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# SINTERING PROPERTIES OF Al-15% GRAPHITE COMPOSITE

**K. Saisarath, P. Jaya raju and T. Raja Rao**

k.sarath0321@yahoo.co.in, Jraj.rocky@gmail.com , Rajarao354@gmail.com

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## ABSTRACT:

**The sintering activity that will be described in this paper was developed to be part of a materials and manufacturing course that currently has a well organized series of laboratory activities. However, it is often useful to have another experiment that can be included to update the standard set of experiments. The sintering process used 99.9 % pure Aluminum powder with a mixture of pure graphite powder compacted specimens with length to diameter ratio almost equals to unity.**

**The main objective of this present work is to determine physical and mechanical properties of the proposed aluminum graphite composites. To investigate and analyses the micro structure samples and characteristics of the aluminum metal matrix composites by using an optical microscope. The sintering temperatures adopted are 500◦c , 530◦c , 560◦c and 590 ◦c respectively. The holding time is varied as 45min, 1.5 hrs, i.e., at each of the sintering temperatures different batches of samples are held for different lengths of time. Finally sintered specimens were tested to achieve better properties and the properties were clearly listed in results and discussions.**

**Keywords: sintering, manufacturing, powder compacted specimens, temperature.**

## Introduction

This chapter describes the experimental procedure as adopted in the present Project-work.

### Selection and Characterization of Raw Materials

Research grade Aluminum metal powder and Graphite particulates were obtained from the market.. The data as obtained from the analysis is also presented below.

### Fabrication of the Green Test Specimen

The Metal- Matrix- Composite test specimens are fabricated by the powder Metallurgy route adopting the usual mixing and solid state sintering

## Mixing of the powders

85% Aluminum powder and 15% Graphite particulates by weight are used for machine Fabricating the composite specimens. The mixing is carried out in the lathe machine.

## Optimization of mixing time

The mixing is carried out for a period of 60 minutes and the m/c is stopped for 5 Minutes And the direction of leaver can be changed.

## Compaction of the powder mixing.

Compaction of powders can be done by using tensile test machine by applying the load of 100MPa.this process can leads to get green shape of test specimen

**Process:** The die used was 3 7/8 in. long and 3 in. in diameter, with a 10 mm hole in the center. The punch is tool steel and purchased as a 15 mm rod. The die separates 1 in from the bottom, so the specimen may be pushed out. .

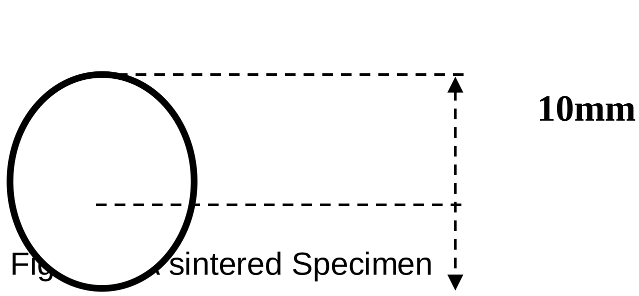
About 10 grams of powdered Al –Gr were placed in a plastic cup which was poured into the die. The piston was placed in the die hole and the Instron was loaded in compression.* The compacting pressure was varied and after removing the specimen from the die, it was measured and weighed. The densities of all the specimens were determined from mass divided (scale- ±0.1 g) by the calculated volume determined from measurements with a dial caliper. The specimens were placed in furnaces at different temperatures for varying lengths of time. After removal from the furnaces, the specimens were reweighed and the volume remeasured and a new density was determined.

## Sintering of the Green Pellets

The green pellets of given dimensions obtained after Cold Isostatic pressing are Subjected to sintering in the high temperature tubular furnace. Solid state Sintering is adopted. Sintering temperature and the time of holding at a given Sintering temperature are varied. The sintering temperatures adopted are 500◦**c ,** 530◦**c** , 560◦**c** and 590 ◦**c** respectively. The holding time is varied as 45min, 1.5 hrs, i.e., at each of the sintering temperatures different batches of samples are held for different lengths of time. A detailed nomenclature of the test samples is Prepared as given below:

## Drilling of the Sintered Test Pieces

The determination of radial crushing strength by a compression test needs ring Shaped samples. The circular sintered samples are now subjected to drilling to Generate a ring shaped sample. A 2mm drill bit is used to perform drilling. Through out the process of drilling care is taken to see that the temperature of the sample is retained at the room temperature. To accomplish this sample is Drilled under a continuous spray of kerosene for the entire period of drilling. The Sample before and after drilling is presented in Fig respectively




Fig[illegible] sintered Specimen

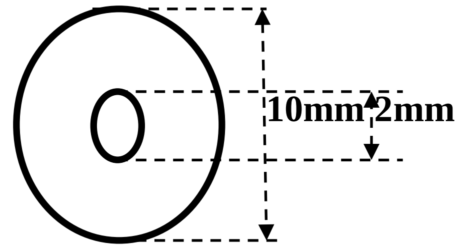



Fig.: 1(b) A drilled Specimen

**Determination of Radial Crushing Strength**

The radial crushing strength is obtained by testing the samples under Compression using Tensometer. A schematic diagram of the test process Showing the holding of the test specimen is presented in fig

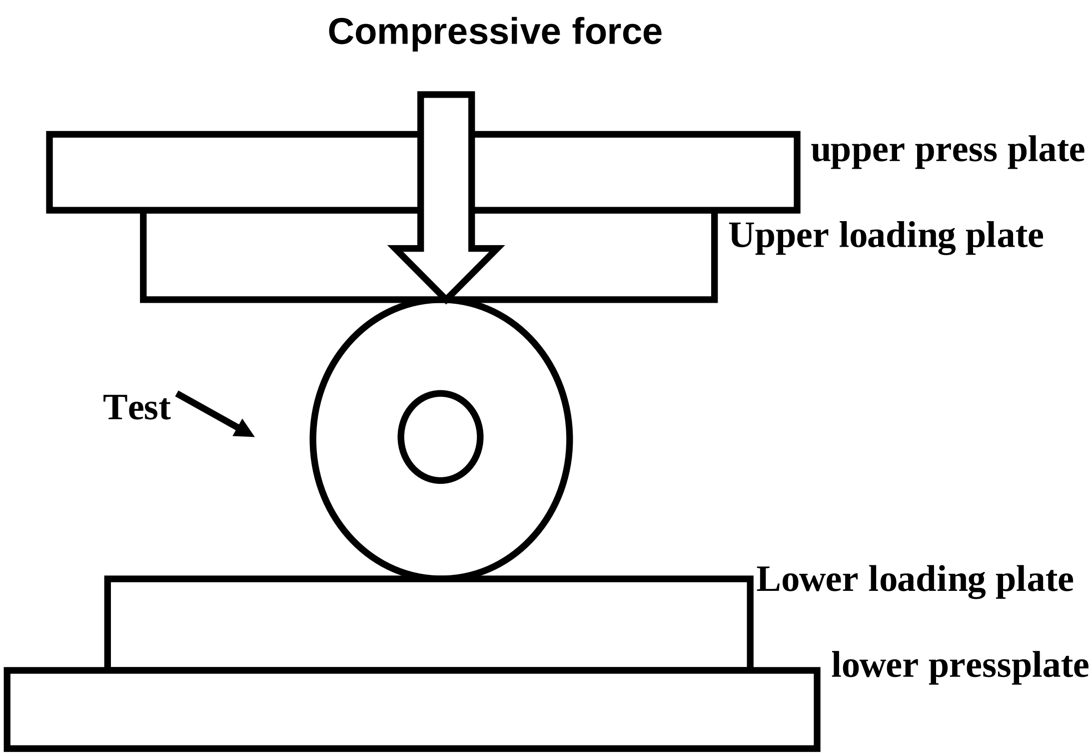



**Fig.: 2** Experimental arrangement showing the holding of the ring shaped Specimen. The Radial Crushing Strength is obtained using the formula given below.

$$K=p(D+d/2)/Lt$$

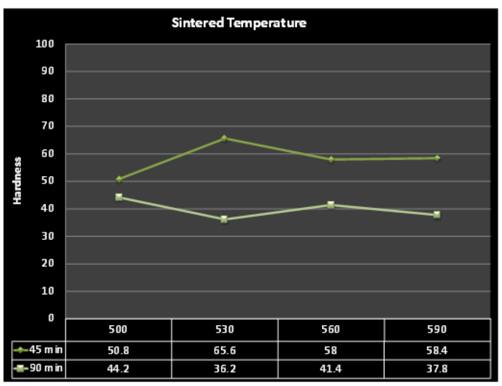
*Where:*
K = radial crushing strength (MPa)
P=Breaking load (N)
D= Outside Diameter (mm)
d = Inside diameter (mm)
L = length (mm)

T = wall thickness (D-d)/2 (mm)

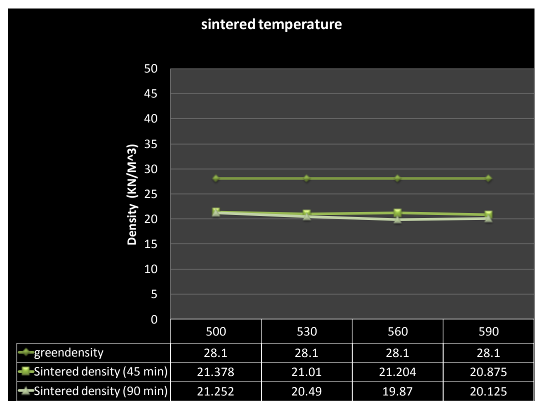
The test is a destructive test. The photographs of a specimen before drilling and a fractured specimen after the compression test are presented.

**The project methodology flowchart is shown below and the objectives of this project are as listed:**

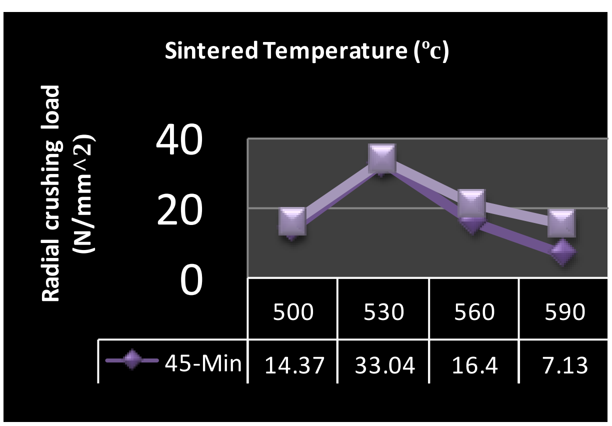
1. Mixing the preferred material (aluminum and graphite) by using a planetary Lathe machine in order to get homogeneous mixture.
2. Compacting the mixture with a constant pressure,100MPa to get the green shape of the test specimen(no of specimens=50)
3. Sintering the samples for 45minutes and 90minutes.
4. Conducting mechanical testing and studying the density, hardness, strength, radial crushingload
5. Analysis sample characterization by using optical microscope.

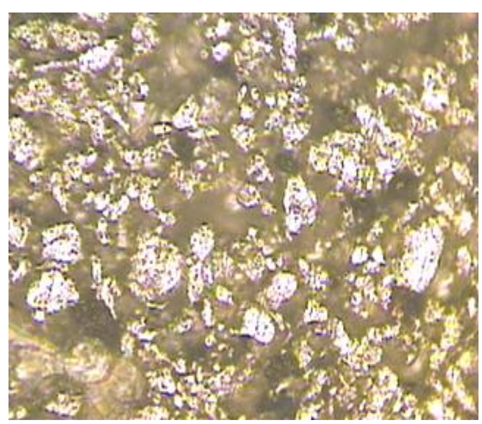



**Sintered temperatureVs hardness**




**sintered temperature Vs Density**



**Sintered temperature Vs Radial crushing load Magnification-400X**

**Fig.1: Microstructure of Al-15% graphite compact edat100 MPa sintered at 500°C -45min.**

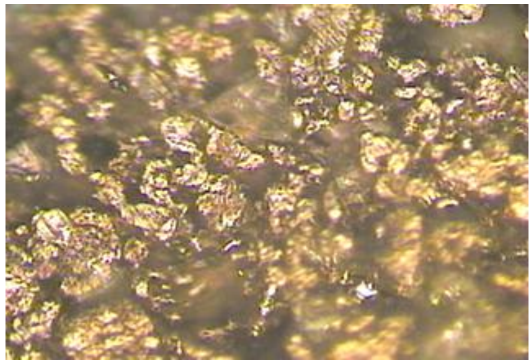
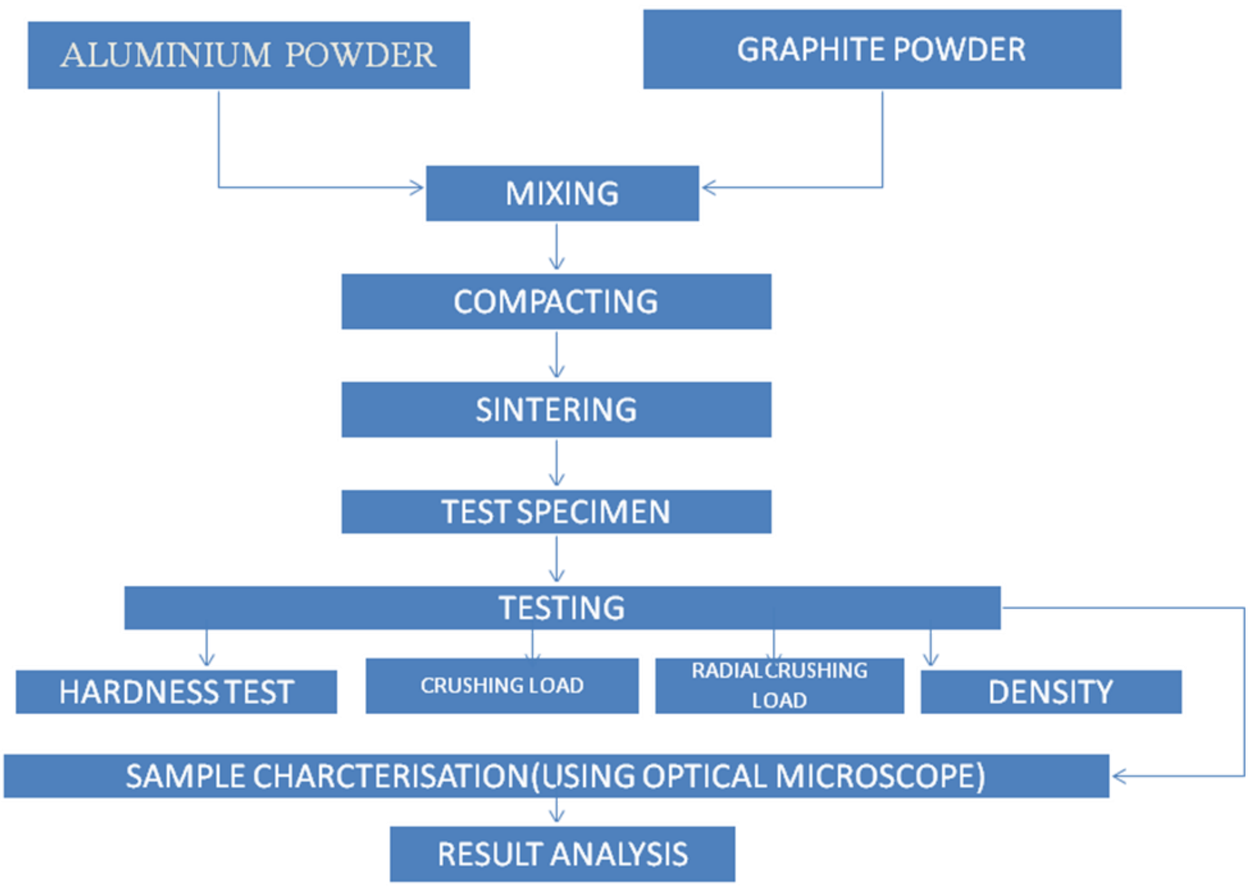


**Fig.:2 Microstructure of Al-15% graphite compact edat 100 MPa sintered at 500°C - 90min.**

## EXPERIMENTAL ANALYSIS




**CONCLUSION**

By the above results which are obtained from the procedure of powder metallurgy techniques we can conclude that the parts prepared by Aluminum-Graphite composites can be used where high temperatures and strongly alternating thermal loads appear. An improvement of durability of the electronic system can be achieved by using parts made out of Aluminum-Graphite, because the Aluminum-Graphite's coefficient of thermal expansion (CTE) is very similar to the CTE of several ceramics and semiconductors. Furthermore, Aluminum-Graphite has a lower density – in comparison to conventional materials as copper – which leads to a vital weight reduction.