Mesoscale Priority Research Direction

In-situ Monitoring of Dynamic Phenomena during Phase Transformations

Opportunity

The creation of microstructures by design with application-tailored properties requires directed synthesis and processing

In-situ monitoring of phase transformations at elevated temperatures will result in the validation and advancement of theories

Approach

In-situ monitoring and control of dynamic phenomena during phase transformations (liquid-solid and solid-solid) using synchrotron x-ray and proton radiography and tomography

Mesoscale modeling of microstructure evolution coupled with in-situ monitoring for feed-forward process control

Meso Challenge

Major challenges include: high spatial resolution (~1 micron) and the ability to analyze bulk and/or high density materials in real-time

Scientific advances include: understanding dynamic phenomena during solidification and phase transformations, coarsening, and microstructure evolution

Impact

In-situ monitoring of dynamic phenomena during solidification and phase transformation processing, with high spatial resolution and in bulk materials, will result in the ability to create microstructures by design with tailored properties

Preliminary experiments are underway at APS and LANL

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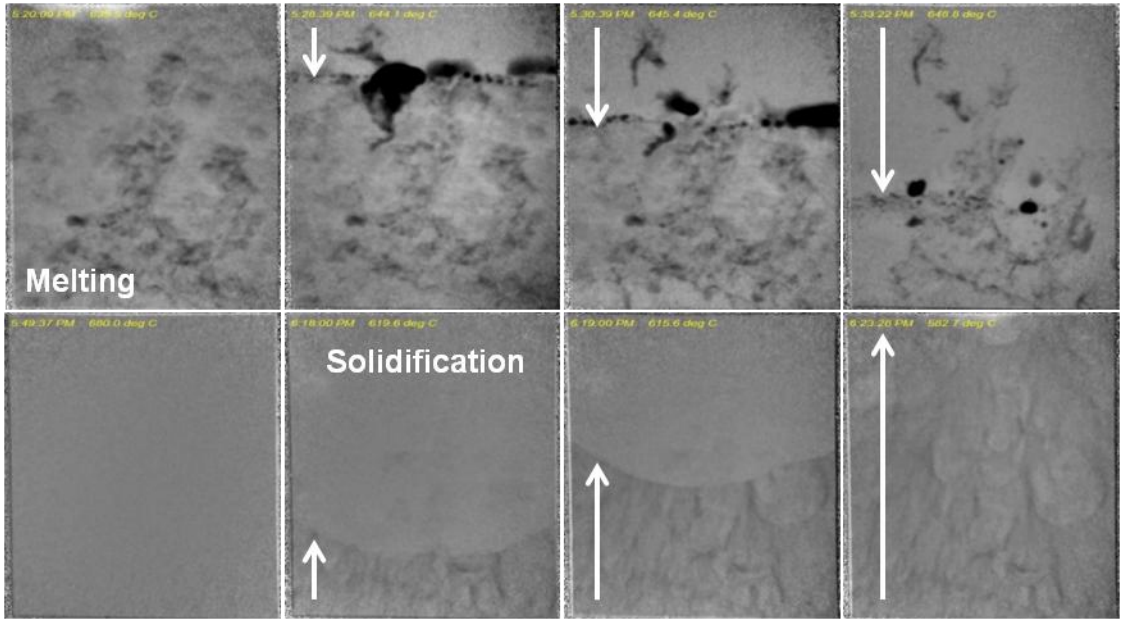
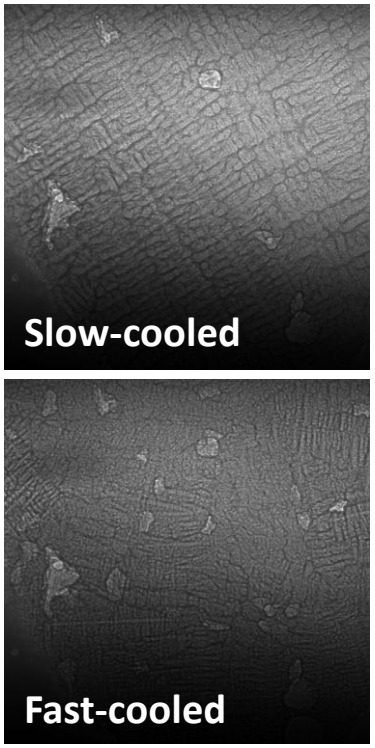
Proton radiography:



Al-In, 6 mm thick, nominally a 44 x 44 mm^2 field of view (August 2011)

Microstructure relevant sampling:
Spatial and temporal resolution, field of view, sample size…

Synchrotron x-ray radiography:



Al-Cu, 100 microns thick, nominally a 1. 4 x 1.4 mm^2 field of view (December 2011)

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