Analysis and Improvement of Composite Materials

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Abstract – the perforation of materials analysis and improvement of composite materials in modern world use full can be utilized from the fact that more of the research in being to the apply the new materials into different components, and different fields of applications. It is the natural for design Engineer to create rely a confidential and advance tested materials, such that the changing today composite materials have converted all the composite materials engineering. The improvement of composite materials the evaluation an opportunity to various designer to use new and batter materials and improving cast reduction, increase to efficiency and goodness utilization of presented resources. The composite materials an improving their applications of different fields in an aerospace industries, manufacturing industries, automobile industries, and biomedical industries etc. the paper manly focuses on the importance of composite materials in Mechanical Engineering and civil Engineering technology applying in composite materials .The various definitions and classifications, properties of the analysis and improvements in composite materials in different space of the world.

Key Words: Manufacturing, Aerospace, automobile, biomedical, industries analysis improvement, research.

INTRODUCTION - The production of new generation materials for in this paper introduces basic concept of density of materials and stiffness, strength weight of the composite materials from renewable sources in an increasing important fields of research and development. The demand for stronger, stiffness and more light weight materials is essential in most industries. The mechanics of fiber reinforced advance composites materials the fibers used in the composites industries can be divided into same categories. Natural fibers and synthetic fibers, natural fibers (can be mostly derived from trees and plants) are considered to be environmentally friendly and therefore, in recent years, this composite materials technology is same times termed " **micromechanics"** the relation between **macroscopic** engineering properties the two or more materials chemically different constituents combined macroscopically. Properties of final product should be significantly different than that of composite materials constituents, manly the volume fraction of fiber. The current used of composite materials in the composed of dissimilar subunits if examined at closed detail.

2. Materials: the current used of the composite materials in the composed of dissimilar subunits if examined at closed detail but the "matrix" material that is reinforced with fibers. For the (fiber reinforced plastic) **"FRP"** usually indicates a thermosetting polyester matrix containing glass fibers and the cast reductions and improvements in material performance. The particular composite has the highly resistant to corrosion and fatigue.

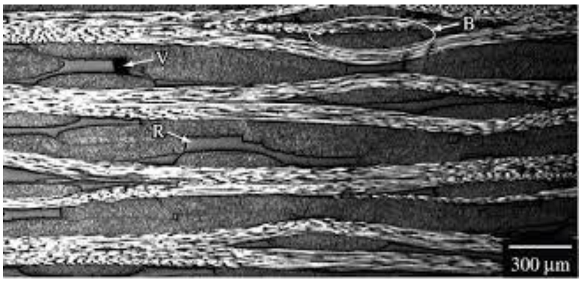

Fig.1. Showing non uniform fiber packing and micro-cracking

The cross plying unidirectional reinforced layers in a 0 – 90° stacking sequence. Their promising characteristics have attracted key players from the industries to support further research on composites increasing of material technology, with performance and airframes and vehicles parts made of composite can be increase the operational range of the aircrafts and reduce the fuel casts. The demand for lightweight and cast effective materials. Table1. That is the fiber used in modern composites have stiffness and strength for above those properties of advance composites materials is presented by the table the high strengths of the raw materials of choice to be used by many industries in eluding the aerospace, automotive, marine, military and defense industries. Actually according to findings natural fibers were utilized more than 3000years ago.

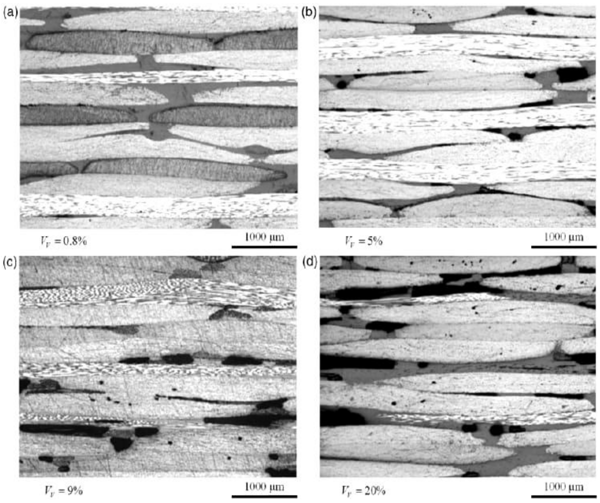

Fig.2.volume fraction of fiber materials in this figure different types of fibers materials to different types of volume fractions

The glass fibers are due to processing that avoids the internal or surface weaken glass, and the strength and stiffness of the polymeric aramid fiber is a consequence of the nearly perfect alignment of the molecular chains with the fiber axis.

The matrix materials that acts to transfer loads to the fibers and also to be presents the fibers from abrasion and environmental attract.

The most research nowadays emphasizes the development of the new materials fiber based composite that exhibit the best performance in terms of impact strength.

Metal and glass are available as matrix materials but these are currently very expensive and largely restricted to DMSRDE Kanpur laboratories. The polymers are much more commonly used, with unsaturated styrene- hard denned polyesters having the majority of low to medium performance applications and epoxy.

Thermoplastic matrix composites are increasingly attractive materials with processing difficulties being perhaps their principal and limitations.

Nomenclatures

Mc	Mass of the composite
Mf	Mass of the fibers materials
Mm	Mass of the matrix materials
Vc	Volume of composite
Vf	Volume of fibers materials
Vm	Volume of matrix materials
Va	Volume of air
ρ	Density of moistures
ρw	Density of water
ρc	Density of composite
ρf	Density of fibers materials
ρm	Density of matrix materials
εc	Strain of composite metal
εf	Strain of fibers materials
εm	Strain of matrix materials
Ac	Area of composite metal
Af	Area of fibers materials
Am	Area of matrix materials
σc	Stress of composite metal
σf	Stress of fibers materials
σm	Stress of matrix materials
Pc	Load of composite metal
Pf	Load of fibers materials
Pm	Load of matrix materials
Ec	Modulus of composite metal
Ef	Modulus of fibers materials
Em	Modulus of matrix materials

αc	Thermal expansion coefficient Of composite metal
αf	Thermal expansion coefficient Of fibers materials
αm	Thermal expansion coefficient Of matrix materials
αT	T.E.C of transfers direction
αL	T.E.C of longitudinal direction
βc	Moisture expansion coefficient of Composite metal
βm	M.E.C of matrix materials
βT	M.E.C. of transfer direction
βL	M.E.C. of longitudinal direction

3. Fibers materials:

The purpose of the matrix is to provide shape and form, to protect the fiber from structural damage and adverse chemical attract, to distributed stress, and to provide toughness.

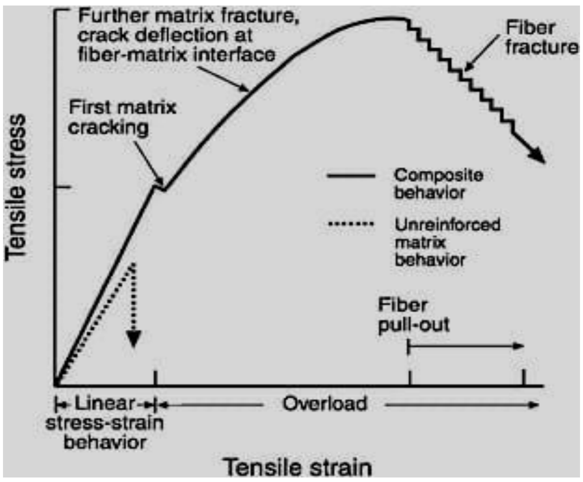

Fig. 3 Stress and strain properties of fiber and matrix materials

The primary function of the reinforcement in composites reinforced with continuous is to provide strength and stiffness and to support the structural load.

The matrix materials also stabilize the composite against buckling in compressive loading situations. Fibers also known as filaments, have finite lengths of at least 100 times their of diameter, the fiber are prepared by methods molten bath, by spinning, chemical vapors deposition (CVDs) on substrate such as tungsten or carbon. They are grouped into bundles or strands of 500 to 12000filaments.

3.1 Advanced Fibers:

The carbon fibers in covalent bond are the strongest in nature carbon fibers in contains 80 to 95.5% of carbon it is carbon fiber is produced at 1300℃. The graphite fiber contains more than 99% carbon graphite fiber is produced in excess of 1900℃. The carbon fibers maximum temperature of used of the fibers ranges from 250℃ to 2000℃ properties changes with temperature at higher temperature.

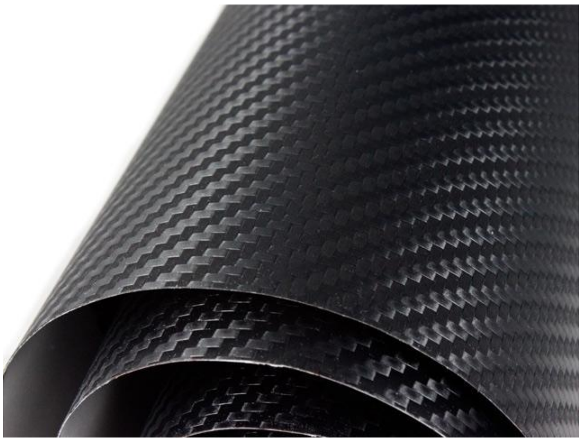

Fig. 4 advance carbon fiber

The glass fibers: a ancient Egyptians made containers from coarse fibers drown from heat softened glass extruding molten glass at 1200℃ high strain.

Fig. 5 Properties testing of advance fibers

E- glass: high strength and high resistivity.

R- glass: enhanced the mechanical properties.

S2- glass: high strength, modulus, and stability under extreme temperature, corrosive environment.

C- glass: resists corrosion in an acid environment.

D- glass: die-electronic properties.

4. Terminology and basic properties of composite metal.

4. 1. Volume and mass fraction of composites.

The mass of the composite = mc, mass of the fibers mf, and mass of the matrix material is mm, mass of the composite

$$mc = mf + mm \quad (1)$$

$$1 = \frac{mf}{mc} + \frac{mm}{mc} \quad (2)$$

$$1 = Mf + Mm \quad (3)$$

The mixture of (n metals) in composite

$$1 = m1 + m2 + \text{----} + mn \quad (4)$$

4. 2 Volume of composite

Volume of the composite = Vc, volume of the fiber r=Vf, and volume of the matrix materials = Vm the total volume of the composite.

$$Vc = Vf + Vm \quad (5)$$

$$1 = Vf + Vm + Va \quad (6)$$

The mixture of (n volume) in composite metal. the total volume of the composite

$$1 = V1 + V2 + \text{-----} + VnVa \quad (7)$$

4. 3. Density of the composites

Equation (1) in dividing by Equation (5)

$$\frac{mc}{vc} = \frac{mf}{vf} + \frac{mm}{vm} \quad (8)$$

$$\rho c = \frac{vf}{vc}\rho f + \frac{vm}{vc}\rho m \quad (9)$$

$$\rho c = vf\,\rho f + vm\,\rho m \quad (10)$$

Equation (10) is the total density of the composite.

4.4 Load shearing between fiber and matrix in composites.

The strain in composite metal = εc, strain of fiber metal is = εf, and εm is the strain of matrix material

Total strain of composite

$$\varepsilon c = \varepsilon f + \varepsilon m \quad (11)$$

$$\frac{\sigma c}{\varepsilon c} = \frac{\sigma f}{\varepsilon f} = \frac{\sigma m}{\varepsilon m} \quad (12)$$

Load sheared by fiber Pf, and load sheared by matrix materials Pm

$$\frac{Pf}{Pm} = \frac{\sigma f.Af}{\sigma m.Am} \quad \mathbf{(13)}$$

$$\frac{Pf}{Pm} = \frac{Ef}{Em}.\frac{Af.Ac}{Am.Ac} \quad (14)$$

$$\frac{Pf}{Pm} = \frac{Ef}{Em}.\frac{Vf}{Vm} \quad (15)$$

$$\frac{Pf}{Pm} = \frac{\sigma f.Af}{\sigma f.Af + \sigma m.Am} \quad (16)$$

$$\frac{Pf}{Pc} = \frac{(\frac{Ef}{Em})}{(\frac{Ef}{Em}) + (\frac{1}{Vf} - 1)} \quad (17)$$

Suppose Vf = 0, lower term is =∞

$\frac{Pf}{Pc}$ = is very high

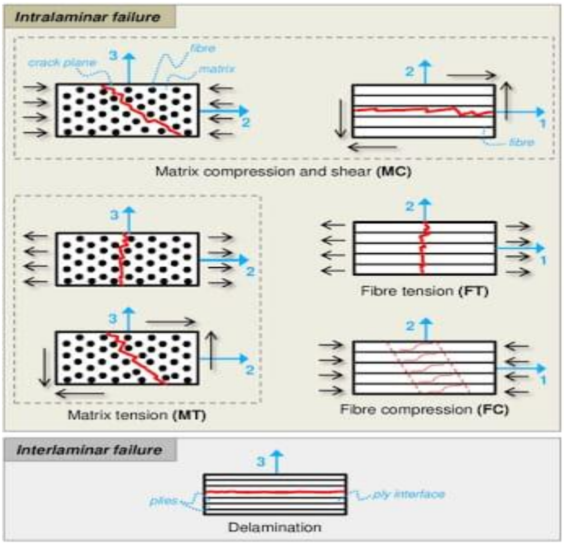

Fig. 6 load sheared by directional and bidirectional fibers metal.

4. 5 Thermal Expansion coefficient (α) of the fibers composites.

The analysis of properties fibers, matrix based composites thermal expansion coefficient of fiber is αf, and the thermal expansion coefficient matrix material is αm

Thermal expansion coefficient of composites longitudinal direction

$$\alpha L = \frac{1}{EL}[\alpha f Ef Vf + \alpha m\, Em\, Vm] \quad (19)$$

Thermal expansion coefficient of transfer's direction of composite

$$\alpha T = \frac{1}{ET}[(1 + \mu f)\, \alpha f Vf + (1\, \mu m) \alpha m Vm \alpha l \mu l t]$$

If (Vf > 0.2) (20)

$$\alpha T = \frac{1}{ET}[\ + (1 + \mu m) Vm \alpha m] \quad (21)$$

3.6 Moisture Expansion Coefficient(βm) of composites

Now assume there is matrix is absorbing of water there is no avoid in the system longitudinal and transfer direction both sides ρ = is the density of moisture and ρw = is the density of the water.

$$\beta m = \frac{1}{3} \cdot \frac{\rho}{\rho w} \quad (22)$$

Moisture expansion of composite is longitudinal direction should be zero

Transverse direction of composite moisture expansion is

$$\beta T = \frac{\rho c}{\rho m} (1 + \mu m)\, \beta m \quad (23)$$

The tensile strength, stiffness and the young's modulus of the kenaf fibers are lower but still comparable to those the composites, properties improvement and analysis of properties by using analytical method and standard formulations of same properties improved before the fibers are finally used in the fabrication of a composite. The size is usually removed by heat cleaning and washing. For PMCs and MMCs fibers are now also available in a pre-impregnated with matrix materials in the uncured state. Fibers are also now becoming. available as mixtures an advanced producer of composites, Textron specialty materials (TSMs) has slandered to market a continuous fibers epoxy resin prepared tape that contains a mixture of smaller diameter carbon fibers, with a fiber density of 65 to 85% such i.e. the carbon fibers is good in tension. It is lacks good compressive properties. The combination material has batter flexural properties, that the application of the manufacturing a submersible structures, sporting good and medicals equipments. Several research studies on polymer composites have already been conducted, such as analysis studies on the hybridization effect and resin application fiber may be utilized in composite materials by providing economical and essential solutions for new developments in materials industries.

4. Composite system and productions

4. 1. Composites with matrices materials:

This is the very important matrices materials, metal matrix composites are currently the focus of intense world- wide research and production these materials are fabricated by liquid-infiltration techniques, such as high pressure infiltration casting and pressure less materials. Power metallurgical techniques, plasma spraying of matrix material. The over properly laid fibers, physical vapors deposition, hot pressing, and self propagating high temperature synthesis or reactive synthesis.

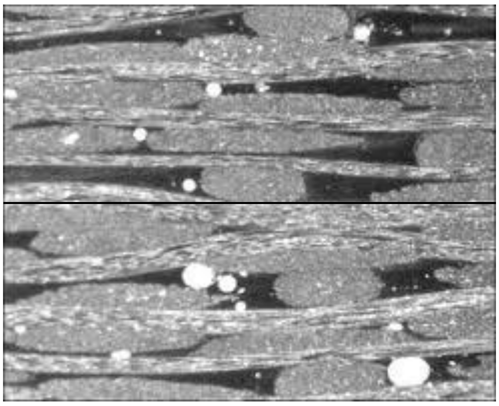

Fig. 7metal matrix material

The matrix materials in nickel- coated and carbon-fiber paper (Ashland carbon flex) has been used in the fabrication of aluminum based MMCs directionally reinforced aluminum composite using AL2O3 and Sic fibers are rapidly emerging as commercial materials for in proving fuel economic and recyclability in the automotive industry. An estimate of the trade-off between weight and fuel economy is that a reduction in weight of 91kg increasing the fuel efficiency by approximately 0.4$kg/litre$.

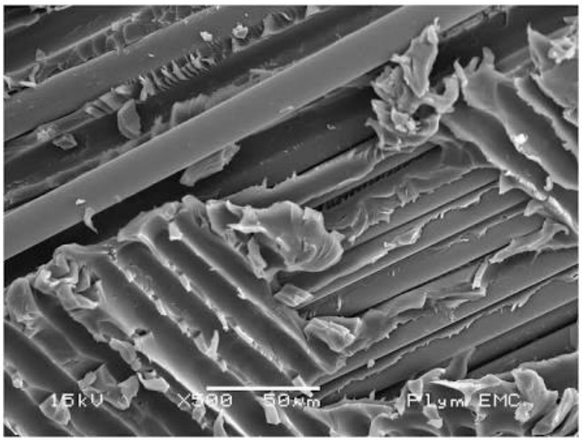

Fig. 8 carbon fiber matrix materials

The infiltration of these porous fiber performs composed of these ours ceramic fibers (such as AL2O3or AL2O3 + SiO2 commercially known as SAFFTVID and KAOWOOL respectively) in this low cast of approach to the manufacture of high performance MMCs. the waiting and spontaneous infiltration of a particulate on fibers perform by a molten metal alloy are effected by a novel proprietary technique involving the use do pant to the properties elements to rise the melt temperature.

Table 1: properties of composite fibers (Axial properties)

Materials	Density ρ g/cm^3	Modulus E (GPa)	Passion ratio µ	Strength σu (MPa)	Specific Stiffness E/σ	Specific Strength σ/ρ	Thermal expansion coefficient
AS4	1.80	235	0.20	3599	5.1	11.1	-0.8
T300	1.76	231	0.20	3654	5.1	11.5	-0.5
P100S	2.15	724	0.20	2199	13.2	5.5	-1.4
IMB	1.8	310	0.20	5171	6.7	16.1	----
Boron	2.6	385	0.21	3799	5.8	8.3	8.3
Kevlar49	1.44	124	0.34	3620	3.5	14	-2.0
Nicalon	2.55	180	0.25	2000	2.8	4.4	
Aluminum	3.95	379	0.25	1585	3.9	1.9	7.6
S-2Glass	2.46	86.8	0.23	4585	1.5	10.6	1.7
E-Glass	2.59	69	0.22	3450	1.06	7.6	5.5
Sapphire	3.98	435	0.28	3600	4.3	5.1	8.8

Table 2 properties of matrix materials

Materials	Density ρ g/cm^3	Modulus E GPa	Poison's ratio μ	Strength σ MPa	Specific stiffness (E/ρ)	Specific strength (σ/ρ)
Epoxy	1.38	4.6	0.36	58.6	0.08	0.4
polyimide	1.46	3.5	0.35	103	0.03	0.4
carbon	8.9	117	0.33	400	0.5	0.3
Silicon carbide	3.2	400	0.25	310	4.9	0.5

Fig.9 testing of the matrix material set- up

The unique properties of MMCs (wear resistance, strength and stiffness) the matrix material properties have already led to more than the laboratory scale manufacture of automotive components such as brake calipers , pump housings, gears, valves pulleys, drive shafts, barons, engine, rotors connecting rods and pistons systems reinforced with continuous fibers such as aluminum fibers.

4.2 Polymer matrix materials Composites (PMMCs):

The matrix materials in polymers (a) thermoplastic (b) thermosetting both are plastics soften upon heating and can be reshaped with heat and pressure become cross linked during fabrication and do not soften upon reheating of the thermosetting plastic.

Thermoplastics are the high toughness high volume and low cast processing and temperature range≥225℃. Processing is faster than thermo set composites since no curing reaction is required only heating, shaping and cooling. Improvement of matrix materials of polyesters Low cast high strength and low viscosity, versatility and application of electrical industries high heat resistance cold and hot molding curing temperature is 120℃. the polymer matrix materials based on thermoplastic, polypropylene, polyvinyl

Chloride (PVCs), nylon, polyurethane, poly- ethe ether keton (PEEK),

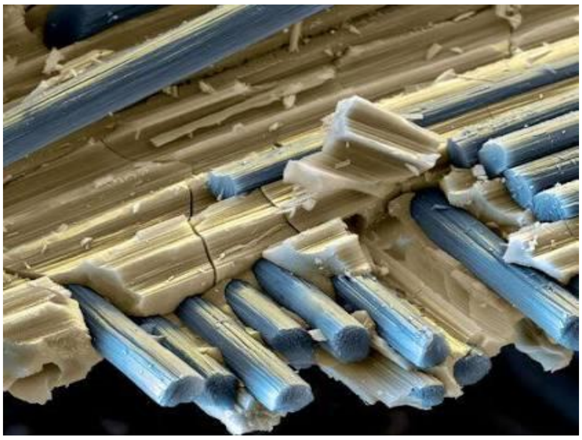

Fig. 10 polymer matrix material (PMMCs)

Chloride (PVCs), nylon, polyurethane, poly- ether-ether keton (PEEK), poly-phenylene

Sulfide (PPS) and poly-sup one.

Fig. 11 testing of polymer matrix materials set-up

The polymer matrix materials susceptibility to environmental degradation due to moisture reduction atomic oxygen (in space) they are therefore used for the interior panels of aircraft, where combustion requirement justify lower properties. Also these materials and the newly developed thermoplastic polyether sulphone (PESs) contain additives that react to fiber by emitting contained water vapors, the thermoplastic materials exhibit higher strain to the failure, and are ideally suitable for use as matrix materials combined with high strength and high- strain carbon fibers. These

Materials include resins such as (PEEK), with a melting point of 334°C

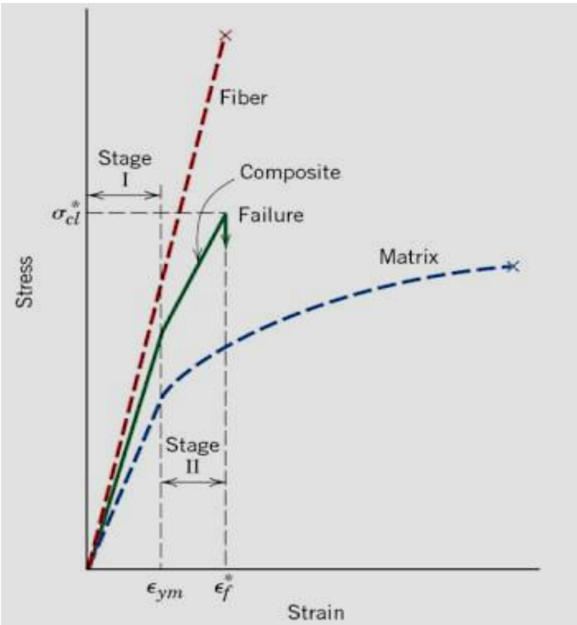

Fig. 11 stress strain properties of composites materials

These materials and the newly improvement of the polymer matrix material composites in polyether sulphone (PESs), contain additives that react to fire by emitting contained water vapors, the thermoplastic materials exhibit high strain to failure, and are ideally suitable for use as matrix materials combined with high strength and high- strain carbon-fibers. The (PMMCs) susceptibility to environmental degradation

Due to moisture, radiation, atomic oxygen in space lower transverse strength of the (PMCs), materials high-residual due to large mismatch in coefficients of thermal expansion both fiber and matrix. Polymer matrix cannot be used near or above the glass transition temperature.

5. Conclusions

New fibers, polymers and processing technique for all classes of the composites are constantly being improved and developed the composites have attractive mechanical and physical properties that are now being utilized in industries and aerospace on a grand scale world- wide. Research in also going to improve repair techniques, and recyclability, and the bonding between fiber and matrix materials.

Table 3 Properties Comparison of matrix material composites.

Properties	Polyester	Epoxy	Steel
Specific gravity	1.1 To 1.4	1.2 To 1.3	7.8
T. modulus MP a	2000 To 4400	2500 To 4500	200000
T. strength MP a	33 To 104	50 To 150	300 To 1000
T.E.C $\times 10^{-6}/°C$	55 To 100	45 To 70	12
W. absorption %	0.15 To 0.65	0.05 To 0.15	0

The standards are being set-up for the testing and computerization of mechanical, physical and chemical properties data banks.

The PMCs are being utilized more in structural and wear- resistant applications in mining and industrial environments. The new application that are being found on an almost daily basis and the continuous reporting of company investment and new ventures into the manufacture of MMCs and CMC, PMMC parts, the important progress has been made to worlds the reduction of processing and manufacturing casts. This emails knowledge of the structural efficiency of the material. Its homogeneous or heterogeneous and isotropic or anisotropic behavior, environmental effects, and its manufacturing requirements, assembly and repair.

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