Future Facilities for In-Situ Observation of Solidification Processes

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Introduction:

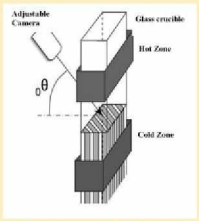
Within the **ELIPS** (European Programme for Life and Physical Science) Programme of the **European Space Agency** two facilities are currently planned to support in-situ observation of solidification processes: **DIRSOL** and **XRMON**.

Directional Solidification Facility (DIRSOL)

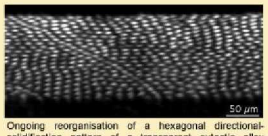
- Directional Solidification Experiments of Bridgman Type with transparent alloy model substances
- Diagnostics by optical observation at high resolution

Scientific Objectives:

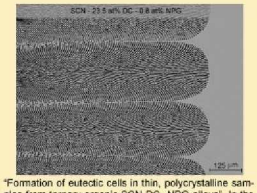
- to study and gain deeper understanding of
  - the pattern formation and instabilities during solidification of multiphase alloys along a eutectic path
  - the columnar to Equiaxed transition (CET)
  - peritectic reactions



Experimental set-up at INSP, Paris
Courtesy: INSP



Ongoing reorganisation of a hexagonal directional-solidification pattern of a transparent eutectic alloy (succinonitrile-d,camphor). Oblique view in dark filed (the eutectic crystal phase that forms fibers is lit). Growth direction upward.
Courtesy: INSP



"Formation of eutectic cells in thin, polycrystalline samples from ternary organic SCN-DC- NPG alloys". In the presence of a third alloying element (NPG) the eutectic solid / liquid interface, composed of SCN and DC growing from the liquid, is constitutionally supercooled and subject to a complex sequence of instabilities that lead to cell formation.
SCN: Succinonitrile, DC: D-Camphor, NPG: Neopentylglycol
Courtesy: ACCESS e.V.

"Columnar-Equiaxed-Transition in Neopentylglycol-Camphor". In the figure you see the columnar front, the first occurrence of equiaxed dendrites and on the left-part the front of a solid-state transformation.
Courtesy: L2MP, ACCESS

- Accommodation: in MSG (Microgravity Science Glovebox) on board the ISS
- In Phase B (readiness for launch 2010)

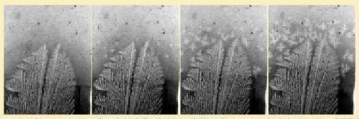
X-Ray Monitoring of Advanced Metallurgical Processes (XRMON)

- Directional Solidification Experiments of Bridgman type of metallic alloys
- monitoring by state-of-the-art in-situ X-ray radiography

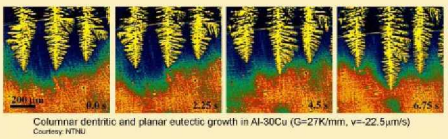
Scientific Objectives:

- To study and gain deeper understanding of
  - columnar to Equiaxed dendritic growth
  - morphological instabilities of ternary alloys
  - particle pushing at cellular and dendritic interfaces in metal matrix composites
  - unconstrained growth
  - macrosegregation

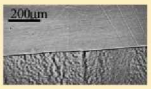
of Al-based samples



Sequence of images of refined Al-3.5wt%Ni solidification, recorded during the CET induced by a sharp pulling rate jump (1.5 to 15µm/s) by synchrotron X-ray radiography. The solid mainly constituted of aluminium appears in grey while Ni enriched liquid is dark.
Courtesy: L2MP



Columnar dentritic and planar eutectic growth in Al-30Cu (G=27K/mm, v=-22.5µm/s)
Courtesy: NTNU



Planar eutectic solidification growth in Al-30Cu (G=46K/mm, v=6.4µm/s)
Courtesy: NTNU

- Accommodation: to be planned as a frequent flyer on up-coming parabolic flights and sounding rocket missions
- Launch in spring 2009

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