Study on Characterization and Mechanical Behavior of Ti-Sic P/M Composites

K. Patterson[a], R. Badrinath[a], K. Rajesh Ragunath[b], J. Karthik[b], G. Murali Manoj[b]

[a]: Assistant Professor,
Department of Mechanical Engineering,
Christ College of Engineering and Technology, Puducherry.

[b]: Student, Department of Mechanical Engineering,
Christ College of Engineering and Technology, Puducherry.

Abstact **-Now a day's automobile industries were more concentrating in replacing with a light weight material for various fuel consumption of the vehicle can be reduced. Titanium is a highly density material were blended with Silicon carbide to improve the bonding nature of two metal matrix composites. However, commercial applications of titanium alloys in important structural parts are limited because of hardness properties. To meet the demands of more applications, titanium alloys with high strength and excellent room temperature property must be developed. A major issue is achieving the best potential of silicon carbide reinforced metal matrix composite is to disperse homogeneously within the matrix of Titanium by using powder metallurgy technique namely blending, compacting and sintering was conducted. The sintering temperature of the Titanium and Silicon carbide is 1200 C in vacuum sintering. Micro hardness, compression, wear tests were analyses on various parameters and their results reveals the intensive and extensive properties the metal matrix composites materials. The characterization of the sintered billets were analyzed using Scanning Electron Microscope (SEM)**

1. INTRODUCTION

Powder metallurgy is a continually and rapidly evolving technology embracing most metallic and alloy materials, and a wide variety of shapes. Powder metallurgy is a highly developed method of manufacturing reliable ferrous and non-ferrous part. Created by mixing elemental (or) alloy powders and compacting the mixture in a die, the resultant shapes are then heated or "sintered" in a controlled atmosphere furnace to bond the particles metallurgical. The high precision forming capability of powder metallurgy generates components with near net shapes intricate features and good dimensional precision pieces are often finished without the need of machining. Many metals can be obtained in the form of fine powder, by different methods. The powdered metal is then compressed in moulds under high pressure. By subsequent heating a fairly strong component is obtained. The Powder metallurgy is consist of four basic steps such as Powder manufacture, Powder blending, Powder compacting, Powder sintering. Compacting is generally performed at room temperature, and elevated temperature process of sintering is usually conducted at atmospheric pressure. The main process consists in cold pressing the metal powders followed by heating. The temperature during the heating process is kept below the melting point in case of pure metals but with alloys the melting point of one constituent is often exceeded. Bonding is obtained by cold pressing but sometimes nonmetallic materials are added to provide metallic bond. Final cohesion is caused by heating in suitable atmosphere.

A much wider range of products can be obtained from powder processes than from direct alloying of fused materials. In melting operations the "phase rule" applies to all pure and combined elements and strictly dictates the distribution of liquid and solid phases which can exist for specific compositions. In addition, whole body melting of starting materials is required for alloying, thus imposing unwelcome chemical, thermal, and containment constraints on manufacturing. Unfortunately, the handling of aluminum/iron powders poses major problems other substances that are especially reactive with atmospheric oxygen, such as titanium, are sinter able in special atmospheres or with temporary coatings.

In powder metallurgy or ceramics it is possible to fabricate components which otherwise would decompose or disintegrate. All considerations of solid-liquid phase changes can be ignored, so powder processes are more flexible than casting, extrusion, or forging techniques. Controllable characteristics of products prepared using various powder technologies include mechanical, magnetic, and other unconventional properties of such materials as porous solids, aggregates, and inter metallic compounds. Competitive characteristics of manufacturing processing (e.g., tool wear, complexity, or vendor options) also may be closely controlled.

2. EXPERIMENTAL DETAILS

2.1 Titanium

Titanium is a chemical element with symbol of Ti. It is a lustrous transition metal with a silver color, low density and high strength. It is highly resistant to corrosion in sea water, aqua regia and chlorine. Titanium can be alloyed with iron, aluminum, vanadium & molybdenum among other elements to produce strong and lightweight alloys for Aerospace. (jet engines , missiles and spacecraft).Titanium Powder metallurgy offers the possibility of creating net shape (or) near net shape parts without the material loss and cost associated with having to machine intricate components from wrought billet.

2.2. Silicon Carbide

Silicon Carbide is the only chemical compound of carbon and silicon. It was originally produced by a high temperature electro-chemical reaction of sand and carbon. Silicon carbide is an excellent abrasive and has been produced and made into grinding wheels and other abrasive products for over one hundred years. Today the material has been developed into a high quality technical grade ceramic with very good mechanical properties. it is used in abrasives, refractories, ceramics, and numerous high-performance applications. The material can also be made an electrical conductor and has applications in resistance heating, flame igniters and electronic components. Structural and wear applications are constantly developing. Silicon carbide is composed of tetrahedral carbon and silicon atoms with strong bonds in the crystal lattice. This produces a very hard and strong material. Silicon carbide is not attacked by any acids or alkalis or molten salts up to 800°C. In air, SiC forms a protective silicon oxide coating at 1200°C and is able to be used up to 1600°C.

2.3 Material

2.3.1 Preparation of Die & Die Manufacturing:

Die is a hollow or solid metal form used in cutting aping coins or shape, drawing bars or wires, embossing (or) thread insides (or) outsides. Hollow die used in casting of forming is also called as mold. A die specialized tool used in manufacture industries to cut on shape material mostly using a press. Like in olds dies are generally customized to the item they are used to create products made with dies range from simple paper lips to complex pieces used in advanced technology.et in Chennai. The Elements used in the Preparation of die materials are D2 STEEL. The high carbon high chromium (HCHR) material is used to make elements like Upper Punch, Lower Punch, and Injector.

2.4 Powder Compacting:

Powder compacting process of compacting metal powder through the application of high pressures. Compacting or briquetting is the process of converting loose metal powder particles into a Green Compacting as it is called of accurately defined size and shape. The Briquette is considered fairly fragile, but it can be handled. The Compacting stage is carried out at room temperature in a die set up on press. The die consists of cavity, the shape of the desired part, but from two to ten times deeper, according to the material handled. Pressure is applied by the upper and lower punch and the powder gets compressed to approximately one third of its volume and the required component is produced. The bottom punch also acts as ejector for the compressed parts. The dies are commonly made up of high carbon steel and high chromium vanadium steel. Metal powder is poured in the cavity, and leveled off flush with the top of the die.

2.5 Powder Sintering:

Sintering is a process of taking metal in the form of a powder and placing it into a mold (or) die. Once compacted into the mold the material is placed under a high heat for a long period (or) time. . It may also be carried out under protective gas normally hydrogen or in a vacuum if the material tends to react with the protective gas. The heating causes the metal particles to sinter, that is a proportion of them partly melt and by so doing cement the remaining particles together in a cellular structure. From the economic point of view, the sintering time should be as short as possible, but the time must be long enough to obtain the required properties. Sintering is performed to achieve all possible final strength and hardness needed in the finished product. The three most important variables governing the sintering process are temperature, time and sintering atmosphere. The work piece dimensions change during sintering. Such changes may be either a shrinkage or growth. In general, bronze tends to expand and iron and brass to contract. After being compacted into a briquette having the shape of the finished work piece, the cold welded aggregate of metal particles is heated in a furnace to the temperature close to the melting point of the basic metal which goes into the mixture. This is carried out in controlled atmosphere furnaces billets are consolidated for Sintering in the Furnace under the temperature of the 1200^{0}c at the approximate 5hours in the furnace

3. TESTING

3.1 Scanning electron microscopy

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. The electron beam is generally scanned in a raster scan pattern, and the beam's position is combined with the detected signal to produce an image. SEM can achieve resolution better than 1 nanometer. Specimens can be observed in high vacuum, in low vacuum, in wet conditions (in environmental SEM), and at a wide range of cryogenic or elevated temperatures. The most common mode of detection is by secondary electrons emitted by atoms excited by the electron beam. On a flat surface, the plume of secondary electrons is mostly contained by the sample, but on a tilted surface, the plume is partially exposed and more electrons are emitted. By scanning the sample and detecting the secondary electrons, an image displaying the topography of the surface is created.

3.2 Micro Hardness test

The Metals Handbook defines hardness as "Resistance of metal to plastic deformation, usually by indentation. However, the term may also refer to stiffness or temper or to resistance to scratching, abrasion, or cutting. It is the property of a metal, which gives it the ability to resist being permanently, deformed (bent, broken, or have its shape changed), when a load is applied. The greater the hardness of the metal, the greater resistance it has to deformation. In mineralogy the property of matter commonly described as the resistance of a substance to being scratched by another substance. In metallurgy hardness is defined as the ability of a material to resist plastic deformation. The dictionary of Metallurgy defines the indentation hardness as the resistance of a material to indentation. This is the usual type of hardness test, in which a pointed or rounded indenter is pressed into a surface

3.4 Compression test

A compression test determines behavior of materials under crushing loads. The specimen is compressed and deformation at various loads is recorded. Compressive stress and strain are calculated and plotted as a stress-strain diagram which is used to determine limit,proportional, yield point, yield strength and, for some materials, compressive strength.

REFERENCES

1. Synthesis of Ti–Sn–Nb alloy by powder metallurgy Alireza Nouri a, Xiaobo Chena, Yuncang Li a, Yasuo Yamadab, Peter D. Hodgsona, Cui'e Wen
2. Fabrication of Ti–Nb–Ag alloy via powder metallurgy for biomedical applications Ming Wen, Cuie Wen, Peter Hodgson, Yuncang Li.
3. Characterisation of titanium–titanium boride composites processed by powder metallurgy techniques: M. Selva Kumar, P. Chandrasekar, P. Chandramohan, M. Mohanraj