2019 IRTD Final Report Summary

IRTD Proposal FY17: Flammability and Corrosion Testing of Lightweight Magnesium Alloys for Mass Reduction and Radiation Mitigation in Spacecraft Applications

PI: M. Clara Wright, Dr. Eliza Montgomery, Dr. Michele V. Manuel

Executive Summary
This project tested the flammability and corrosion resistance of various commercially-available Mg alloys compared to conventional aerospace metallic alloys to determine potential usage in space as secondary structure or other non-structural, non-fracture critical spacecraft hardware. Additionally, development of Mg-Li alloys was investigated as part of the project. These Mg alloys have the potential to reduce weight thereby producing upmass savings for flight hardware. The corrosion and flammability testing showed that there are surface treatments and alloying elements, particularly rare earths, which are favorable for space use. For corrosion resistance, even in the most severe of environments, there were treatments that performed favorable. Flammability testing provided substantive data that payload or flight hardware developers can use if they wish to use either of those alloys in their designs. One limitation that needs to be overcome for the low production rate of flight hardware (and is often encountered regardless of material or process) is the turnaround time for performing surface finishing on Mg samples. It is the hope of the investigators that apparent limitations for NASA use of Mg alloys based on unknown material properties are overcome by this project and similar projects in the future.

*****

IRTD Proposal FY18: Modular Damage Detection System (MDDS) Project

PI: Mark Lewis

Executive Summary
Millions of naturally occurring objects (micrometeoroids) and made-made debris can be encountered during a space mission. NASA has identified potential damage from micrometeoroid and orbital debris (MMOD) impacts as a primary threat to Commercial Crew Program vehicles. The International Space Station (ISS) and extraterrestrial habitats also exhibit the risk of damage caused by MMODs.

Safety of the crew has always been a significant concern for NASA. Currently, no integrated in-situ or real-time health monitoring damage detection system is being used for expandable and inflatable structures. The Modular Damage Detection System (MDDS) expands on previously demonstrated and NASA-patented Flat Surface Damage Detection System (FSDDS) and Flexible Damage Detection System (Flex-DDS) capabilities and technologies. MDDS incorporates interchangeable and replaceable sensory panels in a foldable architecture. The sensory system is an intelligent damage detection “skin” that could be embedded into or added to structures, providing a lightweight in-situ health monitoring capability for space or aircraft vehicles, and for expandable, deployable structures. The design implements technologies that provide for

situational awareness, self-configuration, and damage detection and localization. MDDS has application for the new Gateway and surface and ground support infrastructure.

In FY18/19, the MDDS Independent Research and Technology Development (IR&TD) funded project met its objectives. The team successfully designed and fabricated a modular, interchangeable, tile-like Sensory Panel system. In addition, a flexible and expandable architecture was developed that supports one or more of these Sensory Panels. Algorithms that provide for situational awareness, self-configuration, and damage detection were developed. An iPad application (app) was created for users to interact, control, and monitor the system wirelessly using Bluetooth technology. Four foldable architectural approaches were conceptualized for use in inflatable and expandable applications. A new technology report and technical conference paper were authored. Additional engineering documentation, such as a concept of operations, an interface control document, and electrical schematic and drawings, were generated.

*****

IRTD Proposal FY18: Sodium Removal from Waste Brines to Generate Plant Fertilizer

PI: Ray Wheeler

<u>Executive Summary</u>

A thermal swing process to separate NaCl from other salts in wastewater for use as plant fertilizer was examined. The initial proof of concept tests showed that the thermal swing process is a promising approach for NaCl reduction from wastewater. Several tasks have been planned for further development:

(1) To improve the product purity, better process control is needed. This can be achieved by considering ion interactions (common ion effect) to improve the process modeling.
(2) To improve the total product recovery, the hot filtration setup should be further modified to reduce mass loss (water loss through vapor under vacuum and salt loss associated with the water loss).
(3) Conduct the proof of concept tests using a more realistic brine analog.

In order to control the process parameters more preciously and reproducibly, it would be beneficial to use an automated test stand that is capable of thermal control and mass transfer tasks. The initial temperature control testing is completed, while some functional testing is undergoing and yet to be completed.