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The influence of silver addition on the phase decomposition in Al-Zn-Mg-Cu-Mn alloys

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Introduction

Al-Zn-Mg-Cu alloys are precipitation-hardening type alloys of which hardness increases, when η' or T' metastable phase precipitates. It is known from the previous research that the hardness increase by small addition of Ag[1]. However, the reason is not clarified. In this research, the specimens added by Ag with amounts quantity are prepared and the SR small angle scattering measurement have been carried out. And the influence of Ag addition to the precipitation process of T' metastable phase is investigated.

Experimental

The samples were prepared by adding from 0 to 0.078at% into the base alloy. The composition of the base alloy is Al-3.5Zn-4.0Mg-0.65Cu-2Mn (at%). The sample was solution-treated at 763K for 72ks and then quenched into water. Then isothermal aging was carriied out at 383K for various times. The SR small angle scattering mesurements were carried out at BL-15A of Photon Factory in KEK. The used detector is one-dimentional PSPC and camera length is 1168mm. The hardness test was carried out for the monitering the mechanical property.

Result

The as-quenched hardness increases gradually by addition of Ag and is saturated with the addition beyond 0.01at%. By ageing, the hardness increases and show maximum at 108ks aging and then falls by overaging. Maximum hardness increases greatly by small addition of Ag and falls greatly by superfluous addition beyond 0.03at%.

From the intensity profile of small angle scattering, the Guinier radius of the precipitate was calculated and the change by aging has been investigated. As quenched, the diffuse precipitates exist and their radius was about 0.9nm. This is considered to be a solute clusters like G.P.zone. So the increase of as-quenched hardness by Ag addition is because the formation of solute clusters was promoted. By aging, not-diffuse precipitates form and gradually grow up. And their radius was about 2nm at 108ks aging when the hardness becomes the maximum. They are considered to be T'phase. Pair correlation function with respect to spatial distribution of precipitates was calculated from the intensity profile. And the mean nearest neihgbour distance among precdipitates was estimated. As quenched, the mean distance was about 4nm. By aging, distance gradually increased and was about 10nm at 108ks. Then the volume fraction was calculated by the Guinier radius and mean distance. Fig.1 shows the change of the volume fraction by the additon of Ag for 108ks aging. Although the volume fraction increases a little by small addition, if it becomes more than 0.2at%, it falls greatly.

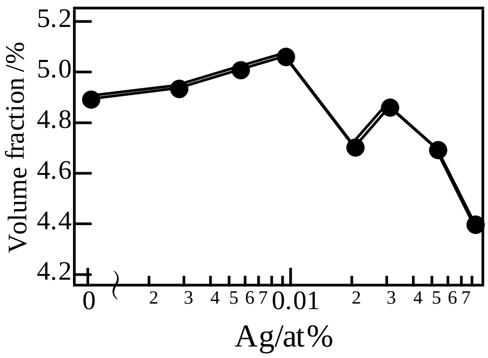

Fig.1 Volume fraction change of T' phase as a function of Ag content

Disccusion and conclusion

In their alloys, it is known that the amount of hardening can be expressed with the coherency strain model. According to the model, the amount of hardening is proportional to the 1/2th power of the amount of coherency strain and the 3/2th power of radius and volume fraction. If it tries to interpret the change of hardness by the addition of Ag using this model, the increases of the volume fraction at 108ks aging by small addition of Ag is not the quantity which can explain the increase fo the hardness. On the other hand, the increases of volume fraction by over addition of Ag is the quantity which can explain the increase of hardness. That is, it is thought that only what depends on the increase of volume fraction cannot explain the increase of the hardness by small addition of Ag, but another cause should be considerd

References

[1] J. Kusui et al., Mater. Sci. For. 1823, 217/222 (1996).

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