IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

Author: Mr. Kinston Wong
University of Alberta, Canada, kinston@ualberta.ca

Ms. Aleeza Batool
University of Alberta, Canada, batool@ualberta.ca
Mr. Evans Frandsen
University of Alberta, Canada, frandsen@ualberta.ca
Mr. George Kajaleme
University of Alberta, Canada, kajaleme@ualberta.ca
Mr. Justin Van Engelen
University of Alberta, Canada, jvanenge@ualberta.ca
Mr. Troy Coward
University of Alberta, Canada, tcoward@ualberta.ca
Mr. Ryan Bererton
University of Alberta, Canada, rbererto@ualberta.ca

LIQUID–SOLID INTERFACE AND PENETRATION OF ORGANIC RESIN BINDER AND IRON-COBALT ALLOY POWDER FOR THE USE OF BINDER JETTING ADDITIVE MANUFACTURING UNDER MICROGRAVITY

Abstract

Additive manufacturing is still very recent in space exploration; with successful research and technological advancement, it could prove very useful for long-duration flights such as life on mars and long operations on the lunar surface. Metal 3D printing of aluminium, titanium, nickel and steel alloys is needed on space missions. Especially, the advantage of prototyping and rapidly printing complex geometries on-demand render it a valuable technology in space.

Recent studies on powder-bed-based Mobile Selective Laser Melting (M-SLM) have been done on Einstein-Elevator as the first experiment under lunar gravity and microgravity worldwide that proved that the powder bed is functional. While M-SLM works well in the previous study, the laser and vacuum environment requirement shows other safety issues, and it is only metal and ceramic-friendly. Thus, the research team has selected a similar but safer binder jetting technology for this project. Binder jetting is compatible with various materials, including sand, metals, ceramics, and even sugar. The printing is done by inkjet deposition of the binder onto the powder bed, which allows the environment to stay near room temperature.

Flying aboard the Canadian Space Agency's Falcon-20 parabolic aircraft in summer 2022, this experiment will evaluate the liquid-solid interface and penetration of 2-butoxyethanol, an organic resin binder, an iron-cobalt alloy powder, a soft ferromagnetic material that is often used for rotor and stator lamination for motors and generators in aerospace power units, with various jetting speed under microgravity. The difference in fluid mechanics and surfaces interactions in microgravity are prompted to have their own characteristics on the print quality.

The experiment is done on a modified fused filament fabrication based 3D printer with a custom piezoelectric print head. A set amount of binder will be jetted to a set thickness of powder with a similar powder size for each experiment with different jetting speeds. Each jetting speed will be its experimental

group. Each experimental group and one in-flight control group will be processed while exposed to microgravity during parabolic cycles. Each experimental group and one control group will be left on the surface and will not be exposed to any changes in gravity.

By observing samples after printing in microgravity for their binder penetration, distribution, homogeneity, and capillary bridge formations, surface morphology, and grain packing porosity, this paper aims to provide and define some input setting requirements and data for future exploration of binder jetting additive manufacturing under microgravity.