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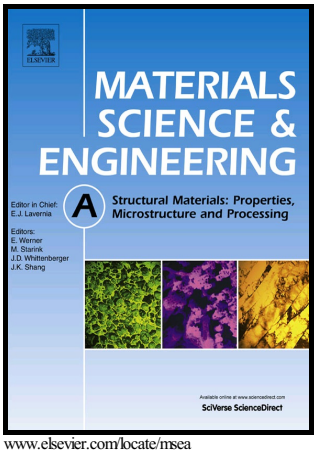

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PII: S0921-5093(18)30158-8
DOI: https://doi.org/10.1016/j.msea.2018.01.119
Reference: MSA36073

To appear in: *Materials Science & Engineering A*

Received date: 16 June 2017
Revised date: 26 January 2018
Accepted date: 27 January 2018

Cite this article as: G.W. Zheng, H. Li, C. Lei, J. Fu, T.J. Bian and J.C. Yang, Natural aging behaviors and mechanisms of 7050 and 5A90 Al alloys: A comparative study, *Materials Science & Engineering A*, https://doi.org/10.1016/j.msea.2018.01.119

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Abstract

The natural aging (NA) behaviors within 24 h of 7050 (Al-Zn-Mg-Cu) and 5A90 (Al-Mg-Li) aluminum (Al) alloys are investigated comparatively. The strikingly different evolution rules of mechanical properties and microstructures of the above two materials are characterized using tensile strength tests and high-resolution transmission electron microscopy (HRTEM), then the mechanisms are revealed based on the analysis of differential scanning calorimetry (DSC) and the calculation of precipitation activation energy. It is found that the NA rate of 7050 Al alloy is pronounced in the initial stage (after quenching), and decreases dramatically from 0 h to 20 h of NA, resulting in remarkable evolution of the microstructures and mechanical properties. In contrary, 5A90 Al alloy is stable and the effect of NA is not evident. DSC analysis indicates that the activation energy of the initial precipitate (GP zones) for 7050 Al alloy is nearly 74.3 KJ/mol, while that of the initial precipitate (δ' phase) for 5A90 Al alloy is nearly 103.6 KJ/mol. Owing to the low activation energy, acicular GP zones precipitate in the matrix of 7050 Al alloy within the first 4 h of NA, causing a dramatic increase in strength. The precipitates continue to grow with increasing aging time, albeit at a slower rate and with reduced influence on mechanical strength. Whereas, the strength of the 5A90 Al alloy remains hardly changed due to the higher activation energy. It is noted that, for 7050 Al alloy, the NA induced decreasing of the solute atomic concentration makes the initial remarkable Portevin-Le Chatelier (PLC) effect weaken gradually with aging time. While for the 5A90 Al alloy, the PLC effect remains little changed all the time since NA phenomenon does not occur in this alloy. It is recommended that the as-quenched 7050 Al alloys should be exposed at room temperature for more than 20 h or refrigerated before practical processing.

Keywords: 7050 Al alloy; 5A90 Al alloy; natural aging; mechanical property; precipitation; Portevin-Le Chatelier effect