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Mechanical Behaviour & Quantitative Analysis Of Ceramic Fiber Reinforced Silica Matrix

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ABSTRACT: - A composite is a structural material which consists of two or more constituents combined at a macroscopic level. The constituents of a composite material are a continuous phase called matrix and a discontinuous phase called reinforcement. Matrix gives shape and protects the reinforcement from the environment. It also makes the individual fibres of the reinforcement act together and provides transverse shear strength and stiffness to the laminated composites. The present work deals, epoxy based composite filled with ultra-light micro-silica is prepared by traditional hand layup method, using ceramic fibre as reinforcement. The effect of various percentages of micro-silica is investigated on the tensile strength, compression strength, impact resistance and thermal stability of the composite using Thermo-Gravimetric Analysis(TGA) analysis. The result reveals that, up to 15% addition of micro-silica enhanced the mechanical properties, thermal stability and increase the weight. However, the addition of micro-silica beyond 15% decreases the enhanced properties of the composites.

KEYWORDS: Ceramic Fibre Reinforcement, Mechanical properties, Silica-matrix & TGA.

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I INTRODUCTION

Composite materials that are resistant to ablation can be used as components in rocket and space shuttle. Hot gas generated from combustion within the combustion chamber of the rocket will have a temperature of 2000-4000 °C that is very high temperatures. During the hot gas flow through a pipe to nozzle of rocket motor to drive the rocket to the goal. As a result, the corrosion has occurred. The reinforcing phase provides the strength and stiffness. In most cases, the reinforcement is harder, stronger, and stiffer than the matrix. The reinforcement is usually a fiber or a particulate. A fiber has a length that is much greater than its diameter. The length-to-diameter (l/d) ratio is known as the aspect ratio and can vary greatly. Continuous fibers have long aspect ratios, while discontinuous fibers have short aspect ratios.

Composites refer to a material consisting of two or more individual constituents. The reinforcing constituent is embedded in a matrix to form the composite. One form of composites is particulate reinforced composites with concrete being a good example. The aggregate provides stiffness and strength while the cement acts as the binder to hold the structure together. There are many different forms of particulate composites. The particulates can be very small particles (< 0.25 microns), chopped fibers (such as glass), platelets, hollow spheres, or new materials such as bucky balls or carbon nano-tubes. In each case, the particulates provide desirable material properties and the matrix acts as binding medium necessary for structural applications.

Ceramic Fiber is produced from high purity alumina silicate material through strictly controlled high temperature furnace melting and fiberizing process. The fiber is white and odourless, suitable for high temperature applications up to 2300°F.Ceramic fiber is shown in the below fig.1

Fig: 1 Ceramic fiber

Fig:2 Micro-silica

Silica fume, also known as micro-silica, is an amorphous (non-crystalline) polymer of silicon dioxide and silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy and consists of spherical particles with an average particle diameter of 150 nm. Micro-silica is shown in the below fig.2.

II OBJECTIVES FROM LITERATURE REVIEW

To develop a light weight ceramic fibre reinforced composites with improved mechanical and thermal stability for Thermal Protection System using TGA Analysis.

To find the effect of Micro-silica filler on Mechanical behaviour of the ceramic composites and their stability at different percentages

III METHODOLOGY & EXPERIMENTAL PROCEDURE

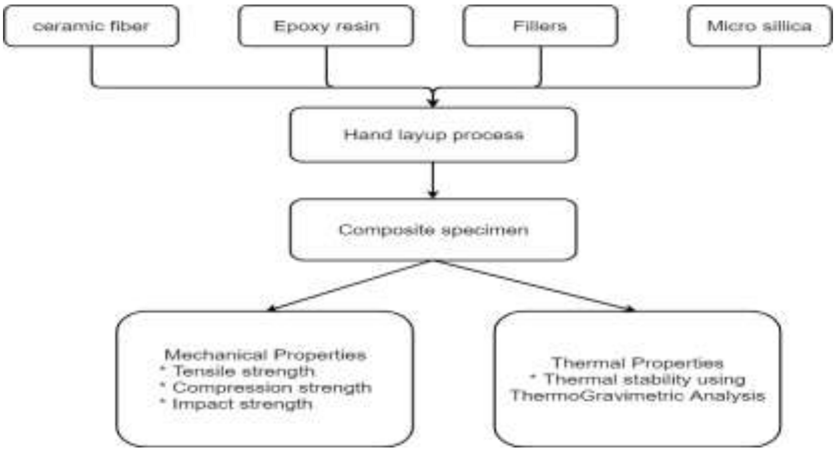

Fig. 3.2 Methodology

EXPERIMENTAL PROCEDURE

Work station preparation Mould preparation Hand Lay-up process
Curing Cleaning

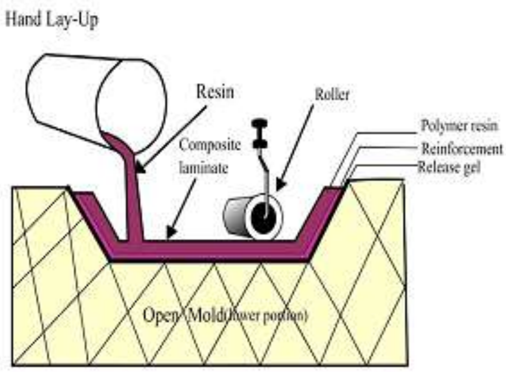

Fig. 3.4 Microwave oven

Fig. 3.3 Hand layup process

3.4 SPECIMEN COMPOSITE AT VARYING MICROSILICA PERCENTAGE

Fig.3.5 Specimen with 0% Microsilica

Fig.3.6 Specimen with 10% Microsilica

Fig.3.7 Specimen with 15% Microsilica

Fig.3.8 Specimen with 20% Microsilica

IV RESULTS AND DISCUSSIONS

4.1 MECHANICAL PROPERTIES

The mechanical testing is performed to quantify the effect of the microsilica on the mechanical performance of the microsilica filled composite. Tensile strength and Compression strength were measured at ambient condition using a universal testing machine. Charpy impact strength was determined at ambient condition using Charpy impact tester.

Fig. 4.1 Automated Universal testing machine

Percentage of filler(%)	Load at Peak (KN)	Tensile Strength (N/mm²)	Load at peak (KN)	Compressive strength (N/mm²)	Energy absorbed (Charpy) in Joules
0	7.92	51.53	2.93	18.85	4.82
5	9.75	64.21	3.62	23.25	6.08
10	10.32	68.88	3.84	25.36	6.86
15	10.95	71.93	4.17	27.21	7.35
20	10.67	70.12	4.06	26.13	7.09

V CONCLUSIONS

The addition of microsilica up to 15% with the epoxy resin as filler in the Ceramic fibre / epoxy resin composite increases the tensile strength, compressive strength , impact resistance , Thermal stability and decrease the weight of the composite. However, the addition of microsilica beyond 15% reduces the tensile strength, compressive strength , impact resistance and decrease the weight of the composite due to poor wettability of the fibre. Hence it is ideal to utilize the composite beyond 15% addition of microsillica. It is found that from the past researches the Ceramic Fiber, epoxy resin and Microsilica Composite can withstand the temperatures up to 1400°C.

High temperature Reusable Surface Insulation (HRSI) in aircraft was primarily designed to withstand 1600°C or 2910°F. Low temperature Reusable Surface Insulation (LRSI) is used to withstand the temperatures up to 649°C or 1200°F. So that it is concluded that this composite specimens can be used in the Aerospace applications because this composite can withstand temperatures up to 1400°C.

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