

論文 / 著書情報
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Category(English)	Doctoral Thesis
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： 材料物理学 専攻
Department of
学生氏名： 高立
Student's Name

申請学位 (専攻分野)： 博士 (工学)
Academic Degree Requested Doctor of
指導教員 (主)： 熊井 真次
Academic Advisor(main)
指導教員 (副)：
Academic Advisor(sub)

要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

The present doctor thesis was written based on the study concerning the characterization of Al alloys processed at semi-solid state through color metallography by using Weck's reagent. Topics related to the applications of Weck's reagent are summarized first. The coloring mechanism of color etching with Weck's reagent is the other important theme of this thesis which is studied by various characterizations of the etched surface. Detailed summary of each chapter is given as follows.

Chapter 1 "General introduction of this thesis"

Background of both color etching metallography and Weck's reagent, objectives of this study are provided.

Chapter 2 "Correlation between the micro-segregation in Al phase and the color revealed by Weck's reagent"

In this chapter, the detailed correlation between color and micro-segregation in Al alloys is studied. Various Al alloys including A356 (with or without Ti added) alloy, Al-Si and Al-Mg binary alloys are used. EPMA mapping mode is applied to characterize the solute distribution and compared to optical micrograph after etching with Weck's reagent. The results show that micro-segregations of Ti, Si and Mg in Al phase can all lead to a color difference. Besides dendritic Al structure, micro-segregation also exists in spheroidal Al grains obtained by semi-solid process. Surprisingly, the spheroidal grain growth occurred when cooling it from semi-solid state to room temperature can also be visualized by Weck's reagent. Discussion about different solutes' micro-segregation in Al phase is also provided in this chapter.

Chapter 3 "accurate solid fraction evaluation of Al alloy at semi-solid state by Weck's reagent"

As a result shown in chapter 2, grain growth during quenching from semi-solid state could be visualized by Weck's reagent. This finding can help to evaluate solid fraction at semi-solid state with a better accuracy by excluding this part when calculating the area fraction of solid particles in the optical micrograph. The results of A356 Al alloy using this method are compared with both the traditional method without excluding the grain growth during solidification and the results from level rule referring to Al-Si binary phase diagram. It is shown that the results obtained with exclusion of the grain growth during water quenching agree well with the results calculated from Al-Si binary phase diagram. The results obtained without consideration of the grain growth showed an overestimation over the above two methods. The overestimation is more serious on the higher temperature side because the grain growth from higher semi-solid temperature is thicker.

Chapter 4 "spheroidization mechanism of Al phase at semi-solid state by compression and partial re-melting process"

In this chapter, the microstructural evolution of Al grains from dendritic to spheroidal is focused. Since the materials was deformed and heated to semi-solid state, recrystallization occurred during heating. As a result, Al grains are refined compared to the specimen without deformation before heating. Weck's reagent finds its application again in this study. By etching the specimen which is transforming from dendritic to spheroidal, compressed dendritic Al grains are found separated and when the eutectic structure starts to melt, liquid phase penetrates into those separation sites and spheroidized Al grains are formed. According to EBSD analysis, high angle grain boundaries are found inside Al phase when the compressed specimen is heated. This suggests that Weck's reagent is also able to reveal grain boundaries in Al phase.

Chapter 5 "coloring mechanism of Weck's reagent studied by characterization of the etched surface"

Coloring mechanism of Weck's reagent was studied by various characterizations and analyses of the etched

surface. It was confirmed by electron scanning microscopy (SEM) that a film whose morphology changes from location to location is formed during etching. Compositional analysis shows that the film consists of Manganese oxide and the structure is amorphous. With the detailed observation by laser microscopy and atomic force microscopy (AFM), the relationship between the color and etched surface is investigated. The results show that the film surface is flat while the interface between film and substrate is relatively rough. The film thickness and the roughness between film and substrate are strongly influenced by the concentration of Ti in Al. The higher concentration of Ti can promote the film growth, which is confirmed by the surface observation. It is concluded that the color of the film is basically brown. But the brightness of brown is strongly influenced by the film's thickness and the roughness of interface between film and substrate.

Chapter 6 “Summary and general conclusions”

A summary of the applications of Weck's reagent which have been found by this study and the coloring mechanism concluded from experimental results are provided.

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 1 copy of 800 Words (English).

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