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著者(和文)	李有眞
Author(English)	Yujin Rhee
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論文要旨

THESIS SUMMARY

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学生氏名:

Student's Name

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系
コース

RHEE Yujin

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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

Microstructure and mechanical properties of Al-Zn-Mg-Cu alloys and Al-Cu-Mg alloys after cold rolling and artificial ageing heat treatment

The Al-Zn-Mg-Cu and Al-Cu-Mg alloys are age-hardenable aluminum alloys, strengthened by nanometer-scale precipitates through artificial aging, and belong to newly developing alloying systems. Due to their desirable mechanical properties such as light weight, high strength, good formability, and corrosion resistance, these alloys are expected to have significant applications in the aerospace and automotive industries. The effects of pre-deformation as well as the solute Zn content in Al-Zn-Mg-Cu and Al-Cu-Mg alloys on mechanical properties and precipitation evolution have been intensively investigated in this thesis. The conclusions of each chapter are summarized based on experimental results and discussions.

The research contents of this thesis consist of three parts: Chapter 2: The effect of pre-deformation on precipitation in Al-Zn-Mg-Cu alloy, Chapter 3: The effect of pre-deformation on age-hardening behavior and precipitation in an Al-3.9Cu-1.5Mg wt.% alloy, Chapter 4: Investigation on age hardening behaviors of Al-Zn-Mg-Cu alloy with various Zn contents

In Chapter 1, Basic knowledge of aluminum and aluminum alloys, its applications and key strengthening mechanisms of aluminum alloys are briefly reviewed. Age-hardening behavior and precipitation evolution of Al-Zn-Mg-Cu alloy and Al-Cu-Mg are also described in detail.

In Chapter 2, Effects of pre-deformation on strengthening and precipitation evolution in a Al-Zn-Mg-Cu alloy during ageing were investigated. Mechanical strength increases with increasing cold rolling ratios due to work hardening and mechanical strength of cold rolled conditions had higher than that of the non-deformed condition for all ageing times. However, the non-deformed condition has a higher age hardening response than that of the cold rolled conditions. A homogeneous precipitate distribution in the non-deformed condition, while non-uniformly distributed precipitates in the cold rolled conditions were observed due to the deformation induced dislocations leading to larger precipitate sizes and a reduction in the precipitate number densities in the cold rolled conditions. η' , η_2 , and disordered η phase were observed in the non-deformed condition, while η' , η_2 and the newly identified Y phase were observed in the cold rolled conditions. The disordered η phase is observed in the Al alloy of low Zn/Mg ratio and considered as a variant phase of η_1 because it contained structural units of the η_1 phase and was associated with reducing the lattice misfit between disordered η phase and the Al matrix. Y phase was observed in the rapid quenching condition with single O and R structure which is half-cell structure of η' in this work. Similar results were not previously reported yet. Y phase is deformation induced and is closely related to an accelerated nucleation rate in the regions of high dislocation density

In Chapter 3, The effect of 90% pre-deformation in an Al-3.9Cu-1.5Mg wt.% alloy has been investigated. 90% pre-deformed sample had higher Vickers hardness than the non-deformed sample for all ageing times and that non-deformed sample has a higher age hardening response than that of the pre-deformed sample. The pre-deformation suppress the formation of cluster due to high dislocation densities and vacancy annihilations during deformation. Common GPB zones from GPB¹ to GPB³ and both S-I and S-II phases were found to coexist in non-deformed sample, whereas in addition to S-I and S-II phase, novel type of phase named here the "Y phase" along dislocations also found in pre-

deformed sample. The crystal structure of Y was identified as monoclinic having a composition of $Al_{12}Cu_5Mg_5$ experimentally. The orientation relationship (OR) of Y phase with the Al matrix satisfied as $[110]_Y // [100]_{Al}$ which is different from previously reported S-I and S-II orientation relationship. Large number of dislocations by 90% heavy deformation acting as major nucleation sites offers various orientation of the dislocations which affects morphology, types of precipitates, and even formation of different variants of precipitates resulting in the formation of novel Y phase in heavy deformed Al-Cu-Mg alloy.

In Chapter 4, Effects of Zn addition on strengthening and precipitation behavior of Al-Zn-Mg-Cu alloys were investigated. initial hardness increases with increasing Zn contents due to the solid solution strengthening by increased total amount of solute Zn and Mg atoms as well as age hardening response increase with increasing Zn contents due to the promotion of η' phase formation by increasing Zn/Mg ratios. The formation peaks of GPII zone is observed in 8.0Zn enhancing the formation of η -phase precipitates compared to 4.5Zn and 5.5Zn samples. Also, T' phase formation appears in both 4.5Zn and 5.5Zn and remains unchanged till peak aged condition suggesting that T' phase forms at the early stage of ageing and acts as co-strengthening precipitates with η' phase. A dense and homogeneously distributed η' phase, T' and disordered η phase was found for all these samples and precipitates size is decrease with increasing Zn contents, while number densities of η' phase was significantly increased. Round shape precipitates over the edge-on/face-on =1 is considered as mixtures of T' , η_2 and disordered η phase and number density of round shape precipitates is increased with decreasing Zn/Mg ratio from 30% in 4.5Zn to 13% in 8.0Zn due to an insufficient amount of Zn to form stable $MgZn_2$ - η phase. We clearly identified the existence of T' phase and η' phase by the phase maps analysis.

In Chapter 5, conclusions obtained from each chapter are summarized

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note: Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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