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Author: Dr. Florian Kargl
Deutsches Zentrum fuer Luft- und Raumfahrt (DLR), Germany, florian.kargl@dlr.de

S. Klein
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, *(email is not specified)*
Prof. Andreas Meyer
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, andreas.meyer@dlr.de

X-RISE: X-RAY INVESTIGATIONS UNDER SPACE ENVIRONMENT

Abstract

The advent of powerful and compact microfocus X-ray sources and improvements in flat-panel detector technology made in-situ investigations of material physics processes possible not only at synchrotron X-ray sources but also in the laboratory, aboard parabolic flights, and on-board of sounding rockets. To this end, first X-ray radiography (XRR) experiments were carried out within the ESA-MAP project XRMON using modules built by Swedish Space Corporation aboard parabolic flights and the sounding rockets MAXUS and MASER. Processes previously inaccessible to the experimenter's eye were observed. The experiments showed XRR also needs to be further developed for platforms offering longer microgravity times.

To this end, we initiated the development of a compact and light-weighted XRR-insert, which is fully compatible with the Materials Science Laboratory (MSL) facility within the Materials Science Research Rack (MSRR) aboard the International Space Station (ISS) [1]. This facility was custom-built by Astrium Space Technology GmbH, Friedrichshafen, and partners and delivered to us in 2009. It has been extensively tested since then and novel cartridge based inserts have been developed for materials science studies. Further, it has been developed by us into a parabolic flight facility (X-RISE – X-ray Investigations under Space Environment [2]) and a module (MIDAS-M – Monitoring InterDiffusion in Alloys and Semiconductors) for the DLR sounding rocket MAPHEUS. X-RISE recently became the umbrella for all our X-ray activities with the aim to make such a facility readily available for research aboard the ISS.

Results are presented of recent XRR experiments on diffusion, solidification, and granular dynamics. The research carried out aboard parabolic flights in April 2013 and the sounding rocket MAPHEUS is discussed in comparison to extensive ground-based research. It is shown, that X-RISE now offers a frequent-flyer XRR-facility for parabolic flights and MAPHEUS. The following experiment inserts are currently available with the developer shown in brackets: i) compact X-ray transparent linear shear-cell for diffusion studies (DLR) [3], isothermal furnace for studies of solidification (DLR) [4], high-gradient furnace for solidification studies (Astrium), and a granular flow-cell for studies of granular dynamics (DLR).

References:

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