm these lab results.

Based on our preliminary results, the Astroplastic project has the potential to be a viable waste management system and reduce the costs associated with long-term space missions.