A R C H I V E S O F M E T A L L U R G Y A N D M A T E R I A L S
Volume 58 2013 Issue 2
DOI: 10.2478/v10172-012-0192-3

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EFFECT OF Mn CONTENTS ON AGE-HARDENING AND MICROSTRUCTURE IN AM60 MAGNESIUM ALLOYS

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The thixotropy phenomenon is strongly connected with the change of viscosity in time, while the of Navier-Stockes equation. The micro- and macroscale models are coupled using CAFE approach.
Keywords: multiscale modeling, thixotropy effect, thixoforming, semi-solid state, cellular automata

Zjawisko tiksotropii polega na zmianie lepkości cieczy przy ustalonej prędkości ścinania i temperaturze. W komputerowym modelowaniu zachowania się materiału wykazującego skończonych.

1. Introduction

Most commercial cast magnesium alloys have been used basing on Mg-Al system. The addition of Al improves the mechanical property and castability of magnesium alloys. It is known that the addition of 6% or more Al to magnesium alloys makes age-hardenability in these alloy [1]. The $Mg_{17}Al_{12}$ phase has been reported as the precipitates formed in the Mg-Al alloys during aging after the solution heat treatment, which were formed the discontinuous precipitation at the grain boundary and continuous precipitate in the matrix [2]. The effect of Mn content on age-hardening in magnesium alloys are not reported so much. In this study, hardness measurement and SEM observation were performed in order to understand the effect of Mn content on age-hardening behavior and microstructures of Mg-Al alloys.

2. Experimental procedure

Mg-6%Al alloys with 0%, 0.15%, 0.3% and 0.5% Mn were used in this study, which were called as 0%, 0.15%, 0.3% and 0.5%Mn alloys, respectively. Sheets of 1 mm thickness were made by hot rolling, followed by solution heat treatment at 686K for 57.6ks in a protective Ar atmosphere and quenched into water. The aging treatment was performed at 473K. The micro-vickers hardness was measured with AKASHI MVK-EII(load:0.98, 0.098N, holding time:15s). The microstructures of the alloys were observed by optical microscope and SEM, EDS analysis was also performed to obtain the chemistry for precipitates.

3. Results and discussions

Fig. 1 shows age-hardening curves of 0%, 0.15%, 0.3%, and 0.5%Mn alloys. 0%Mn alloy shows the highest peak hardness. 0.5%Mn alloy did not show significant age-hardening behavior. It can be seen that the as-quenched hardness becomes higher and the time to the peak hardness becomes faster with the decreasing of Mn content.

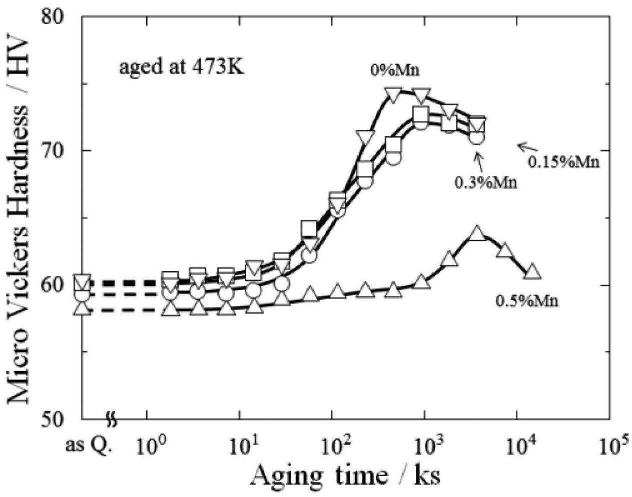

Fig. 1. Age-hardening curves of alloys at 473K

Fig. 2 shows the microstructures of 0%Mn and 0.5%Mn alloys aged for 57.6ks. The discontinuous precipitates were observed in each alloy, although the discontinuous precipitates were slightly observed in 0.5%Mn alloy. Granular-shaped

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precipitates were observed in the area of discontinuous precipitation.

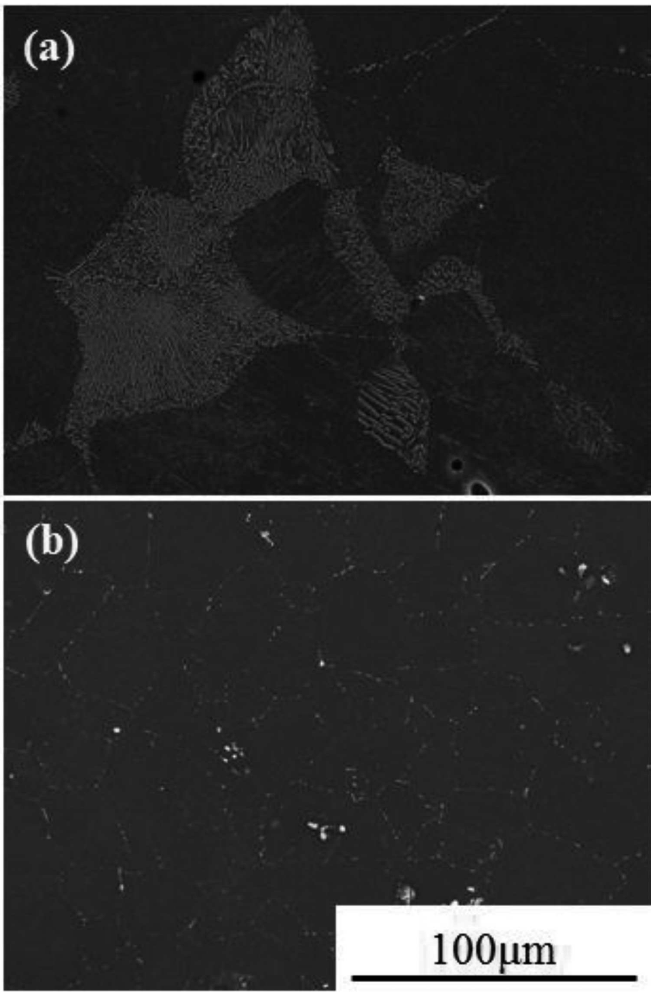

Fig. 2. Microstructure of alloys aged at 473K for 57.6ks. (a)0%Mn alloy and (b)0.5%Mn alloy

Fig. 3 shows the variation of vickers hardness and the area fraction of discontinuous precipitates in 0%Mn alloy versus aging time. It can be seen that the hardness of 0%Mn alloy increases with increasing of aging time. The increasing the hardness after peak hardness is due to the continuous precipitates in the matrix and fully covered discontinuous precipitation about 50% of area fraction.

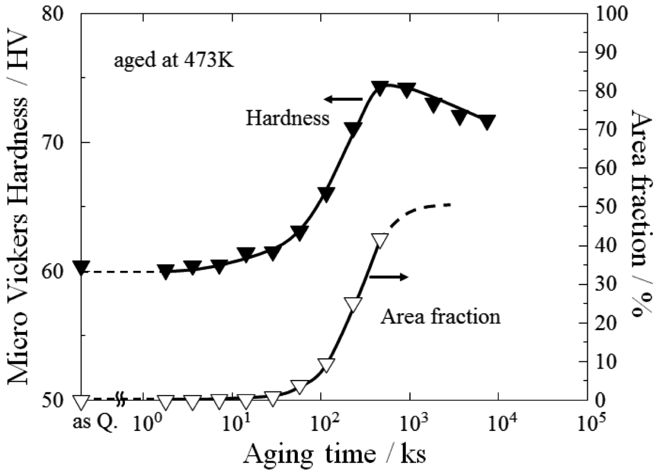

Fig. 3. Effect of aging time on the hardness values and the area fraction of discontinuous precipitates on 0%Mn alloy aged at 473K

4. Conclusion

The peak hardness of Mg-6%Al-x%Mn(x=0, 0.15, 0.3, 0.5) decreased with increase of Mn content. Granular-shaped precipitates were observed in the area of discontinuous precipitation of 0.5%Mn alloy. The shapes of discontinuous precipitates changed with increasing of Mn contents. Increasing of area fraction of discontinuous precipitates were remarkable in 0%Mn alloy and slightly observed in 0.5%Mn alloy.

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Received: 20 January 2013.