INFLUENCES OF VACUUM-BAKING TREATMENT TO SiC PARTICULATES ON PREPARING Al-MATRIX COMPOSITE[1]

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ABSTRACT

A study was made of influences of vacuum-baking treatment to SiC particulates on preparing cast Al-martix composite. By means of quadripole mass analyser (QMA), gases absorbed on the surface of SiC particulate have been investigated. It is found that gases and pollutants absorbed on the surface prohibit SiC particulates from uniformly dispersing in the alloy melt.

Key words: composite material SiC particulate surface treatment absorption vacuum-baking

1 INTRODUCTION

During preparing particulate reinforced materials, it is essential for the particulates to distribute uniformly in the melt. Few research has been reported on the improvement of particles dispersion ability with the aid of vacuum-baking. In this paper, through comparing this ability with and without vacuum-baking treatment to particulates, a kind of technique is provided to improve the dispersion ability of SiC particulates in Al-alloy melt.

2 EXPERIMENTS

Chemical composition of the master alloy is (wt.-%):

Cu4.5, Mn0.8, Ti0.3, Mg0.5, Fe< 0.4.

Average diameter of α-type SiC particulates is 10 μm.

The composites were prepared by usual liquid-solid metallurgy method. About 5 kg master alloy was melted in an Al_2O_3 electric resistance crucible. The melt was cooled down while stirred with a SiN impeller at a frequence of 600 r/min. When down to the temperature corresponding to that of 50 percent solid fraction of dual-element Al-Cu phase diagram, SiC particulates were dispersed into the melt. After having been stirred for another 30 min at this point, the melt was heated to about 720 °C, degased by argon, and cast into testing bars of d50 mm × 50 mm. The specimens of 5 mm × 5 mm in size were sectioned across the center of the bar for avoiding the influence of ununiformly cooling rate. The microstructures were examined, the density and percentage of agglomerates of the SiC particulates were measured.

Gases released from the SiC particulates

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during vacuum-baking were determined with QMA. The main point of vacuum-baking is: gasses absorbed on inside walls of the container was first degased with vacuum about 1.3×10^{-3} Pa and heat treatment at 600 C for 2 h. Then 0.5 kg baked SiC particulates were put into the container. When the pressure was decompressed to 1.3×10^{-4} Pa, it was heated at a rate of 10 C/min while cooling water was exerted on the top of the container. The gases departed from the surfaces of SiC particulates were measured by an quadripole mass analyser.

3 RESULTS

In the composite containing 10 wt-% SiC particulates without vacuum-baking, SiC particulates are distributed in the poistion where the liquid freezes at last. A lot of particles are in an agglommerated state (Fig. 1 (a)). The experiment indicates that such agglomerates accompanied with holes are harmful to the properties of the composites.

After vacuum-baked, there are few agglomerates in the composite, and SiC particulates were dispersed uniformly in the material (Fig. 1 (b)).

The density and area percentage were measured. The latter was got from the metallography treated with an image-processing equipment. The results were given in Table 1. It indicates that through vacuum-baking to SiC particulates, the agglomerates in the composite are removed effectively.

Table 1 Density and area percentage of the agglomerates in the microstructure

treating method	density/cm^2	area percentage/%
water washing	68.6	11.8
silicon washing	54.3	9.7
20%NaOH washing	59.2	9.6
20%HCl washing	62.8	10.6
vacuum baking	0.4	0.12

The analytical results of the gasses escaping from SiC particulates during vacuum-baking are illustrated in Fig. 2. And it is showed that, when heated to about 250 C, H_2O molecules (according to the gram molecular weight— M/e equals 18. Here M —the mass of the material measured; e — that of proton) are released from SiC particles. When heated to 320 C, M/e equals 2, hy-

Fig. 1 As-cast microstrucure of Al-10wt.-% SiC particulated composite
(a)—not treated to SiC; (b)—treated to SiC

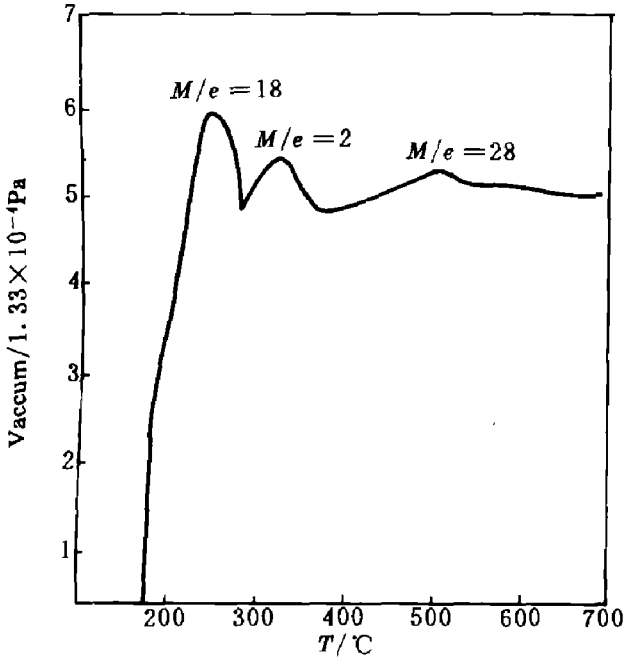

Fig. 2 The QMA curves of the gases absorbed on the surface of SiC particulates

drogen are released. When heated to 500 C the third heat-absorbing peak occurs, and M/e equals 28, it means that CO and N_2 are released. All above suggested that through vacuum-baking, gases such as H_2, H_2O, CO, N_2 and so on absorbed on the surface of SiC particulates are decreased, accordingly, the dispersion of the particulates in the melt is improved apparently.

4 DISUSSION

When SiC particulates are dispersed into the melt, only could they contact with the melt directly, could they be wetted and reacted with the melt. It is the contact that affects the dispersion greatly. The experiment showed that pollutants absorbed on the surface prohibit SiC particulates from contact with the melt. As there is something absorbed on the fracture of glass, α-type SiC particles are ground with big SiC crystals, there are Si^{4+} etc remainders on their surfaces, they could absorb water, oxygen and so on from the air. Such kinds of materials are very difficult to remove.

Absorbed gases made SiC particulates floating on Al-alloy melt, although the density of the former(3.14)is bigger than the latter(2.16). When SiC particulates are put into the melt, if the stirring friction does not remove the absorbed gases effectively, reaction among the absorbed gases will make the SiC particulates agglomerate accompanying with holes. So any measure which is helpful to remove the absorbed gases is helpful to remove or decrease the agglomerates, and to make SiC particulates be dispersed uniformly. Since vacuum-baking make the absorbed gases be removed effectively, composite was obtained almost without agglomerates.

5 CONCLUSION

The absorbed gases prohibit SiC particulates from contact with the Al-alloy melt. Vacuum-baking teatment makes the absorbed gases be removed effectively, the dispersion ability of particulates in the melt is improved effectively.

REFERRENCES

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