Paper ID: 51283
oral

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Robotic/Thermal/Fluidic Systems (7)

Author: Mrs. M Clara Wright
National Aeronautics and Space Administration (NASA), United States

Ms. Elizabeth Barrios
University of Central Florida (UCF), United States

WHY DID NASA LIMIT THE USE OF MAGNESIUM? FLAMMABILITY AND CORROSION TESTING OF LIGHTWEIGHT MAGNESIUM ALLOYS FOR SPACE FLIGHT HARDWARE APPLICATIONS

Abstract

Magnesium (Mg) alloys are some of the lightest metals used in myriad applications across various industries such as automotive, medical, electronics, and aeronautics, yet have not been able to be adopted extensively in aerospace, particularly NASA, applications. Given that magnesium has 2/3 the density of aluminum (Al) and similar specific thickness, Mg components can either provide lightweighting of a subsystem or enhance part stiffness by using a thicker part at a similar weight. An extensive literature search was carried out to determine when Mg alloys were used for NASA missions and a clear reason for the current lack of use. The authors additionally consulted with NASA Materials and Processes (MP) subject matter experts, including the NASA-STD-6016 (Standard Materials and Processes Requirements for Spacecraft) primary author and the NASA Engineering Safety Center (NESC) MP Technical Fellow, to determine the origin of apparent restrictions on Mg alloy use for spacecraft design. In asking these and many other agency technical experts, the (incorrect) beliefs that Mg alloys have not been adopted for aerospace use included flammability, corrosion, and fatigue life but there was no historical data to point towards the advantages or disadvantages of their use. Although advances in surface treatments and alloying additions are paving the way for adoption of Mg use in other industries, aerospace seems to fluctuate in its use. In fact, it appeared that the limited amount of data available in NASA databases for very specific NASA requirements might be the reason why a designer looking to use Mg alloys would be hindered. Information on corrosion behavior, stress corrosion cracking (SCC), flammability in high oxygen environments, and statistically-developed mechanical properties is needed. It became clear that Mg alloys, specifically those alloyed with rare earth metals which provide some beneficial characteristics, need a revamp in NASA test data to better represent current technologies. This talk will delve into NASA testing of commercially-available Mg alloys and discuss specific results including flammability behavior in 24.1 percent O2 environment, and corrosion behavior in both the marine atmosphere at the Kennedy Space Center (KSC) and during accelerated corrosion exposure using an intermittent seawater spray test, a capability unique to KSC's Beachside Atmospheric Corrosion Test Site. The results will show candidate surface treatments for corrosion protection of flight hardware and which alloys are favorable for spacecraft habitable volume.