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

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MATERIAL PHYSICS ROCKET MAPHEUS: DEVELOPMENT, LAUNCH AND RESEARCH

Abstract

Microgravity research rockets provide a cost- and time-efficient platform for experiments in the field of material physics. MAPHEUS (Materialphysikalische Experimente unter Schwerelosigkeit, Material Physics Experiments under Microgravity Conditions), a DLR programme under the lead of the DLR Institute of Space Systems, conducts annual launches of scientific payloads solely dedicated to materials science studies. The experiments are designed and built by the DLR Institute of Materials Physics in Space. The Mobile Rocket Base (MORABA) of DLR is, together with Esrange Space Center of SSC, responsible for launch operations and the provision of rocket systems, comprising a service-, rate control-, and recovery system. Launches take place at Esrange Space Center in Kiruna, Sweden.

Following the maiden flight of MAPHEUS-1 in May 2009, MAPHEUS-2 lifted off successfully on 27 October 2010 and MAPHEUS-3 will be launched in June 2012. Propelled by a two-stage Nike/Improved-Orion motor combination, MAPHEUS offers more than three minutes of less than 10^{-4} g as ensured by the MORABA-built rate control system. MAPHEUS-4 is scheduled for late autumn 2012, with a new S30 motor configuration for increased microgravity time.

The investigated physical phenomena on MAPHEUS-3 include atomic transport processes in liquid Al-based alloys with the ultimate goal of determining diffusion coefficients (ATLAS-M experiment); the miscibility, miscibility gaps and demixing in Cu-based metallic alloys during controlled cooling (DEMIX-M experiment); and the behaviour of magnetically-excited granular matter (MeGraMa-M experiment). MAPHEUS-3 further contains a high temperature shear cell oven for interdiffusion studies (SCID-M experiment) to be integrated into an X-ray radiography instrument on MAPHEUS-4.

Within the programme, flights on a yearly basis and the ability to fly an experiment with different sample compositions on more than one flight opportunity ensure a wealth of scientific results. Experimental challenges on MAPHEUS include the high temperatures and therefore high power required for phase changes in metallic alloys, the setup of furnaces for fast melting of metallic samples and the gas-cooling of samples towards solidification.

The scope of scientific experiments on MAPHEUS is presented, referring also to their scientific results. In addition, the flight of MAPHEUS-3 is discussed based on data of the performance of various rocket systems. An outlook on the setup and experiments of MAPHEUS-4 is given.