# SiC-Mg INTERFACE OF $SiC_P$/AZ80 COMPOSITE ①

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**ABSTRACT** The interface of $SiC_P$/AZ80 composite was examined. It was shown that the $SiC_P$/matrix interface was smooth and there was no evidence of chemical reaction at the interface. $Mg_{17}Al_{12}$ eutectic phase could be observed at the $SiC_P$/matrix interface. The cracks at the interface and SiC particles were also observed.

**Key words** magnesium alloy composite interface SiC particles

## 1 INTRODUCTION

The properties of MMCs are dependent on reinforcement, matrix alloy and the interface between matrix and reinforcement. The interface characteristics determine load transfer and crack resistance of MMCs during deformation. Investigators have studied some methods to obtain good bonding at the interface. For example, decreasing solidification time, choosing the lowest mixing temperature, applying metallic coatings to ceramic particulates and alloying the metallic matrix with reactive materials. Degradation of the reinforcement or an unexpected phase formation have often been experienced at the interface in different composite systems. In other cases, the formation of small intermetallic phases or the development of a reaction zone provide bonding[1-2]. However, even without chemical reaction, diffusion of atoms from one component to the other and good wettability of a liquid phase can provide mechanical and physical interactions at the interface, allowing the development of a strong bond.

The aim of the present work is to study the interfacial microstructure in a $SiC_p$/AZ80 composite.

## 2 EXPERIMENTAL DETAILS

### 2.1 Materials and processing

AZ80 magnesium based alloy was selected as the matrix for the composite. The reinforcement particulates were high purity silicon carbide with an average diameter of 10 μm. Composite ingots with 15% (in volumn) SiC particles were prepared using compo-casting described by Mehrabian *et al*[3], which consists of entrapping the reinforcement phase in a highly viscous, semi-solid alloy, then remelting and mixing above the liquidus. About 1 kg of composite melts were fabricated in an electric resistance furnace using a steel crucible under argon gas.

### 2.2 Analysis

For optical and scanning electron microscopy, the samples were ground through a 1 200 grit SiC abrasive and polished on a soft cloth using 6, 3 and 1 μm diamond pastes and then etched.

The as-cast composite samples were ground and polished to approximate 60 μm and subsequently argon-ion beam thinned at 5 kV, 0.4 mA, and at angles 30 and 10°. The sample foils were examined using JEOL JEM-2000EX.

## 3 RESULTS AND DISCUSSION

### 3.1 Microstructures

Fig. 1 shows the metallographic microstructure of the composite. It can be seen that the distribution of SiC is not uniform, SiC particles

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tend to segregate to interdendritic regions. It appears that during solidification of composite, the SiC particles are pushed by the growing magnesium-rich dendrites into the last solidifying interdendritic regions. This has been attributed to the lower heat diffusivity of SiC particles compared to metallic melts, but few particles are captured in the matrix grains during solidification. That the SiC particles in the liquid magnesium increase the nuclei density by providing many possible sites on the particle surfaces and the particles in the grain boundaries terminate the further growth of primary magnesium grains that result in forming a fine structure. Pores are observed to be associated with the particles during mixing the SiC particles with molten metal.

## 3.2 Interfacial structure

Fig. 2 is the most common type interfacial

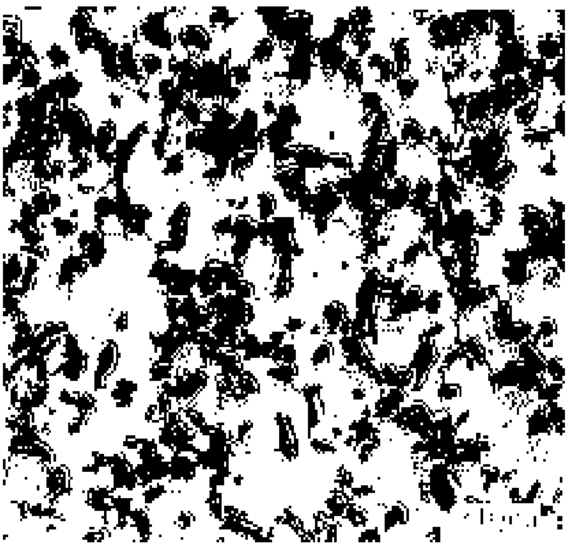

**Fig. 1 Optical microstructure of $SiC_p$/AZ80**

structure. It shows that the interface between matrix and reinforcement is smooth and there is no evidence of chemical reaction at the interface.

As with other composite systems a high dislocation density and extensive twinning around the particles have been observed in magnesium-matrix composites with 10% (in volumn) SiC particles (Fig. 3).

During the solidification, the large difference between the coefficient of thermal expansion (CTE) of the matrix and reinforcement results in sufficient stress to generate a high dislocation density at the interface. This high stress and consequent dislocation generation around the reinforcement have often been related to good bonding at the interface[4].

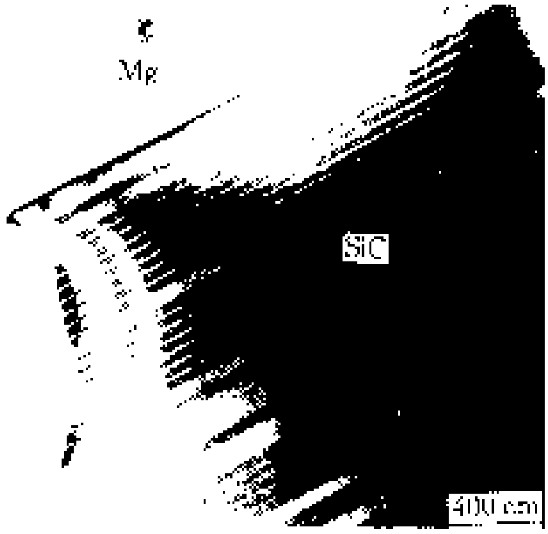


**Fig. 2 TEM micrograph showing Mg/SiC interface**

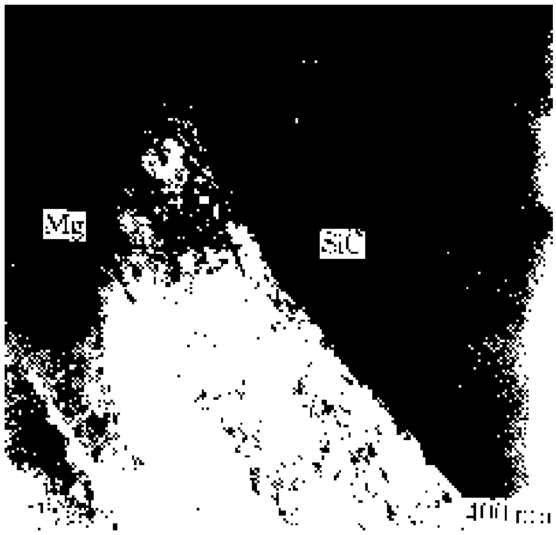


**Fig. 3 A high dislocation density and twinning around SiC particle**

However, a different particle at the interface of SiC/Mg has been observed, as shown in Fig. 4. The particle is $Mg_{17}Al_{12}$ eutectic phase, which is body centre cubic structure, $a = 10.56$ Å The electron diffraction patterns of $Mg_{17}Al_{12}$ eutectic phase are shown in Fig. 5.

Microcracking can also be observed under TEM at the matrix and SiC particles interface (Fig. 6). It shows that cracking takes place in the SiC particles. The cracking which takes place at the interface and on the particles could be caused by the thermal shock which occurs

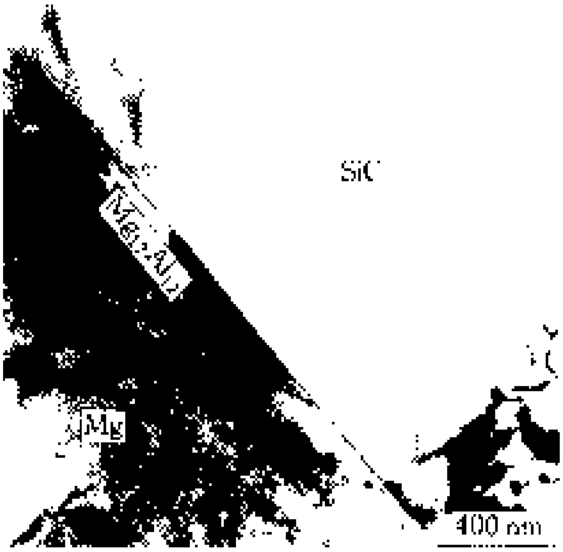


**Fig. 4 $Mg_{17}Al_{12}$ eutectic phase at $SiC_p$/ matrix interface**

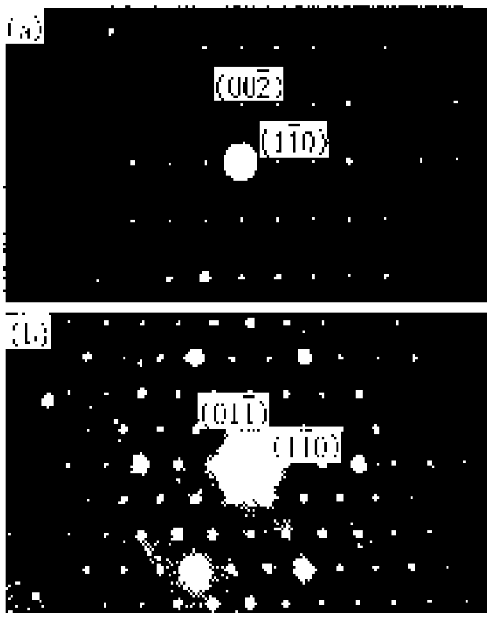


**Fig. 5 Electron diffraction patterns of $Mg_{17}Al_{12}$ eutectic phase**
(a) —[110]; (b) —[111]


**Fig. 6 TEM micrograph showing cracks at SiC and SiC/ matrix interface**

during solidification. It is also likely that during the SiC particles preparation some cracks could be introduced.

## 4 CONCLUSIONS

(1) The interface is smooth and there is no evidence of chemical reaction.

(2) $Mg_{17}Al_{12}$ eutectic phase can be observed at the $SiC_p$/ matrix interface.

(3) Interfacial cracks between the SiC/ matrix and particle cracks are observed.

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