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Atom Probe Study of Early Stage of Precipitation on Binary Al-Li, Al-Cu Alloys and Ternary Al-Li-Cu Alloys

Authors : Muna Khushaim

Abstract : Aluminum-based alloys play a key role in modern engineering, especially in the aerospace industry. Introduction of solute atoms such as Li and Cu is the main approach to improve the strength in age-hardenable Al alloys via the precipitation hardening phenomenon. Knowledge of the decomposition process of the microstructure during the precipitation reaction is particularly important for future technical developments. The objective of this study is to investigate the nano-scale chemical composition in the Al-Cu, Al-Li and Al-Li-Cu during the early stage of the precipitation sequence and to describe whether this compositional difference correlates with variations in the observed precipitation kinetics. Comparing the random binomial frequency distribution and the experimental frequency distribution of concentrations in atom probe tomography data was used to investigate the early stage of decomposition in the different binary and ternary alloys which were experienced different heat treatments. The results show that an Al-1.7 at.% Cu alloy requires a long ageing time of approximately 8 h at 160 °C to allow the diffusion of Cu atoms into Al matrix. For the Al-8.2 at.% Li alloy, a combination of both the natural ageing condition (48 h at room temperature) and a short artificial ageing condition (5 min at 160 °C) induces increasing on the number density of the Li clusters and hence increase number of precipitated δ' particles. Applying this combination of natural ageing and short artificial ageing conditions onto the ternary Al-4 at.% Li-1.7 at.% Cu alloy induces the formation of a Cu-rich phase. Increasing the Li content in the ternary alloy up to 8 at.% and increasing the ageing time to 30 min resulted in the precipitation processes ending with δ' particles. Thus, the results contribute to the understanding of Al-alloy design.

Keywords : aluminum alloy, atom probe tomography, early stage, decomposition
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