Solidification Analysis of an Al-19 Pct Si Alloy Using In-Situ Neutron Diffraction

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In-situ neutron diffraction and thermal analysis techniques were used simultaneously to evaluate the kinetics of the nonequilibrium solidification process of an Al-19 pct Si binary alloy. Feasibility studies concerning the application of neutron diffraction for advanced solidification analysis were undertaken to explore its potential for high resolution phase analysis coupled with fraction solid/liquid analysis of phase constituents.

Neutron diffraction patterns were collected in a stepwise mode during solidification between 983 K and 793 K (710°C and 520°C). The variation of intensity of the diffraction peaks was analyzed and compared to the results of conventional cooling curve analysis.

Neutron diffraction was capable of detecting nucleation of the Si phase (primary and eutectic), as well as the Al phase during Al-Si eutectic nucleation. Moreover, neutron diffraction indicated the possibility of detecting the presence of Si peaks at near liquidus temperature and premature nucleation of a-Al prior to Al-Si eutectic temperature.

The solid and liquid volume fractions were determined based on the change of intensity of neutron diffraction peaks over the solidification interval. Overall, the volume fraction determined was in good agreement with the results of the cooling curve thermal analysis, as well as calculations using the FactSage software.

The potential of neutron diffraction for high resolution melt analysis required for advanced studies of grain refining, eutectic modification, etc. was illustrated. This study will help us better understand the solidification mechanism of Al-Si alloys used for various casting component applications.

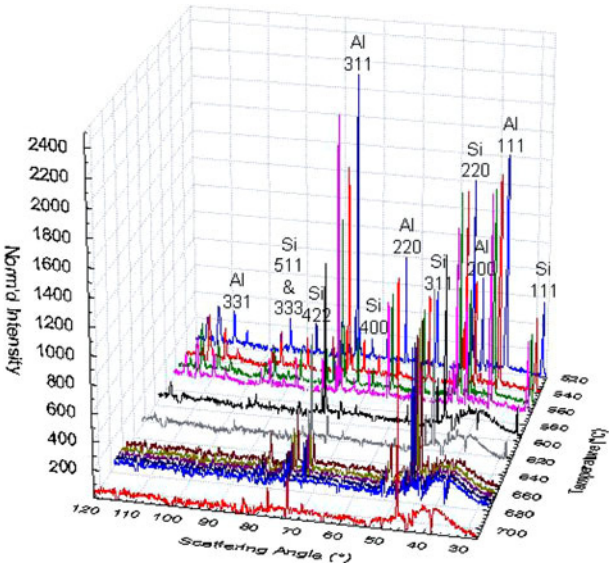

Fig. 1 Neutron diffraction pattern of the Al-19 pct Si binary alloy solidification process collected at various temperatures, ranging from 983 K (710 °C) (38 K above the equilibrium liquidus temperature) to 793 K (520 °C) (23 K below the solidus temperature). Note that the wavelength employed in the experiments was 0.154 nm.

Reference

[1] W. Kasprzak, D. Sediako, M. Walker, M. Sahoo, and I. Swainson. Solidification Analysis of an Al-19 Pct Si Alloy Using In-Situ Neutron Diffraction. Metallurgical And Materials Transactions A. (2011) 42A: 1854-1862