CHAPTER TEN

THE EFFECT OF CORROSION DURATION ON MECHANICAL PROPERTIES OF Mg/SiC COMPOSITES

A well-consolidated composite of Mg alloy reinforced with SiC at weight percentages of 2, 4, and 6, was prepared by compocasting technique, and the composite was corroded in NaCl for various duration (50, 60, 70 and 80 days), and its mechanical properties were determined by destructive testing. The results of the study indicated that as the SiC particle content in the composites increased, there was a remarkable increase in the ultimate tensile strength but there was a decrease in ductility. There was a marginal decrease of tensile strength with corrosion duration, which may be due to the presence of reinforcement; it also enhances the pit formation in the matrix during corrosion.

10.1 Introduction

Metal matrix composites (MMCs) have received increasing attention in the recent decades as engineering materials. The introduction of a ceramic reinforcement into a metal matrix produces a composite material results in an attractive combination of physical and mechanical properties that cannot be obtained with monolithic alloys. Particulate reinforced MMCs among the discontinuously reinforced MMCs have attracted quite a lot of attention both in the industrial sectors and the academic communities. There is an increasing need for knowledge about the processing techniques and mechanical behavior of particulate MMCs in view of their production getting enhanced and their commercial applications becoming wider\textsuperscript{153}. Interest in particulate reinforced MMCs is mainly due to easy availability of particles and
10.2. EXPERIMENTAL PROCEDURE

10.2.1 Corrosion
The initially weighed specimens were immersed in the corrosive environments and taken out at 10 days intervals for testing up to a total of 80 days. One specimen was used for each test condition. Each time, the corrosion products formed on the corroded specimens were removed with a bristle brush.

10.2.2 Testing of mechanical properties.
All tests were conducted in accordance with ASTM standards. Tensile tests were conducted at room temperature using Universal Testing Machine in accordance with ASTM E8-82. The tensile specimens of diameter 8.9mm and gauge length 76mm were machined from the cast composites with the gauge length of the specimen parallel to the longitudinal axis of the castings. Five specimens were tested and the average values of the ultimate tensile strength (UTS) and ductility (in terms of percentage elongation) were measured.
10.3. RESULTS AND DISCUSSION

Fig. 10.1 Effect of corrosion duration on a) the UTS and b) Ductility of both Mg/SiC composite and their respect matrix alloy.

(a) UTS (MPa)

(b) Ductility, %

Corrosion duration, days

Wt. Of reinforcement:
- 0
- 2
- 4
- 6

Fig. 10.1 Effect of corrosion duration on a) the UTS and b) Ductility of both Mg/SiC composite and their respect matrix alloy.
10.3.1 Ultimate tensile strength (UTS)

The Figure 10.1(a) shows the test results of Mg/SiC MMCs with 0 to 6% in steps of 2% by weight of SiC. It can be observed that the UTS of the composite increase uniformly as the particulate content is increased. The UTS of the composite specimens increased by about 21% as the SiC content was increase form 0 to 6 wt %.

It has been reported that the addition of SiC particulate to aluminium alloys improves their yield strength and the UTS of the composites whereas the strain to failure decreases as the weight percentage of SiC particulate increases. Various other workers\textsuperscript{154-159} also have report that the addition of hard ceramic particulate in metal alloys can lead to improved strength of the MMCs. Interphase bonding in the region of the reinforcement side wall promotes void nucleation and growth in the matrix between the side walls of the reinforcement, because the shear lag transfer of load will be hindered by interphase bonding, causing more load to be carried by the matrix in this region.

The increase in UTS is attributed due to the presence of hard SiC particles, which imparts strength to the matrix alloy, thereby providing enhanced resistance to tensile loading. Reduction in composite grain size and the generation of a high dislocation density in the matrix, which is a result of the difference in thermal expansion between the metal matrix and the reinforcement\textsuperscript{160}. And also SiC particles act as a barrier to slip, hence as the weight percentage increases the inter-particulate spacing and slip length decreases\textsuperscript{161}. Sharma et al.\textsuperscript{162} believe that the improvement in UTS may be due to restriction to the plastic flow due to the random distribution of the ceramic particulate in the matrix.
In the present investigation with corrosion and addition of SiC reinforcement, it was found that UTS increased substantially. 80 hours of corroded specimen has shown decrement in UTS of the composites containing 0, 2, 4, & 6 wt.% SiC particle were 41%, 38%, 35%, and 34% respectively. This may be due to high pit formation as well as the interfacial stress affect not only due to the heterogeneous nucleation of precipitates, but also serve as short-circuit paths for pipe diffusion which can accelerate with corrosion process\textsuperscript{163}.

10.2 Ductility

The values of ductility, in terms of percentage elongation, measured for ascast composites are shown in the Figure 10.1(b). The ductility decreases with the increase in SiC content by a significant amount. The reduction in ductility was about 64% as the SiC content was increased from 0 to 2 wt%. The results trends are on par with those obtained by other workers\textsuperscript{164,165}. Mummery et al.\textsuperscript{166} are of the opinion that this behavior is probably due to void nucleation during plastic straining of the reinforcement, either by reinforcement interface or by the de-cohesion of the matrix-reinforcement interface.

Some authors believe that the compressive-to-tensile stress transition for a critical volume fraction could be described as one of the contributing factors for the steep decrease of ductility and fracture toughness of the composites with increasing volume fraction\textsuperscript{166-168}. The ductile failure in the matrix caused either by the nucleation, growth and coalescence of voids from the cracking of the intermetallic inclusions and dispersoids in the matrix\textsuperscript{169,170}, by ductile tearing of the matrix between the reinforcement\textsuperscript{171}. 
Elongation is the parameter most sensitive to corrosion, which was found to slightly deteriorate the ductility of the composites. The percentage decrease in ductility of the composites containing 0, 2, 4, and 6 % SiC were 14%, 25%, 50%, and 60% respectively, after 80 days of corrosion.

10.4 Conclusions:

Particulate-reinforced Mg/SiC MMCs were fabricated by compocasting technique. The tensile and ductility were evaluated, and the results were related to the reinforcement content. The final conclusions obtained were

- The UTS increases with increase in SiC particulate content.
- With increase in reinforcement content ductility decreased substantially.