Development of Ceramic Matrix Composite for Brake Discs

Project Report

Submitted in partial fulfillment of the requirements
for the award of the degree of

Bachelor of Technology
in
Mechanical Engineering

By

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CERTIFICATE

This is to certify that the report entitled **"Development of Ceramic Matrix Composite for Brake Discs"** is a bonafide record of the **Project** done by **Anshad Abdul Aziz** (*Roll No.*: **B180019ME**), **Arjun K.P** (*Roll No.*: **B180194ME**), **Ashwin Pradeep** (*Roll No.*: **B180022ME**), **Aswin P** (*Roll No.:* **B180108ME**) and **Harishankar Suresh Nair** (*Roll No.:* **B180268ME**) under our supervision, in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Mechanical Engineering** from **National Institute of Technology Calicut**, and this work has not been submitted elsewhere for the award of a degree.

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ABSTRACT

Ceramic Matrix Composites (CMC's) are a special class of composite materials. In these, the matrix material and reinforcement fibers are both ceramics. Ceramic matrix composites act quite differently than traditional ceramics and are very different from the high-performance metal alloys that were previously employed. These are hard and stable at high temperatures. They retain a relatively high mechanical strength even at very elevated temperatures. These are lightweight and possess better thermal shock resistance and fracture toughness. The elongation to rupture of ceramic matrix composites can be up to 1%, and they are not susceptible to fracture like traditional ceramic materials.

Here we have tried to fabricate a CMC material using a Silicon Carbide (SiC) matrix, reinforcing it with Chopped E-glass fibers. Chopped E-glass fibers are expected to increase the overall toughness and thermal properties of SiC matrix. The effect of different weight percentages of reinforcement fiber was also studied and compared with a monolithic ceramic sample. The temperature at which the sample is sintered determines the relative density and the porosity of the CMC. The properties and area of application of the CMC vary with these properties. We intend to find out whether the fabricated CMC can be used as an alternative for brake disk material.

CONTENTS

LIST OF ABBREVIATIONS

CMC Ceramic Matrix Composites

PVA   Polyvinyl Alcohol

SiC   Silicon Carbide

XRD   X-Ray Diffraction

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CHAPTER 1
INTRODUCTION

1. INTRODUCTION

Ceramic materials have been in use for centuries, used for various purposes in our everyday lives. Insulating materials, glass, refractories, abrasives, and enamels are examples of traditional ceramics. Their unique properties like low thermal and electrical conductivity enabling them to be used as insulating materials, high melting point and high chemical resistance have been taken advantage of for years. They offer high hardness and low mass density which has been of great use in military and safety equipment. On a whole, Ceramic materials have contributed to major advancements in various fields like aerospace, automobile, electronics, medical etc.

But these have many disadvantages too. Ceramics are very fragile in nature. Their brittle character can cause them to be easily shattered or broken. They are difficult to cut or shape for various uses. These disadvantages are improved upon by using Ceramic Matrix Composites.

CMC's can be fabricated for different purposes and according to desired properties. In general, CMCs are ultra-lightweight, extremely durable, and can perform at extreme temperatures. These properties exhibited by CMC's are very desirable in Brake discs. The majority of passenger vehicles nowadays use disc brake rotors comprised of grey cast iron or Aluminum Metal Matrix composites. But the high temperature generated during braking causes significant wear and inefficiency to the braking system. Ceramic based brake discs are also available. But currently ceramic brakes lack elastic properties and high temperature performance materials combine the best advantages of the engineering ceramics and fiber-reinforced composites including high hardness and strength, as well as greatly increased fracture toughness and graceful fracture behavior.

2.   PROBLEM DEFINITION

The use of Ceramic brake disks over conventional brake disks will give an advantage of longer lifespan, provide better noise control and less wear-and-tear, without sacrificing braking performance.

Here we aim to carry out the modelling of a brake using Solidworks, and then study its thermal and structural properties under different conditions using Ansys Workbench. At first, we assume the material properties of the model to closely resemble the characteristics of grey cast iron, which is the most commonly used brake disk material. The results thus obtained will be compared with the results obtained while analyzing the properties of the CMC material reinforced with chopped E-glass fibers.

For fabricating the CMC, we will be using a Silicon carbide matrix (SiC). Chopped E-glass fibers will be used as reinforcement material with polyvinyl alcohol acting as the binder for the two materials. After completing the fabrication process, the thermal and mechanical properties of the samples will be done. With this, we will be able to determine whether the fabricated CMC will act as a suitable material replacement for brake discs.

We will also fabricate samples with different weight percentages of the filler material. The properties will be studied and compared to find the ideal amount of reinforcement material. This will again be compared with a monolithic sample (SiC) to understand the extent of the effect of reinforcement material.

CHAPTER 2
LITERATURE REVIEW

2.1 Aniket Bharambe,**[1]** talks about the practical use of C-SiC composite material that produces much more effective braking compared to steel disc brakes. Deformation in steel is much higher than composite, which implies the deformation resistance of the composite structure was more than that of steel which was verified using Ansys.

2.2 Fatma Firouz, Atef Daoudb,**[2]** delves into the work oriented toward fabrication of automotive brake rotors from Al-9Si and Al-12Si reinforced with 10 and 20% SiC particles using a stir-casting method. It was observed that the addition as well as the uniform distribution of SiC particles lead to a significant refining effect in the matrix alloy. Hardness of the composites is increased after aging with addition of 20% SiC for both matrices which asks the question of whether other reinforcements could provide better performance.

2.3 Walter Krenkel,**[3]** performs an experimental work that involves the production of Carbon Fiber Reinforced Silicon Carbide Composites (C/SiC, C/C-SiC). It discusses about the properties of CMC's and how fiber reinforced ceramic composites offer better thermal stability and functional properties and how they can be useful for new commercial applications like brake disks and pads, clutches, calibration plates etc.

2.4 Gaurav Agarwal, Amar Patnaik, Rajesh Kumar Sharma,**[4]** studies the Thermo-mechanical properties of silicon carbide-filled chopped glass fiber-reinforced epoxy composites. It discusses the effect of addition of silicon carbide (SiC) filler in different weight percentages on physical properties, mechanical properties, and thermal properties of chopped glass fiber reinforced epoxy composites.

CHAPTER 3

METHODOLOGY

3.1 MODELLING

The sketch and the 3-dimensional model of the ceramic brake disc was created using Solidworks-2019.
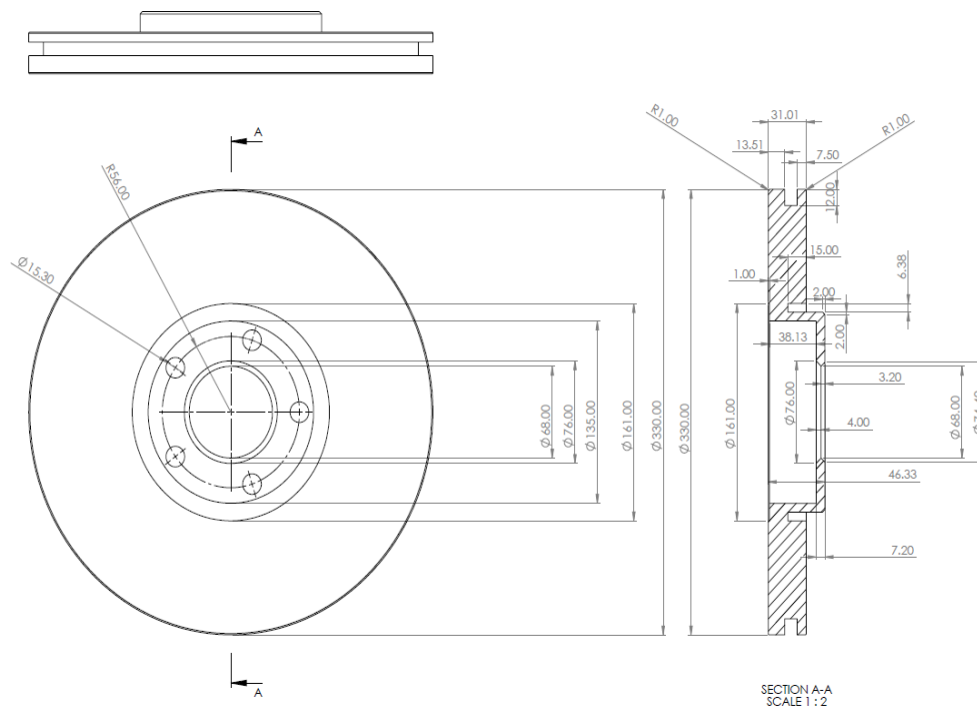
Fig 3. 1.. Orthographic Diagram of the ceramic brake disc.

We use a 330mm disc brake with a rotor thickness of 31mm as shown in Fig 3.1. The material used is Grey Cast iron and then we study its thermal and structural properties under different conditions using Ansys Workbench.
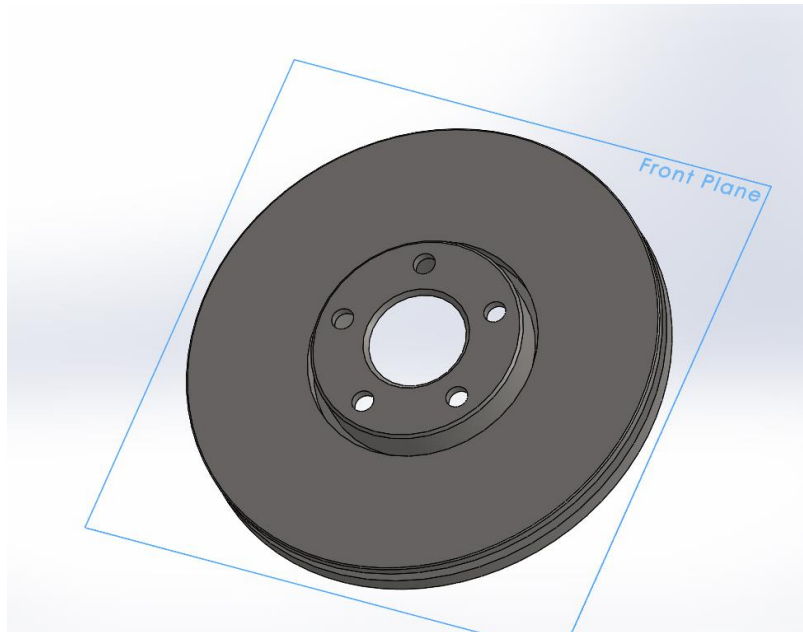
Fig 3.2 3D model of brake disc.

3.2 MATERIAL PROPERTIES OF GREY CAST IRON

The conventional grey cast iron brake discs were modeled and the thermal analysis was performed.

Characteristics	Value	Unit
Density	7340	kg/m³
Young's Modulus	124000	MPa
Poisson's ratio	0.26	
Tensile Yield Strength	250	MPa
Compressive Yield Strength	827	MPa
Isotropic Thermal Conductivity	53.3	W/mK
Specific Heat	490	J/KgK

Table 3.1. Properties of Grey Cast Iron

3.3 MESHING
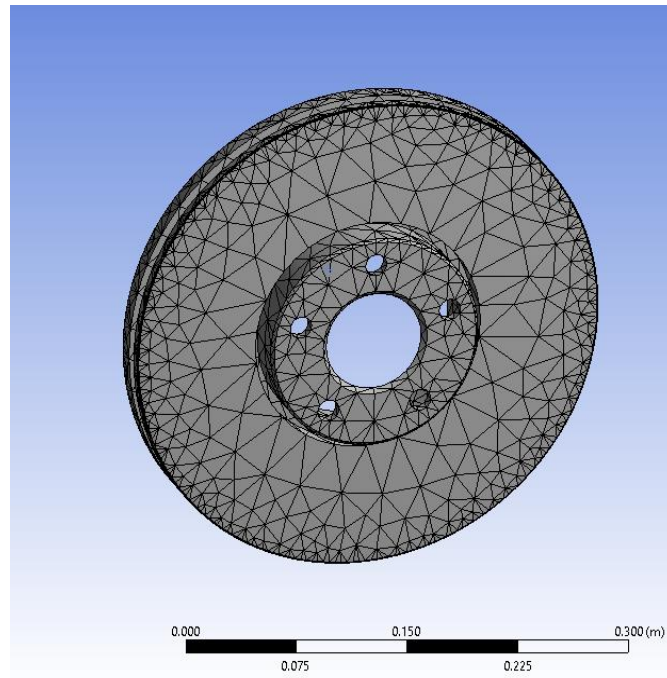
Fig 3.3 Meshing assigned for brake disc

At first, we assume the material properties of the model to closely resemble the characteristics of grey cast iron, which is the most commonly used brake disk material. The results thus obtained will be compared with the results obtained while analyzing the properties of the CMC material reinforced with E-glass chopped fibers.

3.4 BOUNDARY CONDITIONS

3.4.1 Temperature and Convection (Thermal Analysis)

A temperature of 230 °C is applied on the brake discs which are indicated in red. The part indicated in yellow describes the region where heat is dissipated due to convection as the rotor is exposed to air.
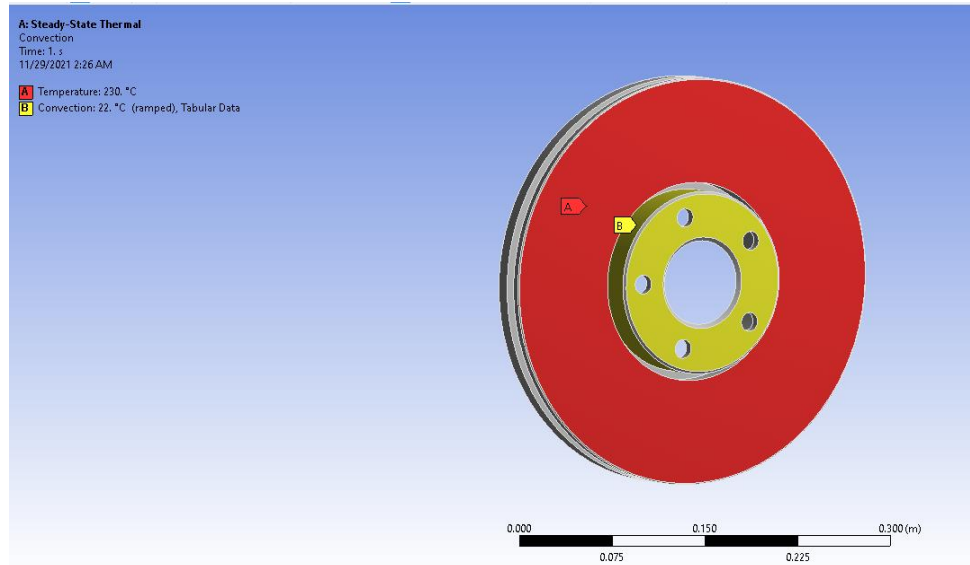
Fig 3.4 Thermal Boundary conditions applied on brake disc

3.4.2 Load Applied (Structural Analysis)

For the analysis of mechanical properties, the primary boundary condition involves fixing the brake discs at the bolting slots and then an angular velocity of 100 rad/s was applied to the given model. A pressure of 1.5MPa is applied to the working surface of the brake discs.
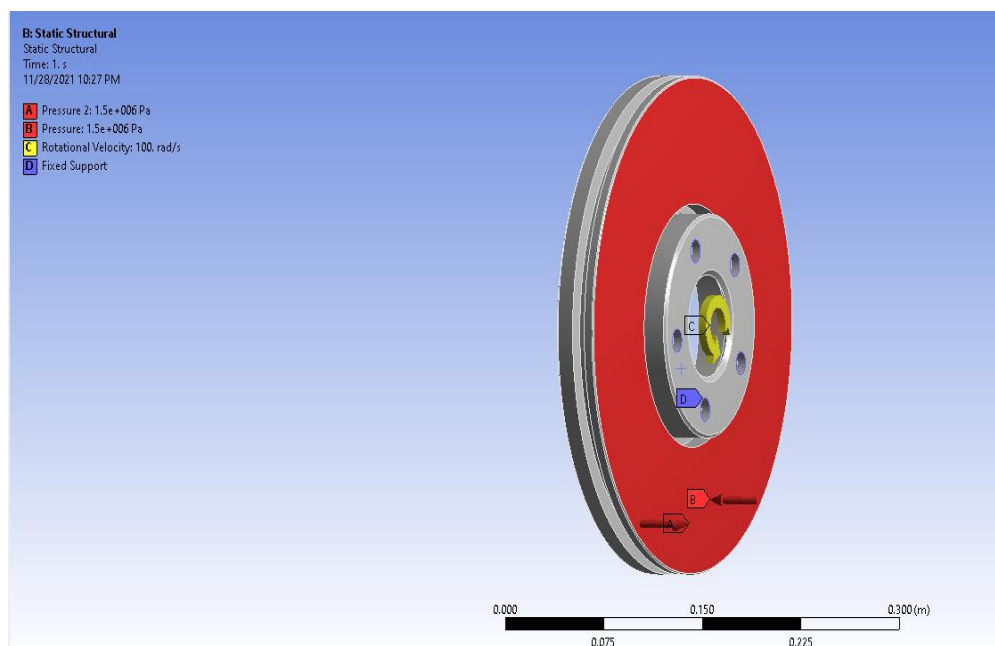
Fig 3.5 Load conditions applied on the brake disc.

3.5 LITERATURE STUDY

SiC is one of the strongest, hardest ceramics currently used. It is a very hard material with a Mohs hardness rating of 9. It has good thermal properties which makes it an ideal base material for our CMC.

Properties of Silicon Carbide

● High thermal shock resistance

● High spalling resistance (Thermal spalling is the process by which surface material cracks and breaks off due to variation of temperature.)

● Exhibits high mechanical properties at high temperatures.

● Light Weight

The shortcoming of SiC is overcome by the addition of reinforcement fibers.

The fibers can be of different forms. Some of these are short fibers, particles, whiskers, and nanofibers. These fibers have a polycrystalline structure similar to traditional ceramics. These fibers are extremely thin, with nanofiber being even thinner. The use of short fibers increases the crack propagation resistance of the CMC. The use of long fibers results in increased toughness as it slows down crack propagation by holding the CMC together when a crack starts to propagate.

Chopped E glass fiber is expected to increase the overall toughness and wear resistance of the CMC.

3.6 EXPERIMENTAL REQUIREMENTS

the experimental proceedings and apparatus required for the fabrication are listed below

3.6.1 Materials Used

1.   Silicon Carbide Powder (95% pure)

Fig 3.6 Silicon Carbide micro powder of 95% purity

2.   Chopped E glass fiber strand mat of 450 gsm(grams per square meter)

Fig 3.7 E-glass fiber mat (400 grams)

3.   Poly Vinyl Alcohol Powder
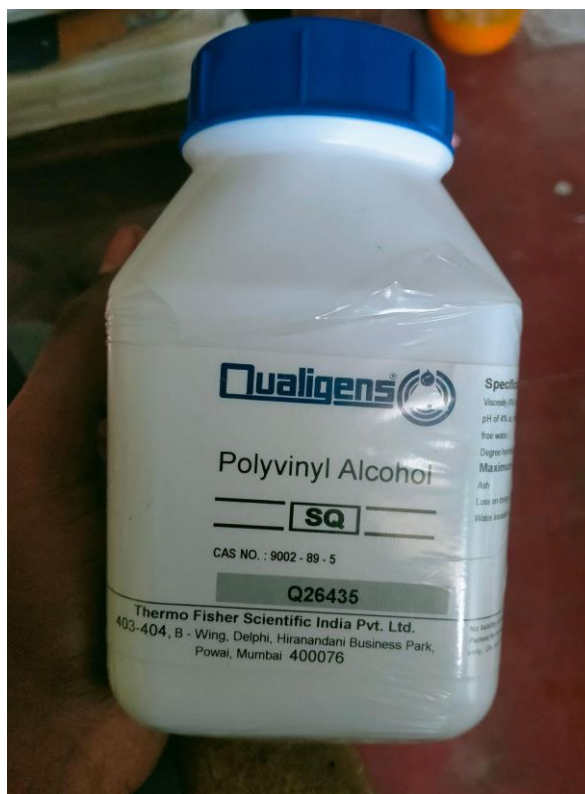
Fig 3.8 Bottle of Polyvinyl Alcohol of 99.9% purity

4.   Acetone
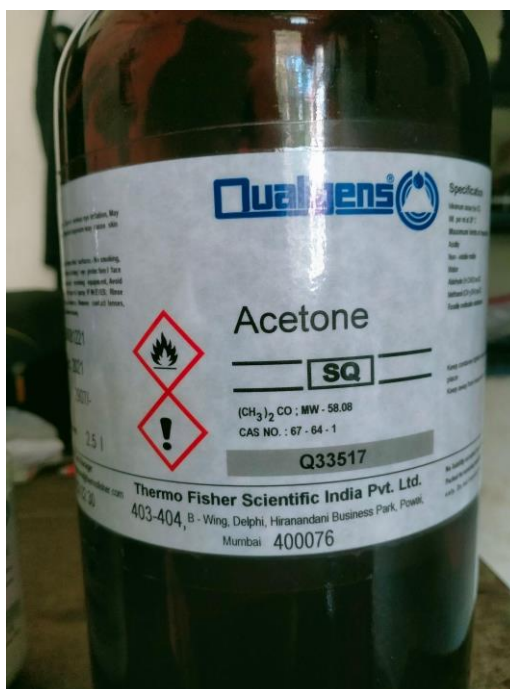
Fig 3.9 2.5L bottle of 99.9% pure acetone.

3.6.2 Procurement

- Silicon Carbide Powder (95% pure) was obtained from M&M manufacturers, Kochi. A total of 1.20 kg was obtained.
- Chopped E glass fiber strand mat was obtained from Carbon black composites, Pune.
- Poly Vinyl Alcohol Powder was obtained from Thermo Fisher Pvt.Ltd, Mumbai. 500g was obtained.
- Acetone was obtained from a local dealer in Calicut. 2.5L was obtained.
- Necessary glassware was sourced from a local dealer in Kozhikode.
- Equipment required for weighing and sampling were obtained from the Material Science Laboratory within NIT Calicut
- Pressing, sintering and testing equipments were utilized from the Ceramics Division of CSIR-NIIST.

3.6.3 Apparatus Required

- Glass rod
- Spatula
- Glass Beaker
- Petri dish
- Hot Plate
- Erlenmeyer flask
- Zip bags
- Stirrer (Check)
- 10mm Diameter Mild Steel Cylindrical Dye
- Hydraulic press
- Inert gas atmosphere furnace

3.7 MATERIAL PREPARATION

3.7.1 Procedure

3.7.1.1 Weighing and sorting the Samples

The silicon carbide powder is weighed according to the requirement. The samples were made in pellet size having a diameter of 10mm and thickness between 3-5 mm.

Fig 3.10 SiC weighed at 1.184g.

Density $\rho = \dfrac{Mass\ (M)}{Volume\ (V)}$

when two substances of different masses m_1 & m_2 and densities ρ_1 & ρ_2 are mixed the density:

$$\rho_1 = \frac{m_1 + m_2}{\dfrac{m_1}{\rho_1} + \dfrac{m_2}{\rho_2}}$$

The diameter (d) of the dye is 10mm and thickness (h) is taken to be 5mm. Hence the volume will be:

$$V = \frac{\Pi d^2 h}{4}$$

$$V = \frac{\Pi * 10^2 * 5}{4}$$

$$V = 392.699 mm^3 = 0.392699 cm^3$$

Considering Monolithic material, i.e., sample with 0% Glass Fiber, density (ρ_{SiC}) of SiC is 3.16g/cm^3. Therefore:

$$\rho = \frac{M}{V}$$

$$M_{SiC} = V * \rho_{SiC}$$

$$M_{SiC} = 0.392699 * 3.16$$

The required mass of Silicon Carbide $M_{SiC} = 1.240g$

Considering the sample with 8% Glass Fiber,

density (ρ_{SiC}) of SiC is 3.16g/cm^3

density (ρ_{gf}) of E-glass Fiber 2.54 is g/cm^3

$$\frac{M_{SiC}}{Mgf} = \frac{92}{8}$$

$$M_{SiC} = \frac{92 * Mgf}{8}$$

$$V = 392.699mm^3 = 0.392699cm^3$$

$$V = V_{SiC} + V_{gf}$$

$$V = \frac{M_{SiC}}{\rho_{SiC}} + \frac{M_{gf}}{\rho_{gf}}$$

$$V = \frac{92 * Mgf}{8 * \rho_{SiC}} + \frac{M_{gf}}{\rho_{gf}}$$

$$V = M_{gf} * \left(\frac{92}{8 * \rho_{SiC}} + \frac{1}{\rho_{gf}}\right)$$

$$V = M_{gf} * \left(\frac{92 * \rho_{gf} + 8 * \rho_{SiC}}{8 * \rho_{SiC} * \rho_{gf}}\right)$$

$$M_{gf} = V * \frac{8 * \rho_{SiC} * \rho_{gf}}{92 * \rho_{gf} + 8 * \rho_{SiC}}$$

$$M_{gf} = 0.392699 * \frac{8 * 3.16 * 2.54}{92 * 2.54 + 8 * 3.16}$$

$$M_{gf} = 0.0913728g$$

$$M_{SiC} = \frac{92 * Mgf}{8}$$

$$M_{SiC} = \frac{92 * 0.106467}{8}$$

$$M_{SiC} = 1.2243g$$

Mass for all the other sample were found out using the similar method

Composition	M_{SiC}	M_{gf}
Monolithic	1.240g	0
2.5% Eglass Fiber	1.202567g	0.030835g
5% Eglass Fiber	1.164479g	0.06129g
8% Eglass Fiber	1.1197g	$0.0913728g$

Table 3.2. Material contents in subsequent mixtures of varying proportions.

3.7.1.2 Making E glass fibers according to the requirement

Chopped E glass fiber strand mat had to be cut into individual strands of 2mm - 4mm. These strands were chopped into the required length using scissors. These chopped fibers were weighed according to requirement.

One strand of the chopped fiber contains about 50 thinner individual strands.

The chopped fibers are immersed in acetone solution in order to disperse the fibers and isolate them into the individual strands. The fibers are left in acetone till they are separated into individual strands.

Fig 3.11 (a)&(b) E-glass fibers chopped at 2-3mm length.

3.7.1.3 Mixing of SiC and E glass fiber

Silicon carbide powder can be mixed with the chopped glass fibers in two ways:

Method 1 :

The powder is added directly to the fibers dispersed in acetone solution and mixed. Initially, the fibers will remain immersed in acetone for 10 mins for them to get separated into individual strands. Then the weighed SiC powder can be added and mixed. The mixing is done till the chopped fibers are completely mixed with the

silicon carbide powder. Acetone will evaporate during the mixing process. More acetone can be added to ease the mixing process. Excess acetone present in the mixture can be heated on a hotbed till it completely evaporates. The whole mixing process takes almost 45 mins when done by hand. The final mixture will be in a powdered form.

Fig 3.12 (a)&(b) Mixing process when acetone is present

Method 2 :

The glass fiber immersed in acetone is kept till the acetone completely evaporates. Then SiC powder is added and is thoroughly mixed. The mixing is done till the constituents are in inseparable and almost in a powdered form

Fig 3.13 Chopped E-glass fibers dispersed in acetone.

Both the methods were carried out. The first method was found to be more convenient as mixing was easier when having acetone as a dispersing medium. Also, the time required for evaporation of acetone could be avoided as it happens during mixing itself.

3.7.1.4 Preparation of PVA Solution

Preparation of PVA Solution: PVA acts as binder and keeps the mixture together to form it into pellets during pressing. For this a 5 % concentrated (By weight) PVA solution is made from PVA powder. Laboratory grade PVA powder and distilled water is used for preparing the solution. PVA is mixed with distilled water. It is then heated at 75 and stirred using a mechanical/magnetic stirrer. This is done for 1 hour and the solution is cooled.

Fig 3.14 (a)&(b) Preparation of PVA Solution

3.7.1.5 Adding Binder to the mixture

The prepared PVA solution when cooled is mixed with the SiC- Chopped glass fiber mixture. For 10 g of the sample mixture, 3 ml of PVA solution is used. This is added and mixed thoroughly till the mixture becomes thick and sticky. This mixing has to be done by hand and can take almost 1 hour to mix.

Fig 3.15(a)&(b) Adding PVA to the mixture of SiC & Chopped glass fiber

3.7.1.6 Heating the Mixture

The Silicon Carbide chopped glass fiber PVA bound mixture is heated on a hot bed at 100 degrees Celsius. This is carried out to evaporate water completely from the PVA solution present in the mixture. The dehydrated final product after hours of heating and stirring is obtained in the form of fine powders.

Fig 3.16 (a)&(b) Mixture after water evaporation

3.7.1.7 Pressing the Sample

1g of the Silicon Carbide fiber reinforced mixture is loaded into a 10mm dye. The dye was pressed on a hydraulic press and a pressure equivalent to 7 tons was applied to the given dye. The hydraulic press offered by the research institution of CSIR was used for carrying out the pressing process. After pressing, the sample is obtained in pellet form with diameter 10mm and thickness 4-5mm.

Fig 3.17 (a)&(b) Setting up and pressing the mixture using the dye

Fig 3.18 (a)&(b) Pressing of different Sample

Fig 3.19 Sample after it is pressed

3.7.1.8 Sintering

The above processes were carried out for 3 more samples with variation in weight % of the E-glass chopped fibers. The weight % of the E-glass fibers in the mixture used are 0, 2.5%, 5%, 8%. The four pellet samples are placed onto a miniature boat which is loaded into an inert atmosphere gas furnace. After loading the samples a vacuum atmosphere is created using vacuum pumps for maximum oxygen depletion. This is a necessary process as Silicon Carbide present in the mixture can only be sintered in the absence of oxygen as otherwise it will be decomposed to Silica and Carbon dioxide at higher temperatures. After the vacuum atmosphere is created a streamline flow of Nitrogen gas is supplied throughout the sintering process within the inert atmosphere furnace again basically to prevent any formation of oxides. The process involves mainly 7 segments.

Segment 1
The samples are initially kept at room temperature. The temperature is increased at a steady rate of 5 degree Celsius per minute till the sample reaches 100 degree Celsius.

This steady heat treatment process is known as ramp rate.

Segment 2

Segment 2 involves the dwelling phase where the samples are kept steady at 100 degrees Celsius for about 30 minutes. This is done in order to remove any moisture content that may be present in the sample.

Segment 3

After keeping the temperature constant for 30 minutes, again a ramp rate is applied at the same rate of 5 degree Celsius per minute up to 600 degrees Celsius.

Segment 4

At 600 degrees Celsius, we apply a dwelling phase again for an hour. This is done in order to ensure complete evaporation of PVA so that it does not interfere in the softening and melting of the glass fibers once we reach the higher temperatures.

Segment 5

We apply a ramp rate of 5 degree Celsius till the maximum temperature that can be applied to the inert gas atmosphere furnace which is 950 degrees Celsius.

Segment 6

Dwelling phase is carried out at 950 degrees Celsius for two hours.

Segment 7

Now the material is cooled down via natural cooling at a controlled slow rate within the inert atmosphere gas furnace. The natural cooling process takes about 15 hours to reach room temperature.

The entire heating process including the 2-hour dwelling phase of the sample within the inert gas atmosphere furnace takes about 6 hours and 40 minutes. Adding this to the time taken during natural cooling, the total process takes about 22 hours to

unload the sample back from the furnace. During all this time including the cooling process, nitrogen was supplied in streamline flow.

The graphical representation of the sintering process with respect to time is given below.
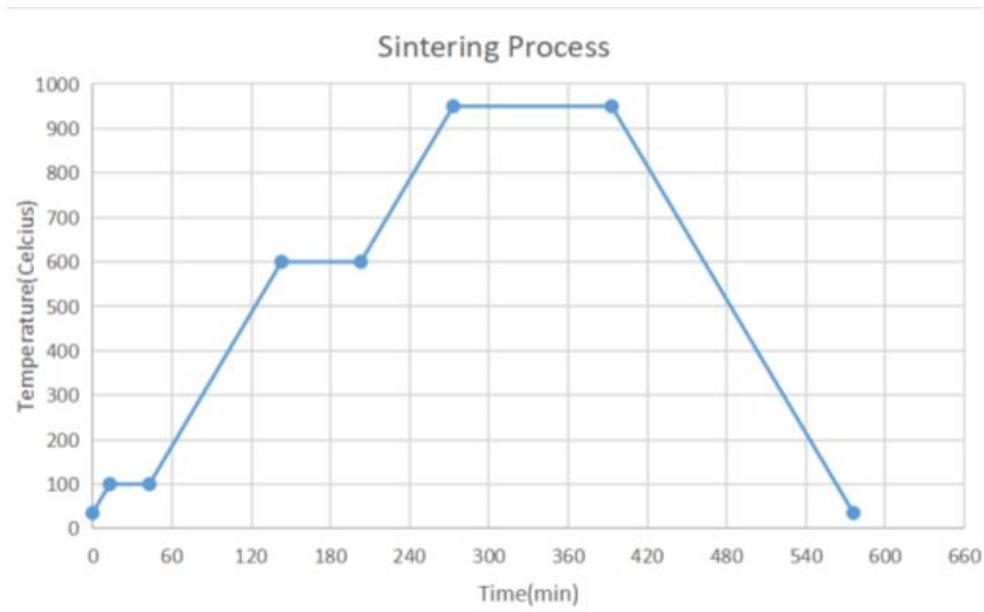

Fig 3.20 Time vs Temperature graph for sintering process

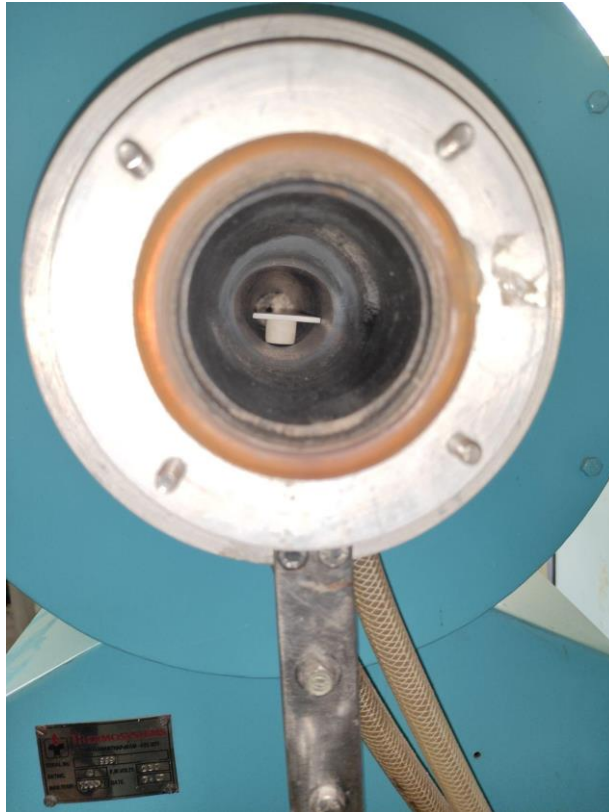Fig 3.21 Pressed pellets placed in the crucible for sintering

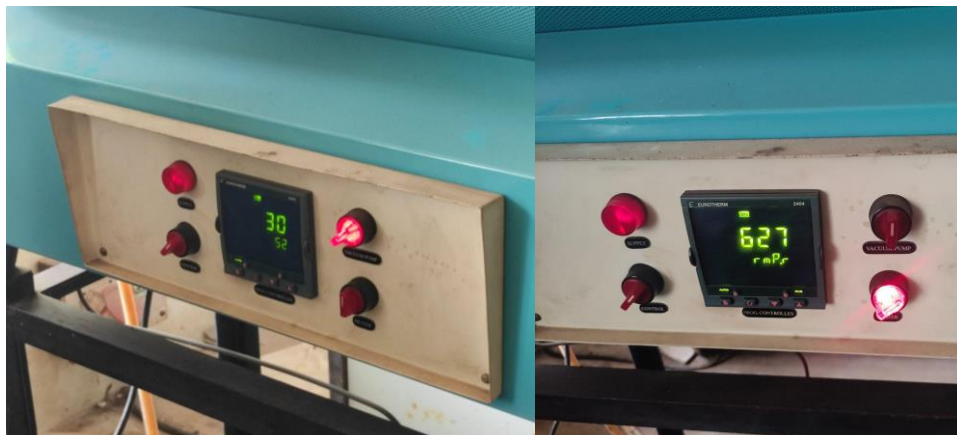Fig 3.22Crucible placed inside the inert atmosphere furnace.

Fig 3.23 (a)&(b) Different segments involved in the Sintering Process

CHAPTER 4
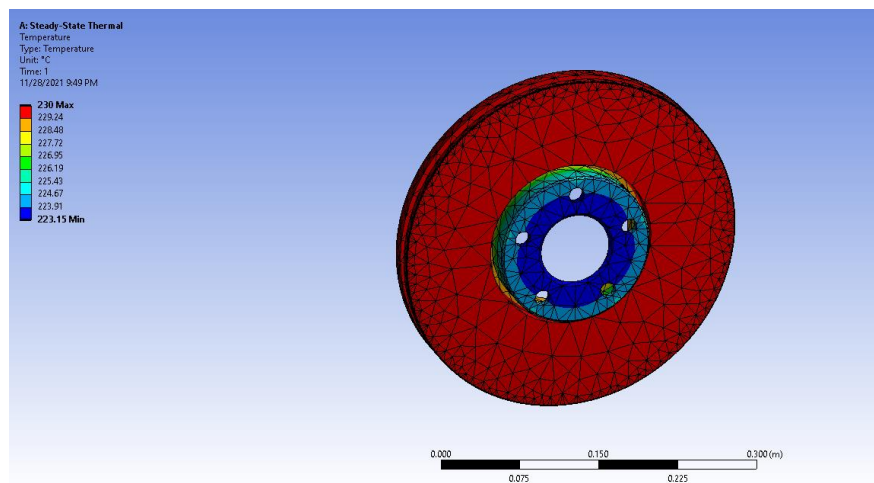# RESULTS AND ANALYSIS

4.1 THERMAL ANALYSIS

Fig 4.1 Temperature variation of brake disc

In the steady state thermal analysis, the part shown in red is where we applied a temperature of 230 degree Celsius which is about the maximum heat that is generated during brake application. The interior part is exposed to air and therefore it will be subjected to heat dissipation in the form of convection.

In the results we observed that a minimum of 223 degree Celsius was achieved for the model disc at the interior of the rotor.

4.2 STRUCTURAL ANALYSIS

In the static structural analysis, we applied an angular velocity of 100 rad/s to the model and a pressure of 1.5 MPa during brake application keeping the bolted slots as our fixed support.

In the results for total deformation, it was observed that the total deformation is linearly proportional to the radius and is maximum at the outer disc and comes to about 0.4mm.
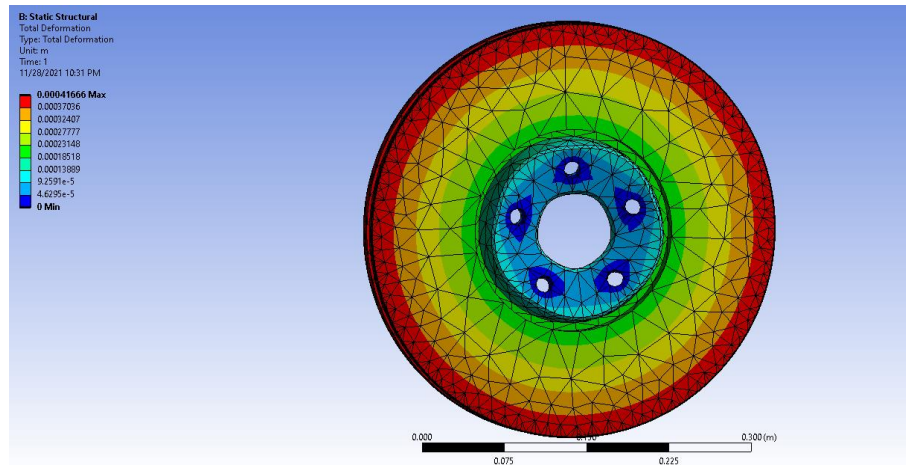

Fig 4.2 Total Deformation of brake disc

The Von-Mises Stress was observed to be minimum at the outer disc and maximum at the bolted joints and it comes to about 500 MPa.
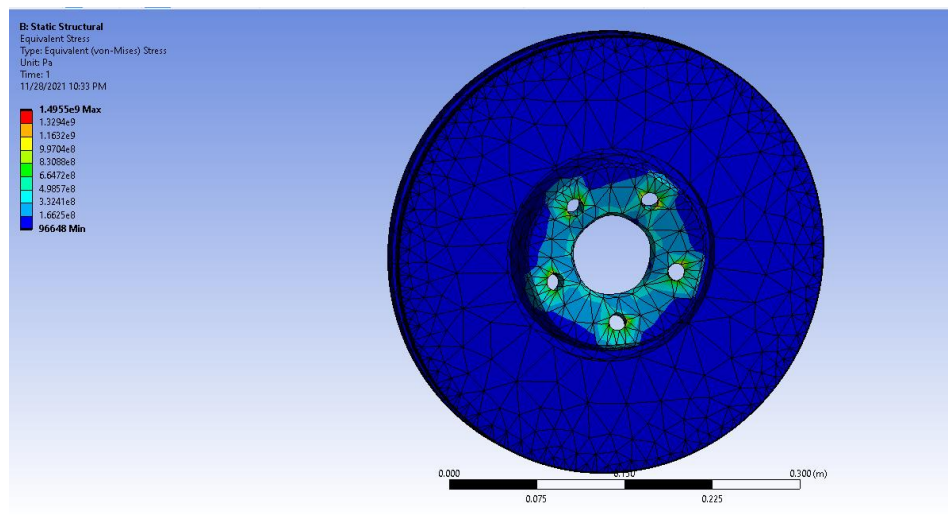

Fig.4.3 Equivalent Von-Mises Stress

4.3 DENSITY

Percentage Composition(M/M)	0	2.5	5	8
Diameter(mm)	10.27	10.15	10.24	10.04
Thickness(mm)	5.68	5.01	5.2	5.50
Mass(g)	0.9648	0.8459	0.8891	0.9482
Theoretical Density(g/cm³)(ρ_T)	3.16	3.140833	3.12189	3.0994
Density of the sample(g/cm³)(ρ_S)	2.050492	2.08669	2.0761	2.15411
Relative density (%)	64.889	66.43748	66.50138	69.49930

Table 4.1. Properties of CMC

For a sample with 95% SiC and 5% E glass Fiber

$$\boldsymbol{\rho_T} = \frac{m_{SiC} + m_{gf}}{\dfrac{m_{SiC}}{\rho_{SiC}} + \dfrac{m_{gf}}{\rho_{gf}}}$$

Where:

m_{SiC} is Mass of SiC

m_{gf} is Mass of E Glass fiber

ρ_{SiC} is Density of SiC

ρ_{gf} is Density of E Glass Fiber

Here:

m_{SiC} =95

m_{gf} =5

ρ_{SiC} =3.16

ρ_{gf} =2.54

$$\rho_T = \frac{95 + 5}{\frac{95}{3.16} + \frac{5}{2.54}}$$

$$\rho_T = 3.12189$$

$$\rho_S = \frac{M}{V}$$

Where:

    M is Mass of Sample

    V is Volume of Sample

    $V = \frac{\Pi d^2 h}{4}$

    d is diameter of the sample

    h is thickness of the sample

Here

    M=0.8891g

    d=10.24mm

    t=5.20mm

$$V = \frac{\Pi * 10.24^2 * 5.20}{4}$$

$$V = 428.2458 \, mm^3$$

$$V = 0.4282458 \, cm^3$$

$$\rho_T = \frac{0.8891}{0.4282458}$$

$$\rho_T = 2.0761 g/cm^3$$

$$Relative\ Density = \frac{\rho_S}{\rho_T} * 100$$

$$Relative\ Density = \frac{2.0761}{3.12189} * 100$$

Relative Density = 66.50138%
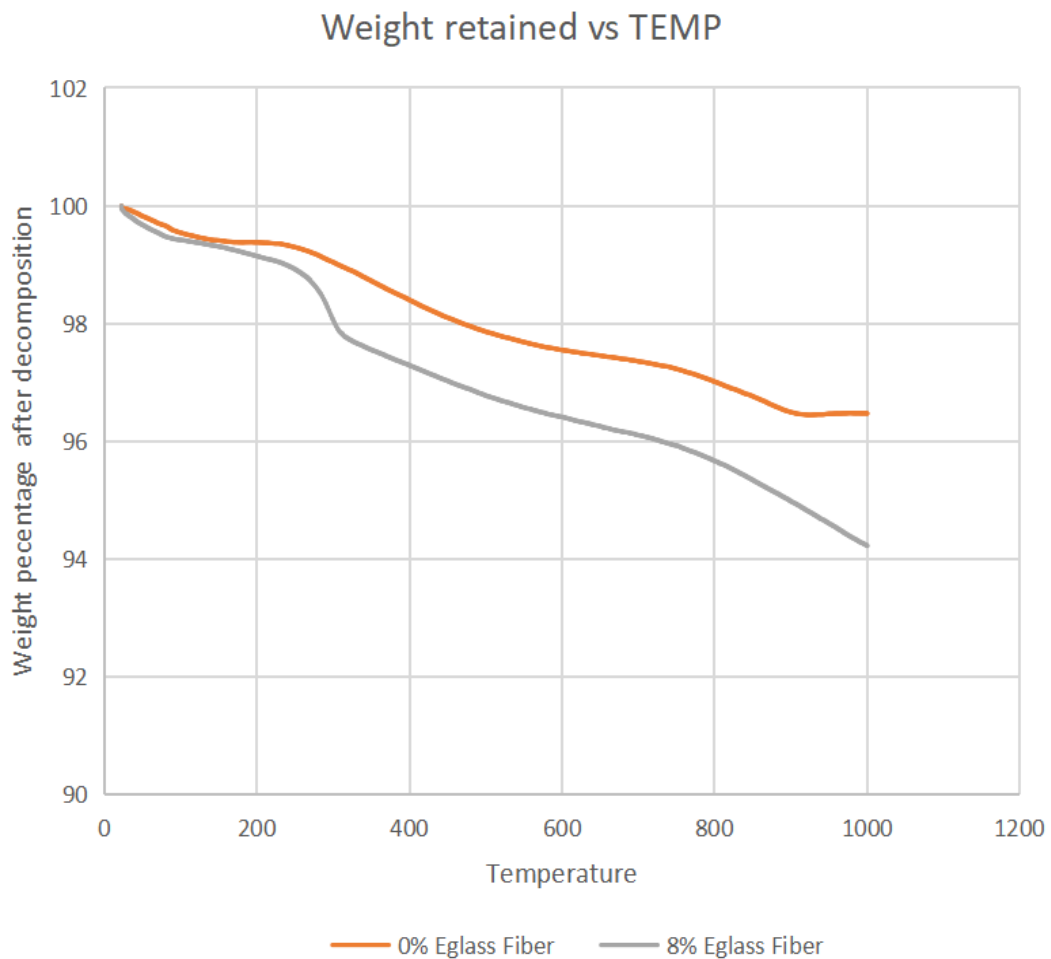
4.4 THERMO GRAVIMETRIC ANALYSIS

Fig 4.4 Weight Retained vs Temperature graph

From the figure it is understood that more degradation happened in mixture of 8% Eglass fiber, this is because the melting point of Eglass fiber is less than that of SiC, and the degraded substance is Eglass
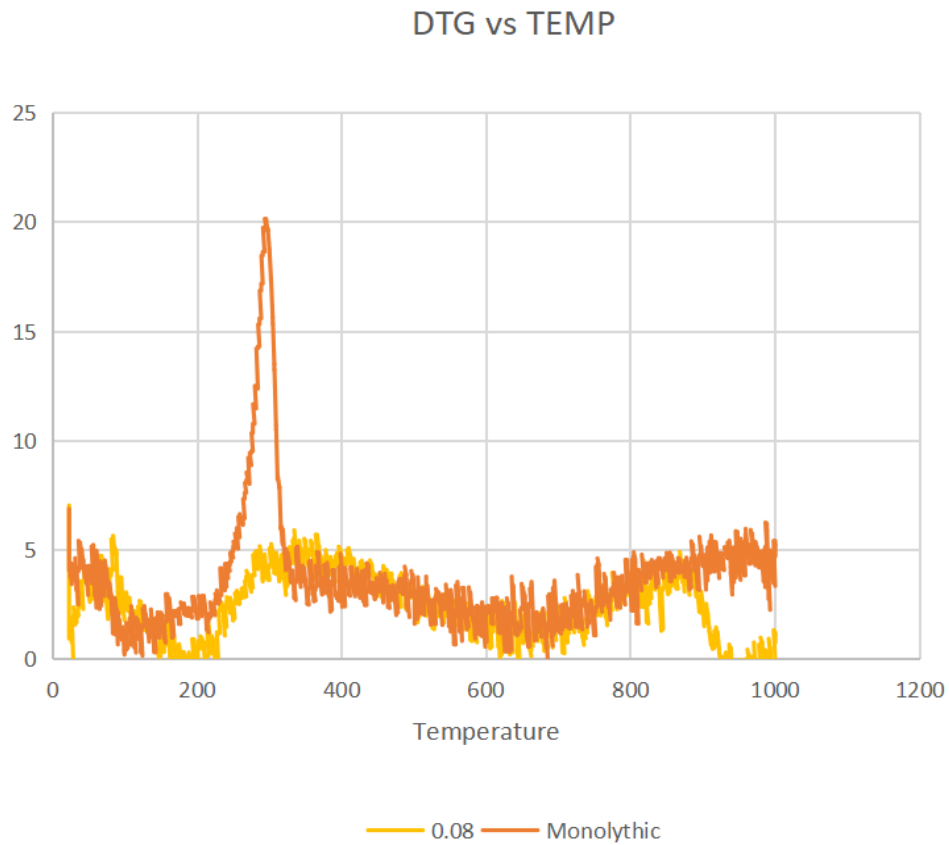
Fig 4.5 Weight Retained vs Temperature graph

From the figure it is understood that Monolithic has variable in degradation at nearly 300°C. also by seeing the chart we can see that 1% degradation happened at 305°C for Monolithic and 236°C for 8% mixture.
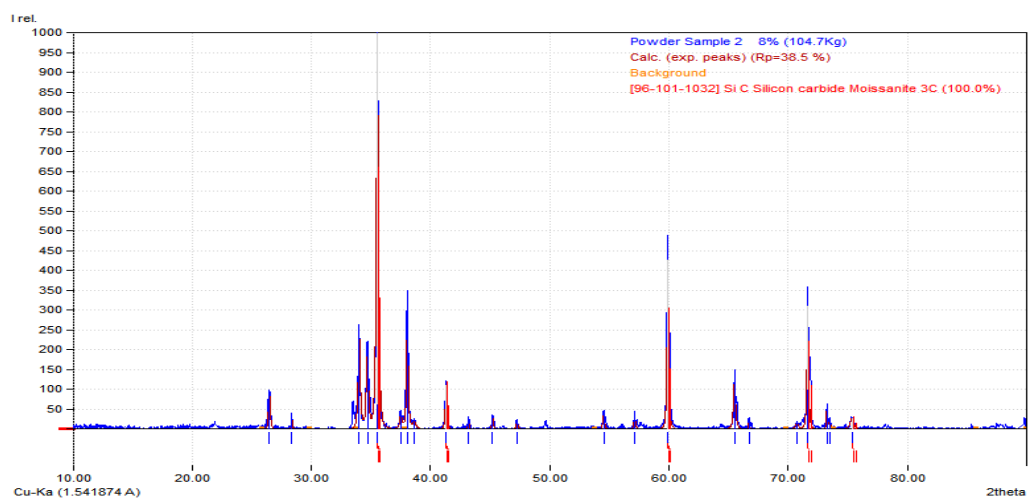
4.5 X-RAY DIFFRACTION

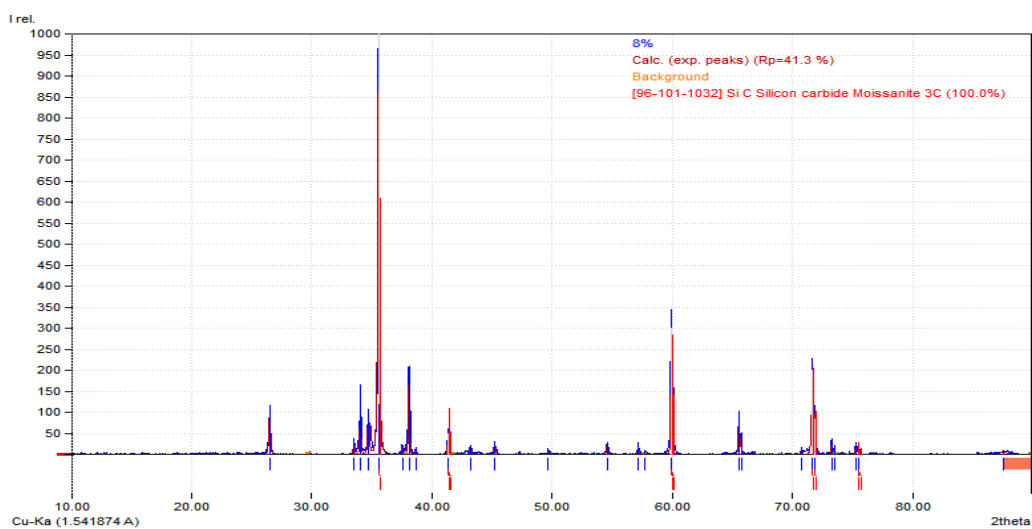Fig 4.6. XRD test of 8 % powdered sample

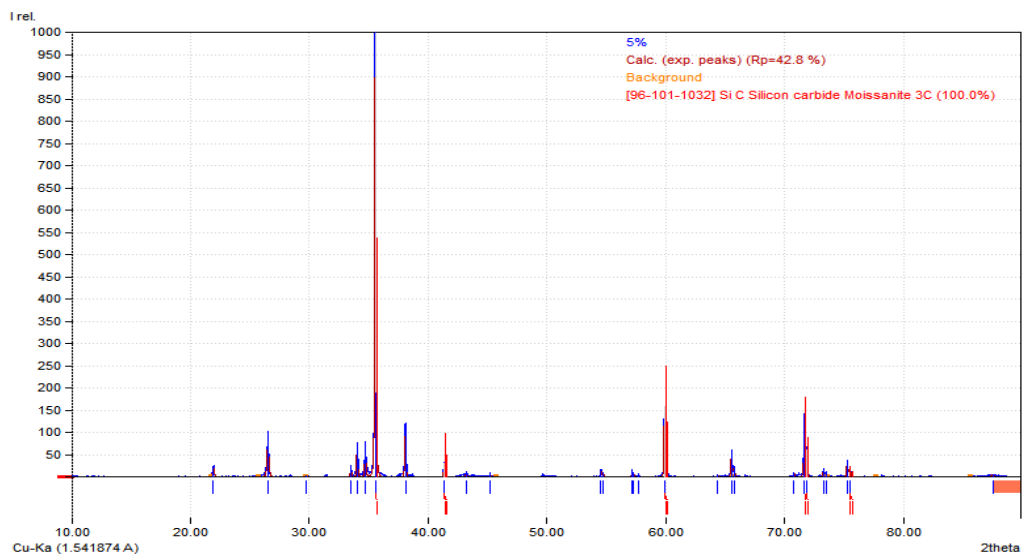

Fig 4.7. XRD test of 8 % sintered sample

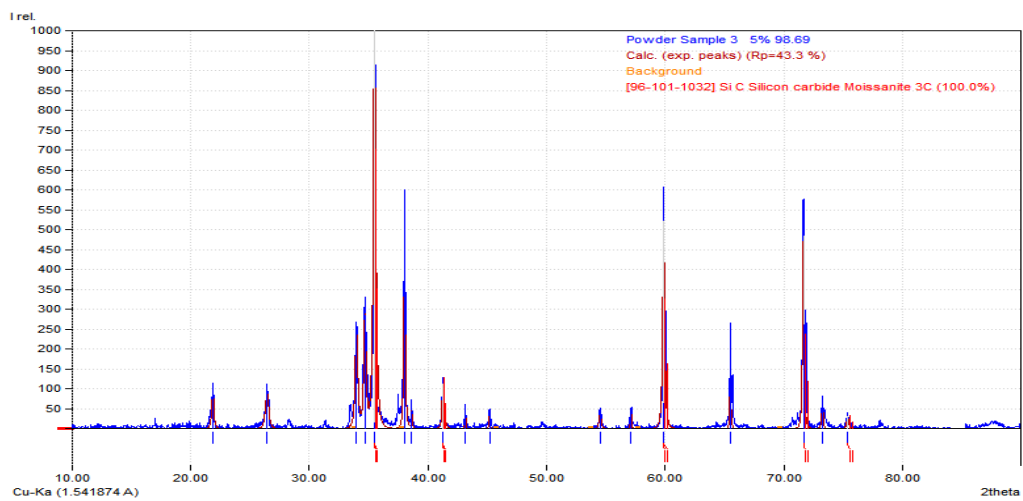Fig 4.8. XRD test of 5 % sintered sample

Fig 4.9 XRD test of 5 % powdered sample

CHAPTER 5
CONCLUSION AND FUTURE WORKS

5.1   CONCLUSIONS

Our intention was to make a Silicon Carbide hard material that was reinforced with E-glass chopped fibers for the material of the brake disc. Due to lack of access to required facilities for the high temperature firing, we could incorporate the fiber at different weight percentages, pressed the sample into pellets and heat treated it in an inert atmosphere. But unfortunately, we got the pellet with geometrical stability but the sintering had not taken place. But there is a way to improve the densification either by infiltrating with the polymer at room temperature or by infiltrating with the glass fibers. If we infiltrate with glass fibers, we may be able to get a dense material but again it will be a brittle material. The final product that we obtained was E-glass blended Silicon Carbide porous pre-forms. These porous pre-forms with respect to its pore size and porosity can be used in the applications of hot gas filtration such as to exempt water vapor from steam etc.

5.2   FUTURE SCOPE

1. Silicon Carbide porous pre-forms such as this can be utilized in immobilizing epoxy resins to the maximum extent possible. i.e., This might be the way to incorporate maximum ceramic phase within the polymer matrix. In general, using solution casting technique, a maximum of 40% filler can only be used in the polymer matrix because otherwise there will be change in viscosity therefore casting cannot be done. Epoxies are brittle materials with relatively low mechanical strength. By introducing this preheated fiber reinforced Silicon Carbide, we may be able to enhance their mechanical properties. It gives the material structural reliability and can be used in structural bearing applications.

2.Hot gas filtration. If we delve more into the porosity of the sample, we understand that it can be used in application of hot gas filtration. For Example, by passing steam into the given sample modified with silanes (alkyl silanes, amino propyl trimethoxy silane) we can extract the water vapor content and release dry steam because of their hydrophobic nature. It can be used in oil water separation.

3. Electro ceramics. Silicon Carbide and chopped E glass fibers provide excellent reinforcements for polymers that can be used as materials for making mobile phone body covers. Silicon Carbide is a partially conducting material. If we apply mild heat to it, Silicon dioxide will be formed on the shell and Silicon Carbide will be maintained in the core. At the interface of these two a Silicon dioxide layer is formed which is a low di-electric. With the conducting material and the di-electric outer shell coming in close vicinity a duplex microstructure is formed which will exhibit interesting electronic properties.

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