CHAPTER-7

SUMMARY OF CONCLUSIONS AND SUGGESTION FOR FUTURE WORK

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This chapter provides the overall conclusions of SiC and TiC particulates reinforced magnesium alloy. The comparative conclusion based on mechanical testing and wear analysis have been presented in this chapter. The scope of future work related to these composites is also presented.

7.1. Summary of conclusions

The primary objective of the current thesis was to develop a stir casting facility for processing of magnesium alloy based metal matrix composites. Two experimental set-ups have been fabricated to fulfill the current objective. The first experimental set-up fails to provide the desired cast product of the magnesium alloy. The main drawback of this set-up was unable to prevent oxidation of the magnesium alloy because magnesium shows very high affinity toward atmospheric oxygen. After performing experiments with the first set-up, a new idea came in authors mind that melting and melt protection is the main issue in processing magnesium through casting routes. There was a requirement of an inert atmosphere to protect magnesium alloy from atmospheric oxygen. Therefore, a new set-up as a different research facility has been designed and developed for processing magnesium alloy in a controlled atmosphere. For complete removal of the oxygen, a vacuum pump was also incorporated in the experimental set-up. Two different sets of the composites have been fabricated through developed experimental set-up. Four different volume percentages of SiC (40 µm) particulates (3 %, 6%, 9 %, and 12%) were reinforced into the AZ91 magnesium alloy matrix in the first phase. The mechanical and wear properties of the developed composites have been presented and discussed. The properties of the composites will depend on the types, size, physical and mechanical properties of the reinforcement. The second set of composites is prepared by reinforcing magnesium alloy with four different percentages of TiC particulates (3 %, 6%, 9 %, and 12%) is fabricated to verify the above statements in the second phase. The overall conclusions derived from these two different sets of composites are given as follows

1. The addition of a small percentage of hard ceramic particle the microstructure of the magnesium alloy based metal matrix composites has been refined in both type of reinforcement (i.e., SiC and TiC).
2. The density and porosity of the magnesium alloy composites are increased with an increase in the percentage of reinforced particulates. However, the porosity in SiC particulate reinforced composite was found to be more than TiC reinforced composites. It is due to the smaller size of the TiC particulates (20 μm) in comparison to SiC particulates.
3. The XRD peaks in case of SiC particulates reinforced composites confirm the presence of Mg, $Mg_{17}Al_{12}$ and SiC phases, whereas in case of TiC reinforced composites only Mg and $Mg_{17}Al_{12}$ phases matched with the data available in JCPDS/PCPDF win.
4. The Vickers microhardness value of SiC particulates reinforced composites was higher than TiC reinforced composite. It is increased by ~30% on addition of 3% of SiC particulate and it further increased up to ~78% on addition of 12 % of SiC particulate, while in case of TiC reinforced composites the hardness is increased by ~ 24 % on addition of 3% of TiC particulate, and it further increased up to ~ 75% on addition of 12 % of TiC particulate.

5. The yield strength and ultimate tensile strength was found to be initially decreased and then increased with increase in the amount of SiC/TiC particulates in magnesium alloys. The exact value of increment and decrement depend on the types and size of the reinforcements. The addition of TiC particulates in magnesium alloys increases the yield strength and ultimate tensile strength more in comparison to SiC reinforced composites because of finer size of TiC reinforcements.
6. The ultimate compressive strength is increased by ~27% on addition of 3% of SiC particulate and it further increased up to 50% on addition of 12 % of SiC particulate, while in case of TiC reinforced composite the ultimate compressive strength is increased by ~2% on addition of 3% of TiC particulate, and it further increased up to ~15% on addition of 12 % of TiC particulate.
7. The tensile factograph of both types of composite shows mixed mode fracture (i.e., ductile and cleavage), the fracture surface morphology of the composite also reveals that small size dimple, micro-crack, and cleavage fracture increases with increase in reinforcement.
8. The compression factograph of AZ91 exhibit dominant shear failure and showed more shear bands when compared to SiC/TiC reinforced composites, which on the other hand shows rough fracture surfaces with a mixed mode of shear and brittle features.
9. The dry sliding wear behaviors in magnesium alloy and both the composites were slight abrasion and moderate oxidation and delamination at the sliding speed of 1.39 m/s and a normal load of 19.62 N.

10. The dry sliding wear behaviors in magnesium alloy and both the composites were found to be heavily adhesion and slightly softening at the sliding speed of 2.6 m/s and a normal load of 58.86 N.

11. The wear weight loss and wear rate of the SiC/TiC reinforced composites is lower than the unreinforced composites at all loads and both velocities.

12. The average coefficient of friction of both types of composites is lower than unreinforced alloy, and it is decreased with an increase in normal load.

13. The wear rate at higher sliding velocity is higher, and the effect of the difference in velocity is decreased with an increase in normal loads.

14. The SEM images show the clear indication of abrasion; oxidation and delamination wear present in case of base alloy and both the composites.

7.2. Suggestions for future work

The casting and characterization of two different sets of composites are carried out and result presented in this thesis show some benefits over monolithic alloy. The cast structure is generally shown inferior properties that other form of materials. Therefore, more improvement can be achieved by performing some operation on the fabricated composite through the experimental set-up developed in the current study. However, the following aspects have still to be investigated:

[1]. The effect of secondary processing such as forging, rolling and extrusion on microstructural, mechanical properties and as well as wear behavior. It assumes that secondary processing will improve the overall properties of the composites.

[2]. Some more test should be done to examine the other important properties such as creep, fatigue and flammability test to accelerate its diverse application in automobile, aerospace, sports, and domestic products.

[3]. Study related to machining, welding other joining process needs to be done.

[4]. Study of machinability of Mg-alloy and composites: Effect of feed, depth of cut and speed on the surface roughness of the alloy and composites need to evaluated during different machining operations.

[5]. Corrosion behavior of magnesium alloy and composite under different concentration of saline water, acidic and the basic solution should be performed.

[6]. The effect of the addition of nano-particle in combination with microparticles for the magnesium alloy composite process through the different processing techniques has to perform.