# CHAPTER 1

# INTRODUCTION

## 1.1 RESEARCH BACKGROUND

Aluminum alloys is an important material for tribological applications due to its low density and high thermal conductivity. Therefore, the investigation of tribological behavior of aluminum based materials is becoming increasingly important. In the recent past, another class of material, namely the metal matrix composite (MMC), is becoming increasingly important. The need for new materials able to match increasingly stringent engineering requirements has led to the development of MMC for aerospace and automotive applications. Properties such as friction and wear resistance in lubricated or unlubricated conditions are of particular importance for the development, for example, of brakes or engine pistons. Recently, a number of Al alloys have also been developed as light-weight materials for such uses as bearings. Although Al alloys meet many requirements for such applications, their poor resistance to seizure make them vulnerable under poor lubricating conditions (Arik et. al., 2006).

Alumina ($Al_2O_3$) are characterized by high level of physical and mechanical properties, e.g. high temperature strength, thermal cyclic resistance, wear resistance, good thermal conductivity, hardness and stiffness and low linear expansion coefficient. Alumina will influence the Al MMC because it is reinforcement used for good products and structures (Abouelmagd, 2004).

The powder metallurgy (P/M) industries have expanded more rapidly than those using the conventional process, and are widely used for a variety of products. This is mainly due to the outstanding advantages, such as, facility of components manufacture, material utilization, and economical advantages for large production. Other advantages include, energy saving, the possibility of producing near net shape products of complex geometries and high strength, use of re-cycled metals, less noise, and no toxic fumes or pollutants. However, despite these distinct advantages, the PM technique has some disadvantages such as, initial tooling costs, raw material, i.e. powder costs are higher than conventional solid bulk, and special care must be taken against corrosion (Al-Qureshi et. al., 2008).

Powder metallurgy is a net shape forming process consisting of producing metal powder, blending them, compact them in dies, and sintering them to impart strength, hardness and toughness. Although the size and the weight of its products are limited, the powder metallurgy 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 is blending and mixing the powder, second steps compaction, in which the powders are pressed into the desired part shape and lastly 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 aluminum) 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 OBJECTIVES

The objectives of this study are;

i. To investigate the effect of different sintering temperature on mechanical behavior of $Al_2O_3$ reinforced Al MMC.
ii. To study the characteristic physical and mechanical behavior of Al MMC reinforced $Al_2O_3$.

## 1.3 PROJECT SCOPES

This research is focus on powder metallurgy process which is to investigate influence of different sintering temperature on mechanical properties of $Al_2O_3$ reinforced Al MMC. This study was done based on the following aspect:

i. The sintering temperature are 400 $^0$C, 450 $^0$C, 500 $^0$C, 550 $^0$C, and 600 $^0$C.
ii. Produce specimens by using powder metallurgy process.
iii. 10% of $Al_2O_3$ mixed with 90% of aluminum powder.
iv. Pressure applied during compaction is 300kg/cm$^2$.
v. Two types of testing (Vickers hardness test, and image analyzer test).
vi. Sintering duration is 10 minutes.

## 1.4 PROBLEM STATEMENT

Metal matrix composites (MMCs) represent a new generation of engineering materials in which a strong ceramic reinforcement is incorporated into a metal matrix to improve its properties including specific strength, specific stiffness, wear resistance, excellent corrosion resistance and high elastic modulus. MMCs combine metallic properties of matrix alloys (ductility and toughness) with ceramic properties of reinforcements (high strength and high modulus), leading to greater strength in shear and