

On the modification and segregation behavior of Sb in Al–7Si alloy during solidification

A.K. Prasada Rao ^{a,*}, K. Das ^b, B.S. Murty ^c, M. Chakraborty ^b

^a Center for Advanced Aerospace Materials, Pohang University of Science and Technology, South Korea

^b Department of Metallurgical and Materials Engineering, IIT Kharagpur, India

^c Department of Metallurgical and Materials Engineering, IIT Madras, India

Received 11 July 2007; accepted 1 November 2007

Available online 21 November 2007

Abstract

This article reports on the modification of eutectic silicon in Al–7Si alloy inoculated with Sb. Present results suggest that Sb results in better modification of eutectic silicon on longer melt holding than at short holding after inoculation. The results also reveal that Sb segregates to the bottom of the crucible on prolonged holding of the melt at 720 °C, which later forms AlSb particles during solidification.

© 2007 Elsevier B.V. All rights reserved.

Keywords: Solidification; Microstructure; Al–Si alloy; Modification; Antimony

1. Introduction

Al–Si alloys have been investigated since 1856 [1]. However use of Al–Si alloys for the production of castings received a strong boost in 1921 since Aladar Pacz [2] discovered that addition of small amounts of Na or its salts to the molten alloy results in significant modification of the microstructure. Since then, modification has been a well-known foundry practice employed for refining the large size eutectic silicon needles to fine fibrous or lamellar in morphology. Modification can be achieved by several methods like faster solidification, mould vibration, melt agitation in mushy state and melt inoculation by using some elements like Sr, Sb etc. [1,3,4]. It has been reported that Sb results in fine lamellar morphology of eutectic silicon [5,6]. In another investigation present authors showed that Sb results in finer modification of eutectic silicon on longer holding of the melt than at shorter holding for a given addition level of Sb [7]. However,

the mechanism responsible for such behavior has not yet been well reported. Hence present work is an attempt to explore the possible action of Sb in hypoeutectic Al–Si alloy during solidification on longer melt holding time.

2. Experimental details

2.1. Modification experiment

Al–7Si alloy was melted in a zirconia coated graphite crucible (preheated at 300 °C) under a cover flux (50 wt.% NaCl+50 wt.% KCl) in a pit type furnace. The melt was brought to a temperature of 720 °C±5 °C and then degassed (to remove H₂) using commercial degasser, hexachloroethane (C₂Cl₆). After degassing, a part of untreated melt was poured into a cylindrical graphite mould (25 mm diameter and 100 mm height) with its top open for pouring. Later, a calculated amount of modifier (Sb) was plunged in to the melt in the form of powder, duly wrapped in an aluminum foil. The melt was stirred for 30 s with zirconia coated graphite rod, after which no further stirring was carried out. Parts of the melt were poured at regular intervals (5 and 120 min) into similar kind of mould (25 mm diameter and 100 mm height). Specimens collected in this study were cut across the diameter in transverse axis at a height of

* Corresponding author. Center for Advanced Aerospace Materials, Pohang University of Science and Technology, San 31, Hyoja Dong, Pohang, 790-784, South Korea. Tel.: +82 54 279 2823; fax: +82 54 279 5887.

E-mail address: prasad@postech.ac.kr (A.K.P. Rao).

25 mm from the bottom of the casting for microstructural characterization in-order to avoid experimental error.

2.2. Vertical segregation experiment

The experimental procedure followed for vertical segregation experiment is almost same as that followed for modification experiment described above. However, melt was not stirred at any stage of the experiment in this case. Also four identical graphite crucibles (25 mm diameter and 100 mm height) were used for four melts of Al–7Si alloy for addition levels of Sb of 0.2, 0.5 wt.% and holding time of 5 and 120 min respectively. And each melt was solidified in the respective crucible itself with out pouring. After cooling, the top portion (10 mm in height) of the cylindrical casting was removed (and discarded) by cutting it transversely in order to remove the solidified dross and oxidized melt from the top part of the casting. The remaining cylindrical rod was further sectioned vertically across the diameter along the longitudinal axis and prepared for microstructural characterization using SEM, TEM. The concentration profile of Sb in Al–Si alloy castings was examined with the aid of Optical Emission mass spectroscopy.

3. Results and discussion

Fig. 1(a) shows the SEM photo-micrograph of as-cast Al–7Si alloy without addition of Sb. The microstructure seen in Fig. 1(a) reveals coarse platelets of eutectic silicon. Fig. 1(b) and (c) represent the microstructure of Al–7Si alloy inoculated with 0.2% Sb and cast after 5 min and 120 min respectively. It is obvious from and Fig. 1(a) and (b) that the eutectic silicon needles decrease in size after addition of 0.2% Sb (5 min holding). It is evident from Fig. 1(b) and (c) that on longer holding (120 min) of melt prior to casting, the size of eutectic silicon needles become finer than at short holding time (5 min). On the other hand Al–7Si alloy inoculated with 0.5% Sb and cast after 5 min (Fig. 1(d)) and 120 min (Fig. 1(e)) also exhibit the similar behavior as in the case of 0.2% addition level of Sb. It can also be observed that the Al–7Si alloy inoculated with 0.5% Sb results in finer eutectic silicon particles than at 0.2% Sb for respective holding times of the melt. Above results prove that Sb results in better modification of eutectic silicon on longer holding time (120 min) of the melt, than at short holding (5 min) for the same addition level. This observation suggests that mere presence of Sb in liquid Al–7Si does not aid in better refinement of eutectic silicon. In addition, holding time of the melt also has significant role to play on the eutectic silicon modification. However, according to some earlier reports [8,9] the modification (refinement) of eutectic silicon in Al–Si-alloys (with minor amounts of Sb) occurs due to the constitutional super-cooling. Never-the-less, these theories could not

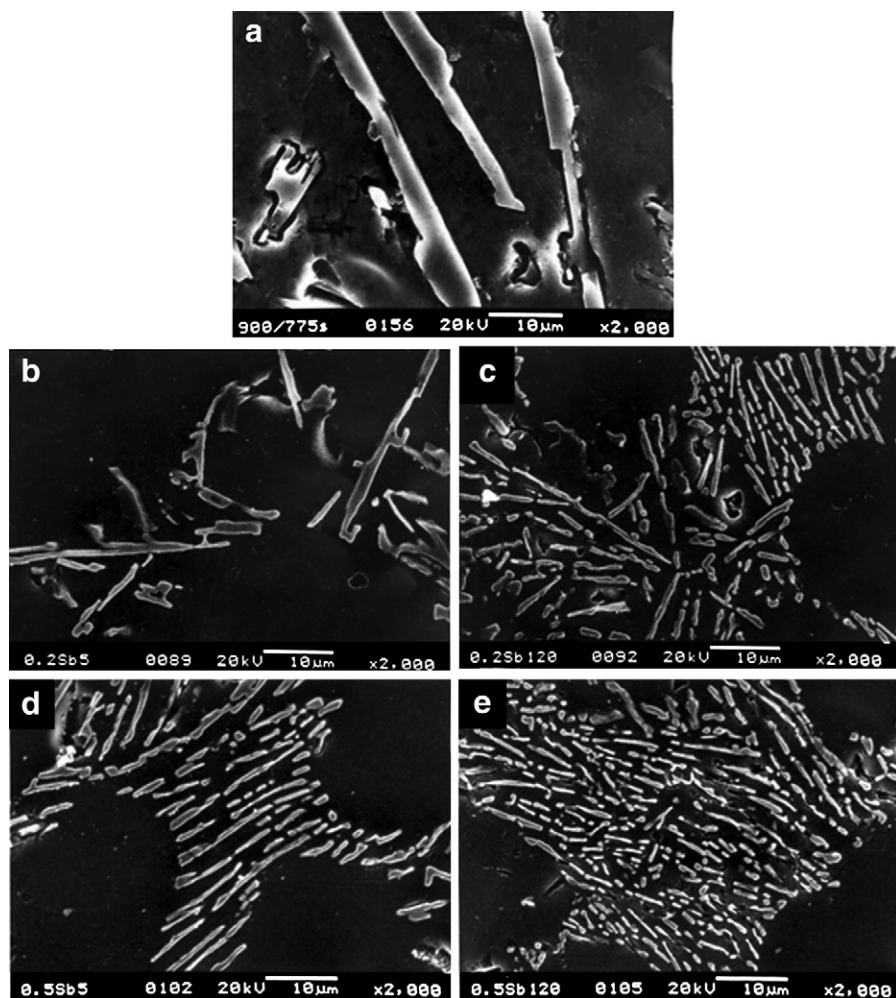


Fig. 1. SEM photo-micrograph of as-cast Al–7Si alloy (a) without inoculation, (b) inoculated with 0.2% Sb-5 min, (c) inoculated with 0.2% Sb-120 min, (d) inoculated with 0.5% Sb-5 min, (e) inoculated with 0.5% Sb-120 min.

Download English Version:

<https://daneshyari.com/en/article/1651751>

Download Persian Version:

<https://daneshyari.com/article/1651751>

[Daneshyari.com](https://daneshyari.com)