

IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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SOLIDIFICATION RESEARCH ON DIFFERENT MICROGRAVITY PLATFORMS

Abstract

The properties of materials strongly depend on their microstructure that forms during solidification from the molten state and from subsequent processing steps. Understanding and controlling the complex interplay between technical processing of the raw material, microstructure formation and final properties is of tremendous interest for alloy and process design to master the quality and performance of a wide range of materials for different applications. In addition, improved knowledge is achieved by an increasing number of integrated numerical modeling approaches, which model the solidification process from the atomistic to the macroscopic scale or along the processing route. Material selection and processing conditions are key factors for microstructure formation in classical casting technologies, as well as for additive manufacturing by controlling, among others, heat and mass transfer during solidification. Gravity often complicates the solidification process by phenomena mainly related to additional buoyancy driven convection. Microgravity is thus a unique environment to study microstructure formation under conditions of diffusive transport for heat and mass, without sedimentation, floatation and metallostatic pressure. Under these simplified and well-defined conditions, generic solidification phenomena can be studied experimentally to provide benchmarks for numerical modeling. We present examples for microgravity experimentation on different platforms (parabolic flights, sounding rockets, ISS) focusing on different aspects and materials like the columnar to equiaxed transition in grain growth, the influence of intermetallic particles on flow effects in aluminum alloys and on in-situ observation techniques in both metallic and organic alloys. These examples mostly involve international cooperation in the framework of several ESA-programs.