

論文 / 著書情報  
Article / Book Information

題目(和文)	Weck ' s試液を用いたカラーメタログラフィーによるA356アルミニウム合金のミクロ組織解析
Title(English)	Microstructure analysis of A356 aluminum alloy by color metallography using Weck ' s reagent
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学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

(博士課程)  
Doctoral Program

## 論文要旨

THESIS SUMMARY

系・コース : Department of Graduate major in	材料 材料	系 コース	申請学位 (専攻分野) : Academic Degree Requested	博士 Doctor of	(工学)
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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

The present doctor thesis was written on the study concerning the microstructure analysis of A356 aluminum alloy by color metallography using Weck's reagent. The coloring behavior of semi-solid die-cast A356 aluminum alloy etched by Weck's reagent was studied by various characterization methods. The effect of etching condition on color contrast was also examined under various different etching times and etchant temperatures to obtain the most suitable etching condition. The influence of the cooling rate on the growth behavior of the solid growth layer around the pre-existing spheroidal primary  $\alpha$ -Al by water quenching was examined by using specimens with different volume to confirm the applicability of the Weck's reagent for the correct evaluation of solid fraction in the semi-solid slurry. Detailed summary of each chapter is given as follows.

### Chapter 1 "General introduction"

The background of color metallography was briefly reviewed and the etchant called Weck's reagent was introduced. The representative recent works concerning the applications and coloring mechanism of Weck's reagent were explained. Several subjects which were still left unsolved in this research field were picked up, and the motivation and the purpose of this study were described.

### Chapter 2 "Coloring behavior in the eutectic solidified region of semi-solid die-cast A356 aluminum alloy etched by Weck's reagent"

In this chapter, the coloring behavior of the eutectic solidified region was intensively investigated. Various characterization methods were applied to understand more about the manganese dioxide film formed during etching process in terms of the topography of interface between manganese dioxide film and substrate. It was confirmed by electron scanning microscopy (SEM) that aluminum and silicon in the eutectic solidified region exhibited different height. The cross-sectional observation and compositional analysis by using scanning transmission electron microscopy (STEM) and dispersive X-ray spectroscopy (EDS) revealed that only aluminum matrix reacted with Weck's reagent and the film was formed by the conversion coating. No film formation was observed on the silicon phase. The influence of the morphological change of silicon phase in the eutectic solidified region on etching behavior by Weck's reagent was also investigated.

### Chapter 3 "Effect of etching time and temperature on coloration by Weck's reagent"

In this chapter, the influence of etching conditions on the color contrast revealed by Weck's reagent was examined. As-cast and solution-treated specimens were etched by Weck's reagent with different etching conditions and the change in surface topography of the etched specimens was characterized by SEM. The etching results showed that the color contrast revealed by Weck's reagent was very sensitive to both etching time and etchant temperature. The best etching condition for the as-cast specimens was the etching time of 12 s and the etchant temperature of 25 °C. The best etching condition for the solution-treated specimens was the etching time of 12 s and the etchant temperature of 15 °C. This suggests that the best coloring condition changes depending on the micro-segregation in the aluminum substrate since the thickness and morphology of the manganese dioxide film are controlled by the local distribution of the solute elements.

### Chapter 4 "Applicability of Weck's reagent for accurate evaluation of solid fractions with different cooling rates"

In this chapter, the applicability of the Weck's reagent for the accurate evaluation of solid fraction in the semi-solid slurries with different cooling rates was focused. Semi-solid processed specimens being solidified under different cooling rates were etched by Weck's reagent to visualize the solid growth around the pre-existing spheroidal grains during water quenching. The semi-solid slurries of A356 alloy with different volume of various solid fractions were fabricated and water

quenched to freeze the morphology of the aluminum grain in the semi-solid state. Optical microstructure observation by using Weck's reagent was carried out to visualize the inner microstructure of spheroidal aluminum grains, with a focus on the solid growth area around each spheroidal aluminum grain during water quenching. A ring-shaped pale color contrast region was observed around the spheroidal aluminum grain, and this region corresponded to the solid growth during water quenching from the original spheroidal aluminum grain surface. The amount of solid growth during quenching  $\Delta q$ , increased as decreasing the cooling rate. It was found that  $\Delta q$ , of each spheroidal aluminum grain also increased when the local solid fraction decreased. These results suggest that the present color metallography is effective for the correct evaluation of solid fraction of the A356 alloy slurry.

#### Chapter 5 "Summary and general conclusions"

The coloring behavior of the eutectic solidified region by Weck's reagent, the influence of etching conditions on the color contrast and the applicability of Weck's reagent for accurate evaluation of solid fractions were 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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