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Facilities and Operations of Microgravity Experiments (5)

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TRANSPARENT ALLOYS, A MULTI-USE FACILITY FOR DIRECTIONAL SOLIDIFICATION EXPERIMENTS IN ISS

Abstract

As part of the ELIPS Program, the ultimate goal of the Transparent Alloys development is to establish a smart, scientific space instrument, suited to host various experiments in the field of material science. More precisely, the Transparent Alloys facility will enable in-situ monitoring of the dynamics of physical processes during controlled directional solidification under microgravity conditions. The instrument is designed to be operated on board of the International Space Station (ISS), accommodated inside the Microgravity Science Glovebox (MSG) host facility. Five groups of European scientists will use the Transparent Alloys facility to test different transparent model materials. This multi-user aspect was the main challenge for the design of the facility as most of the parameters were variable: different quantities of experiment material, specific optical requirements and a large temperature range from -10C up to +250C. Furthermore, some of the experiment materials require 3 levels of containment for safety reasons.

The core elements of the Transparent Alloy facility are the experiment cartridges of flat, rectangular shape. They consist of fused quartz glasses, sealed between stainless steel end parts and resistant to a combination of internal stresses due to phase changes and high local thermal gradients.

A complex exchange mechanism will ensure that a cartridge can be safely inserted and removed from the Transparent Alloys experiment unit, while maintaining 3 levels of containment. During the experiment, the cartridge is pulled through a Bridgman assembly at variable speeds. The hot zone will induce melting while the cold zone will induce re-solidification. Two observation cameras can observe the cartridge between the hot and cold zone of the Bridgman assembly. The perpendicular camera can focus on the full field of view and the second camera makes high resolution images under an inclination of about 45. A dedicated electronic box will ensure facility control; e.g. control of the 11 different motors, temperature settings, vapour sensor operation and data control. During initialization, downlink is foreseen for adjustment of the settings. The bulk of the microscopic images will be stored for download afterwards. The results of the transparent model materials will be compared with ground-based experiments and related to metallic substances. As support to the casting industry, numerical models will be validated and improved to reduce scrap rates and improve product quality.