

論文 / 著書情報
Article / Book Information

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Title(English)	Effects of Mn/Fe Ratio and Cooling Rate on Modification of Fe Intermetallic Compounds in Cast AA356 Based Aluminum Alloys with High Fe Contents
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種別(和文)	論文要旨
Type(English)	Summary

(博士課程)
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論文要旨

THESIS SUMMARY

専攻 :	材料工学	専攻	申請学位 (専攻分野) :	博士 (Engineering)
Department of			Academic Degree Requested	Doctor of
学籍番号 :			指導教員 (主) :	小林 郁夫
Student ID Number			Academic Advisor(main)	
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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

Fe is the most common and harmful impurity in cast Al-Si alloys. It will form the Fe intermetallic compounds with Al and Si during solidification due to its small solid solubility in Al matrix. Among the different intermetallic compounds, β type Fe compound with the morphology of platelet shape has been accepted as the most detrimental one to mechanical properties of cast Al-Si alloys, especially ductility. When the Fe is inevitable, to modify the platelet β type Fe compound to α type Fe compound with morphology of Chinese script is beneficial to improve the mechanical properties of cast Al-Si alloys. In this thesis, effects of three factors, Fe content, Mn/Fe ratio (Mn as a modifier) and cooling rate on this modification process in cast AA356 aluminum alloys are studied systematically.

In Chapter 1 "General Introduction", the background of the whole research work is explained. Against the background, the objectives of this thesis are presented.

In Chapter 2 "Influence of type, amount and size of different Fe compounds on tensile properties of cast AA356 based alloys", the tensile properties of alloys with different amount, size and type of Fe compounds were investigated. Fe content is the main factor which can determine the final tensile properties of cast Al-Si alloys. Higher Fe content will lead to the significant amount increase of Fe compounds, which will damage the mechanical properties greatly. It is very important to keep the Fe content as low as possible. When the Fe is inevitable, to modify the Fe compound solidify as the Chinese script α type is very effective to improve the tensile properties of cast Al-Si alloys, especially the small size Chinese script compounds. Both the large size platelet β type Fe compound and polyhedral shape α type Fe compound show very detrimental influence on the tensile properties of cast Al-Si alloys.

In Chapter 3 "Influence of Fe content, Mn/Fe ratio and cooling rate on morphology of Fe intermetallic compounds in cast AA356 based alloys", the attempts are proceeded to modify the Fe compound solidify as Chinese script α type Fe compound instead of platelet β type Fe compound and polyhedral shape α type Fe compound. Effects of three factors, Fe content, Mn/Fe ratio and cooling rate on this modification process are investigated. The size of platelet β type Fe compound increases significantly with increasing the Fe content. Mn addition is very effective to modify the β type Fe compound to α type Fe compound with morphologies of Chinese script and polyhedral shape. High cooling rate can restrict the formation of polyhedral shape α type Fe compound, instead, increasing the amount of Chinese script α type Fe compound in the alloys with high Fe content and high Mn addition.

In Chapter 4 "Evolution of Fe intermetallic compounds during solidification in cast AA356 based alloys with different Fe content and Mn/Fe ratio", the evolution of Fe compounds during solidification in modification process was investigated. Water-quenched experiments were conducted to reveal the solidification sequence of Fe compounds. A new finding is proposed firstly in this chapter. In the alloys with or without Mn addition, at the beginning of the solidification, the nucleation of platelet β type Fe compound occurs. In the alloys with Mn addition, with the solidification proceeding, the growth of Chinese script α type Fe compound accompanies by the decrease of the amount decrease of platelet β type Fe compound. More Mn addition make the nucleation and growth of α type Fe compound occur at higher temperature, even at the very beginning of the solidification. Furthermore, the solidification sequence of alloys with different Fe contents and Mn/Fe ratios are discussed.

In Chapter 5 “Mechanisms of modification of Fe intermetallic compounds by different factors: Fe content, Mn addition and cooling rate in cast AA356 based alloys”, a new model is firstly proposed to explain the mechanism of Mn addition in modification of Fe compounds. The formation of α type Fe compound in the alloys with Mn addition mainly comes from the replace of Mn by Fe in the Mn compound $Al_{15}Mn_3Si_2$. Both the composition analysis and crystal structure analysis supply strong evidences to support this propose. Additionally, the mechanisms of Fe content and cooling rate on the modification of Fe compounds are well discussed. Increasing Fe content can increase the size of Fe compounds significantly. High cooling rate can refine the size of Fe compounds by shortening the growth period of Fe compounds during solidification.

In Chapter 6 “General conclusions”, the general conclusions of 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 2 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 2 copies of 800 Words (English).