CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Composite materials are important engineering materials due to their outstanding mechanical properties. Composites are materials in which the desirable properties of separate materials are combined by mechanically or metallurgically binding them together. Each of the components retains its structure and characteristic, but the composite generally possesses better properties. Composite materials offer superior properties to conventional alloys for various applications as they have high stiffness, strength and wear resistance. The development of these materials started with the production of continuous-fiber-reinforced composites. The high cost and difficulty of processing these composites restricted their application and led to the development of discontinuously reinforced composites (Ozdemir et. al.1999).

Aluminum (Al) is a silvery white and ductile member of the poor metal group of chemical elements. Al is an abundant, light and strong metal which has found many uses. Like all composites, aluminum-matrix composites are not a single material but a family of materials whose stiffness, strength, density, and thermal and electrical properties can be tailored. The matrix alloy, the reinforcement material, the volume and shape of the reinforcement, the location of the reinforcement, and the fabrication method can all be varied to achieve required properties. Regardless of the variations, however, Al composites offer excellent thermal conductivity, high shear strength, excellent abrasion resistance, high temperature operation, nonflammability, minimal attack by fuels and solvents, and the ability to be formed and treated on conventional equipment.

Silicon carbide (SiC) is composed of tetrahedral of carbon and silicon atoms with strong bonds in the crystal lattice. This produces a very hard and strong material. SiC is not attacked by any acids or alkalis or molten salts up to 800^{o}C. In air, SiC forms a protective silicon oxide coating at 1200^{o}C and is able to be used up to 1600^{o}C. The high thermal conductivity coupled with low thermal expansion and high strength gives this material exceptional thermal shock resistant qualities. SiC ceramics with little or no grain boundary impurities maintain their strength to very high temperatures, approaching 1600^{o}C with no strength loss. Chemical purity, resistance to chemical attack at temperatures, and strength retention at high temperatures has made this material very popular as wafer tray supports and paddles in semiconductor furnaces. Properties of silicon carbide are low density, high strength, low thermal expansion, high hardness, and high elastic modulus.

Particle reinforced composites have relatively isotropic properties compared to short fiber or whisker reinforced composites. The properties of the composites can be tailored by manipulating parameters such as reinforcement particle distribution, size, volume fraction, orientation, and matrix microstructure (Ayyar et. al, 2006). Metal matrix composites (MMCs), such as SiC particle reinforced Al, are one of the widely known composites because of their superior properties such as high strength, hardness, stiffness, wear and corrosion resistance. SiC particle reinforced Al based MMCs are among the most common MMC and available ones due to their economical production. They can be widely used in the aerospace, automobiles industry such as electronic heat sinks, automotive drive shafts, or explosion engine components. The physical and chemical compatibility between SiC particles and Al matrix is the main concern in the preparation of SiC/Al composites.

Therefore, the particle reinforced metal matrix composites can be synthesized by such methods as powder metallurgy (PM), standard ingot metallurgy (IM), disintegrated melt deposition (DMD) technique, spray atomization, and co-deposition approach. Different method results in different properties. In this study, the PM method is carried out to prepare SiC particle reinforced Al MMC. The effect of weight percentage of the reinforced particles on mechanical behavior such as hardness and microstructure of the composites can be investigated. The PM processing route is generally preferred since its shows a number of product advantages. The uniform distribution of ceramic particle reinforcements is readily realized. On the other hand, the solid state process minimizes the reactions between the metal matrix and the ceramic reinforcement, and thus enhances the bonding between reinforcement and the matrix (Wang et. al, 2007).

Powder metallurgy is a net shape forming process consisting of producing metal powder, blending them, compacting them in dies, and sintering them to impart strength, hardness and toughness. Although the size and the weight of its products are limited, the PM process is capable of producing relatively complex parts economically, in net shape form and wide variety of metal and alloy powders. Basically, in the conventional PM production, after the metallic powders have been produced, the sequence consists of three steps. Firstly, blending and mixing the powder, and then compaction, in which the powders are pressed into the desired part shape. The last step of PM method is sintering, which involves heating to a temperature below the melting point to cause solid state bonding of the particles and strengthening the part. Blending refers to when powders of the same chemical composition but possibly different chemistries being combine. After that, in compaction (pressing), high pressure is applied to the powders to form them into the required shape. The pressure required for pressing metal powders ranges from 70MPa (for Al) to 800MPa (for high density iron parts). After pressing, the green compact lacks strength and hardness. Sintering is a heat treatment operation performed on the compact to bond its metallic particles. Sintering is a high temperature process used to develop the final properties of the component.

1.2 PROBLEM STATEMENT

Aluminum metal matrix composites (Al MMCs) are attractive for a wide variety of aerospace and defense applications. But it has lower resistance, ductile, low strength and hardness. To overcome this problem, silicon carbide is added as a