Preliminary In Situ and Real Time Study of Directional Solidification of Metallic Alloys by X-Ray Imaging Techniques

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Material properties strongly depend on the microstructure left in the solid during processing. Directional solidification is one major technique frequently used to control the processing of the material. Depending of control parameters, microstructures could appear at solid – liquid interface during directional solidification of binary alloys. The origin of this microstructure is the constitutional supercooling in the liquid [1, 2]. The transition from the planar to the cellular structure is established by linear stability analysis of solid-liquid interface by Mullins and Sekerka [3]. However, a better knowledge of development of microstructures is necessary for the control of quality of the material. One major difficulty for this study is in real time and in situ observation of the interface, especially for metallic alloys. A possibility is to use powerful and coherent X - Ray source of 3rd generation (ESRF).
By using different techniques of X-Ray imaging (absorption, phase contrast and topography), we studied directional melting, thermal stabilisation then solidification of aluminium-based alloys (figure). First results in ESRF show the high potential of these experimental tools for dynamical study of solid-liquid interface on metallic systems.

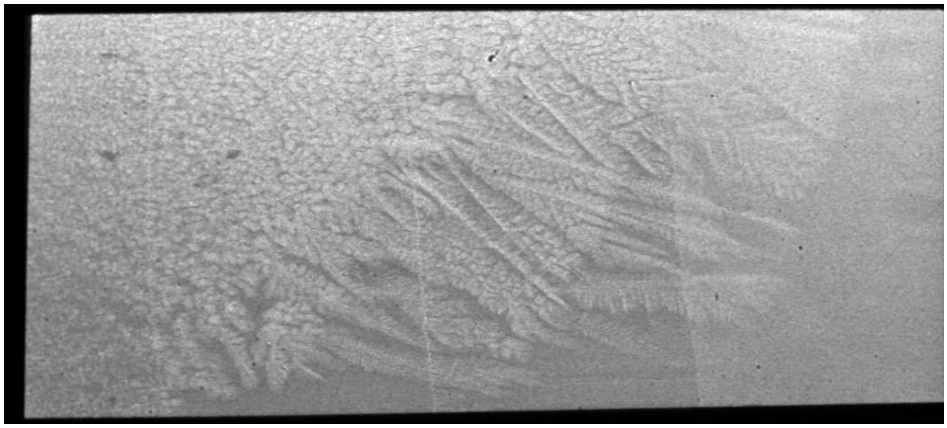

Figure: Picture of solidification microstructures of Al-5.7 wt%Ni alloy (V= 4.4 μm / s) obtained by absorption and phase contrast radiography

References

[1] - J.W. Rutter, et B. Chalmers, *Canad. J. Phys.* **31** (1953) 15
[2] - W.A. Tiller et al. *Acta. Met.* 1 (1953) 428
[3] – W.W. Mullins et R.F. Sekerka, *J. Appl. Phys.* **35** (1964) 444