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APPLICATION OF SYNCHROTRON-BASED X-RAY PHOTOELECTRON SPECTROSCOPY IN COMPOSITIONAL ANALYSIS OF RAPIDLY SOLIDIFIED AL ALLOYS

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Rapid development of third-generation synchrotron radiation light sources around the world has been promoted the progress in the field of condensed matter physics. In particular, scanning photoelectron microscopy (SPEM) utilizes photoelectron spectroscopy for characterization of heterogeneous materials with probing depth up to a few nanometers, providing information about the morphology and chemical composition of the surface and subsurface regions at submicrometer length scales [1]. Therefore, this powerful technique is considered to be particularly important in the study of nanoscale precipitation processes in solids. In this respect, SPEM can yield quantitative insight into the evolution of various microstructures resulted from non-equilibrium solidification of metastable solids produced at exceptionally high cooling rates by means of rapid solidification. This fact enhances significantly the potential of such synchrotron-based investigations on rapidly solidified aluminium alloys where the segregation of alloying elements [2] depends on the composition and microstructure at sub-mm scales.

The purpose of our work is to report a brief review of recent application of SPEM in the compositional analysis of rapidly solidified Al-Ti and Al-V alloys produced by the centrifugal melt quenching method in the air at the cooling rate on the order of 10^6 K/s.

Revealed effects of rapid solidification on composition and structure evolution through the foil depth include a nanoscale chemical elements redistribution and alloying elements agglomeration beneath the sample bottom. The SPEM images indicate that precipitates take the form of local nano-sized agglomerates with a size which is not enough for X-ray photoelectron spectroscopy analysis to investigate the chemical states of species of interest. Foils are impoverished by V and Ti in substrate regions. This study suggests that the revealed nonuniform V and Ti depth distribution, as far as the high density of quenched-in vacancies is concerned, can be directly related to the reduction of vacancies concentration compared with rapidly solidified pure Al and affects H behaviour in rapidly solidified Al-V and Al-Ti alloys.

To summarize this report, our work demonstrates that SPEM investigations of Al alloys with alloying elements of technological interest contribute to the future multiscale framework aimed to develop understanding of H/microstructure interactions in rapidly solidified materials in order to control hydrogen embrittlement in aluminum materials developed for automotive and aerospace sectors.

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