IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Facilities and Operations of Microgravity Experiments (5)

Author: Dr. Jan Walter Schroeder
CisLunar Industries, Germany, walter@cislunarindustries.com

Dr. Abdoul-Aziz Bogno
CisLunar Industries, Luxembourg , aziz@cislunarindustries.com
Mr. Gary Calnan
CisLunar Industries, United States, gary.calnan@cislunarindustries.com
Mr. Toby Mould
CisLunar Industries, United Kingdom, toby.mould@cislunarindustries.com
Mr. Kai Staats
International Space University, United States, kai.staats@community.isunet.edu
Mr. Romain Pecher
CisLunar Industries, Belgium, romain@cislunarindustries.com

THE SPACE FOUNDRY LAB MODULE ON THE ISS: A COMMERCIAL AND UPGRADED ELECTROMAGNETIC LEVITATION FURNACE FOR METAL RESEARCH IN SPACE

Abstract

CisLunar Industries is building a commercial microgravity furnace called the Space Foundry Lab Module (SFLM) that will be hosted on the Bartolomeo external platform on the International Space Station (ISS). The SFLM will be able to melt metal, produce metal parts, create novel alloys, and offer these capabilities to customers on a commercial basis for metallurgical research and production. This work discusses the capabilities of the furnace and presents key findings of the design process. Most of the useful metals are produced from a partially or fully melted sample. The transformation of the sample from liquid state into solid state, termed solidification, is characterized by heat and mass transport, which influences the metal formation and its resultant properties. Indeed, the conditions of heat and mass transport in the melt play a very important role in the solidification macro- and microstructures. For Earth-based metal production, the transport of heat and mass is usually affected by gravity driven convection. In addition, the crystal growth in the bulk liquid is also affected by sedimentation or floatation and hydrostatic pressure. A microgravity environment significantly reduces convection, removes sedimentation and suppresses hydrostatic pressure. By reducing these gravity-related sources of heat and mass transport, microgravity leads to a homogeneous microstructure and isotropic mechanical properties of the metal. The cost of access to space currently being very high, commercial benefits from space provided microgravity results typically from relatively small experimentation on spacecraft or on the ISS which lead to change in the Earth-based processes rather than in large-scale manufacturing in space environment. In order to improve this situation, CisLunar Industries, is developing a microgravity furnace with an in-space metal processing, refining capability to produce raw materials for on-orbit utilization so that sustainable and commercially viable orbital manufacturing can be achieved. An electromagnetic levitation type furnace is designed using 1,600 Watts of induction power supplied by the Airbus Bartolomeo platform on which it is hosted. The furnace design is based on the TEMPUS, where the melt specimen is placed into a superposition of a quadrupole and a dipole field. The quadrupole field serving as positioning and the dipole field for heating. Melting is designed to be achieved in a smart approach, considering the lack of heat convection in space. Conduction and radiation are going to be used efficiently in the furnace

operation to achieve required melt temperatures. The furnace is robotically enabled and is minimum to maintenance-free.