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ABSTRACT:

Grain Boundary Diffusion Maps and Grain Boundary Phase Diagrams in Cu-Bi and Ni-Bi alloys

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Kinetic and structural changes associated with grain boundary phase transitions induced by Bi alloying in dilute Cu–Bi [1] and Ni–Bi [2] alloys are analysed. Grain boundary diffusion of both, Cu and Bi in the Cu–Bi alloys and that of Ni in the Ni–Bi alloys were measured applying the radiotracer technique across single-phase towards two-phase regions of the corresponding bulk phase diagrams [1, 2]. Whereas a step-like increase of both Cu and Bi GB diffusivities were observed in the Cu–Bi alloys within a single-phase (solid solution) region as a result of pre-melting GB phase transition, three distinct regions of the dependence of the Ni grain boundary diffusion rates on the Bi concentration were distinguished in the Ni–Bi alloys. A slight increment in Ni grain boundary diffusion was observed at lower Bi contents which was driven by Bi grain boundary segregation. Beyond a critical Bi concentration and still within the single-phase solid solution region, the Ni diffusivity enhances dramatically with increasing Bi content, which correlates with the appearance of multi-layer Bi segregation along the grain boundaries. At higher Bi concentrations, which corresponds to the appearance of a liquid layer of Bi at the grain boundaries, the Ni diffusivity attains the highest values. A close correlation between the atomic transport and the structure modifications due to grain boundary phase transitions in the Cu–Bi and Ni–Bi alloys is highlighted. As a result, the Cu–Bi and Ni–Bi grain boundary diffusion maps are proposed.

[1] S. V. Divinski, M. Lohmann, Chr. Herzig, B. Straumal, B. Baretzky, W. Gust, Phys.-Rev. B., 71, 104104 (2005).

[2] B. Bian, S. Taheriniya, G. Mohan Muralikrishna, A. Godha, S.K. Makineni, S. Sankaran, B.B. Straumal, Y. Du, G. Wilde, S.V. Divinski, Acta Materialia 245 (2023) 118632