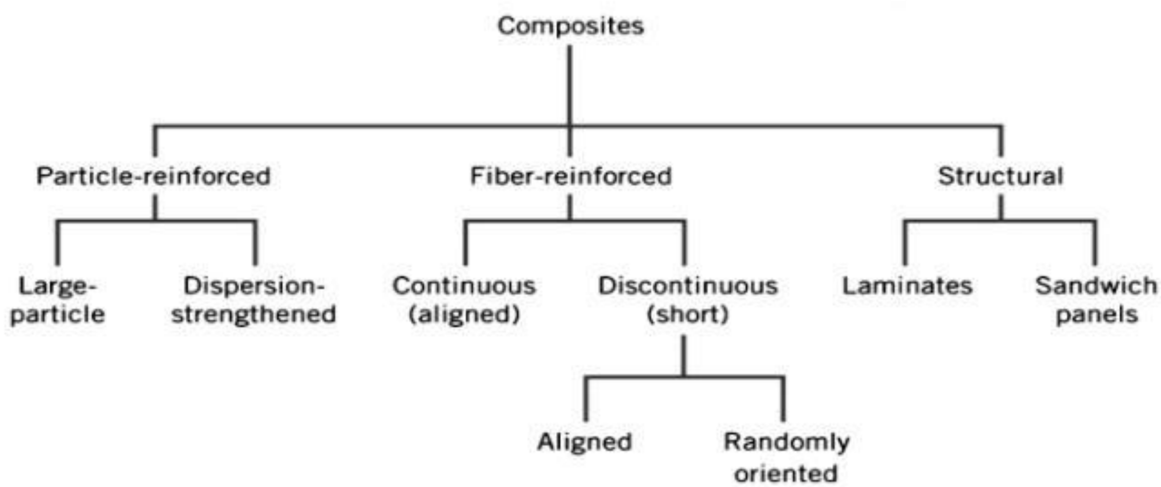
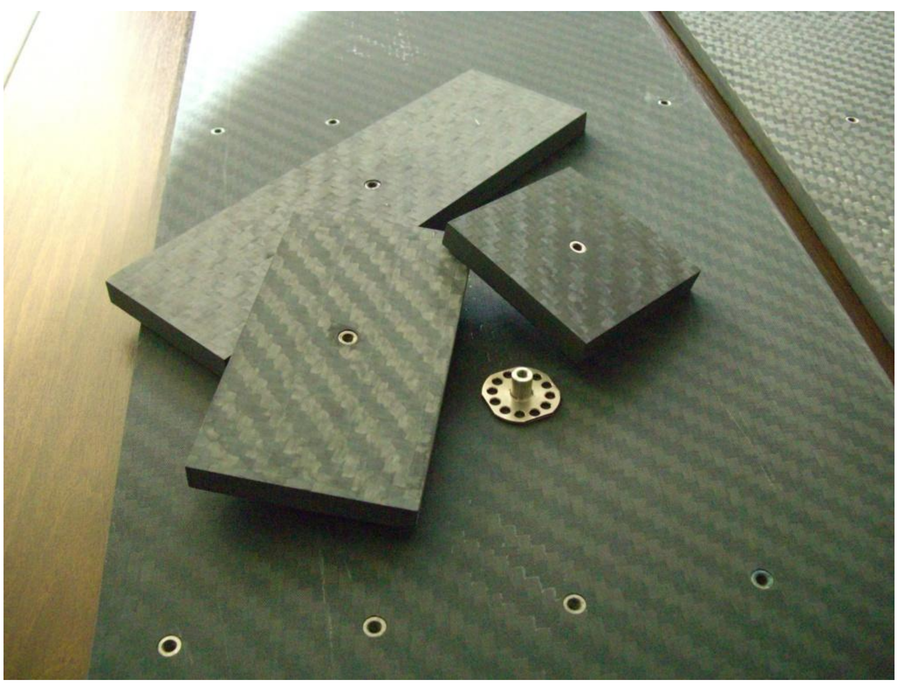
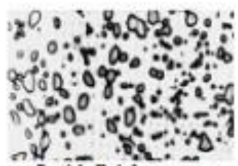
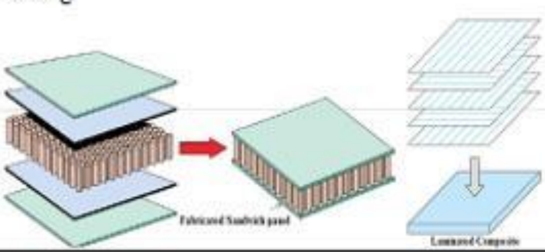
AGS-TECH Inc., Tel: 505-550-6501 and 505-565-5102, Fax: 505-814-5778,

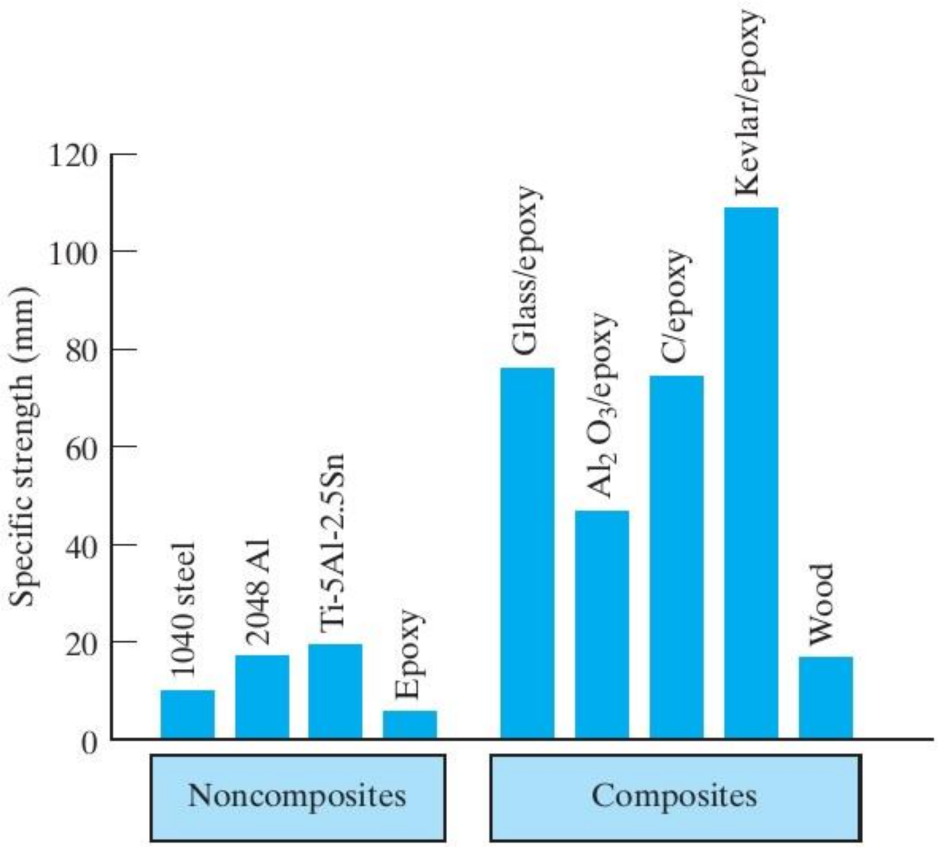
Email: sales@agstech.net, Web: http://www.agstech.net

COMPOSITES AND COMPOSITE MATERIALS MANUFACTURING:





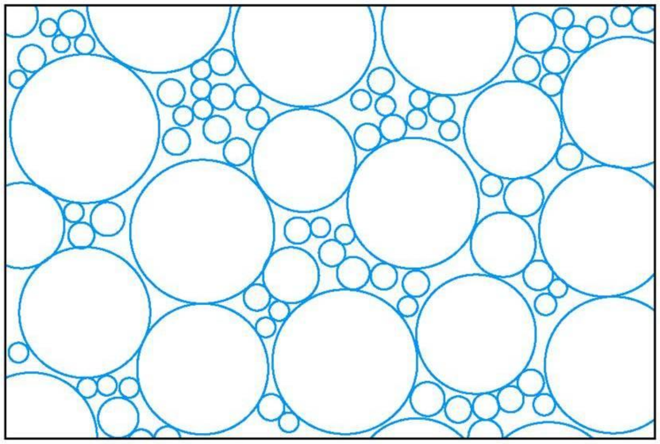
Sl. No.	Type of Composite	Application
1	Particulate Composites are composed of particle of one or more material is suspended in a matrix of another material to make the material stronger.  Particle Reinforcement	For example wood particle boards, in concrete the particle of sand or rock bound together by a mixture of cement and water. used as fillers to improve strength, toughness, processibility, dimensional stability, frictional wear and lubrication properties, and, in some cases, resistance to ultraviolet radiation.
2	Fiber Reinforced Composites are the long fiber of one material is embedded in the matrix of other material which turns out to be extremely strong.  Aligned Continuous Aligned Discontinuous Random	These FRC can be used as bulletproof vests where crisscross system of fibers is used. Is used in concrete by reinforcing elements like carbon fiber, aramid fiber, grid type reinforcement elements, etc. Add reinforcing steel rods, wires and bars (rebar) to uncured concrete to enhance mechanical strength. .
3	Sandwich Composites or Laminated composites are layers of two or more different material are bonded together by sandwiching two layers of strong 	The sandwich composites are used as Space shuttle heat panels. The decorative surface laminates are thick and bonded to wood offering improved heat and moisture resistance and allowing a wide range of decorative effects.

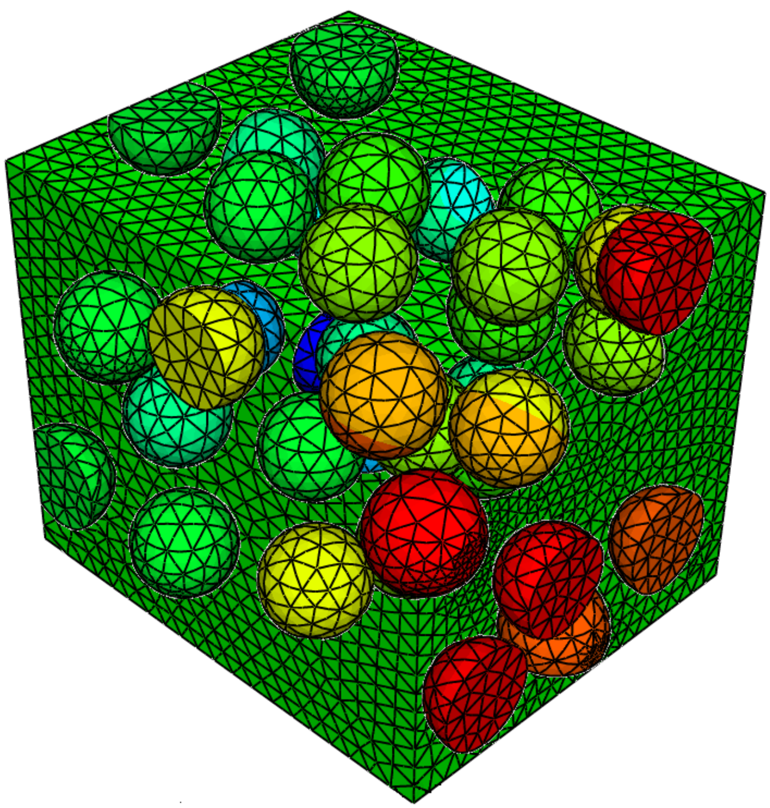


A bar graph plot of the data illustrates the substantial increase in specific strength possible with composites.

PARTICLE-REINFORCED COMPOSITES :

Large-particle composites





- Some polymeric materials to which fillers have been added are really large- particle composites.
- The fillers modify or improve the properties of the material.
- Example of large-particle composite is concrete, which is composed of cement (the matrix), and sand and gravel (the particulates).
- Particles can have quite a variety of geometries, but they should be of approximately the same dimension in all direction (equiaxed).
- For effective reinforcement, the particles should be small and evenly distributed throughout the matrix.
- The volume fraction of the two phases influences the behavior; mechanical properties are enhanced with increasing particulate content.
- Rule of mixture: equation predict that the elastic modulus should fall between an upper and lower bound as shown:

$$E_c(u) = E_m V_m + E_p V_p$$

$$E_c(l) = \frac{E_m E_p}{V_m E_p + V_p E_m}$$

where:

Ec: elastic modulus of composite

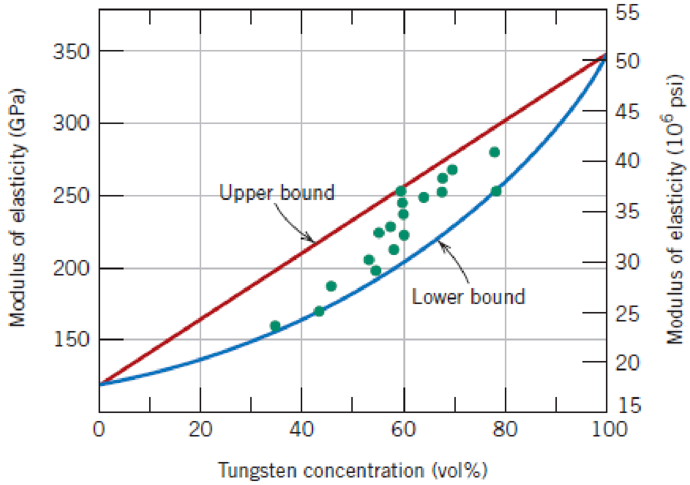
Ep: elastic modulus of particle

Em: elastic modulus of matrix

Vm: volume fraction of matrix

Vp: volume fraction of particle

Example: Fig. 16.3 plots upper and lower bound Ec – versus Vp curves for a copper – tungsten composite; in which tungsten is the particulate phase.



Application to other properties:

− Electrical conductivity,σe:replace E by σe .

− Thermal conductivity: K: replace E by K.

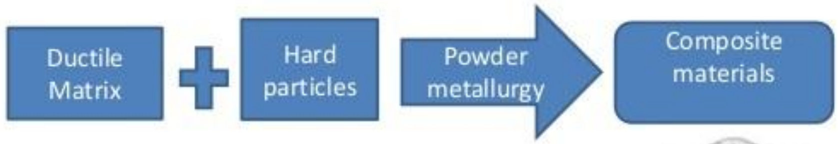
Dispersion-Strengthened Composites

Dispersion-strengthened metals. Particular composites in which a stable material, usually an oxide, is dispersed throughout a metal matrix. The particles are less than 39 in (1 m) in size, and the particle volume fraction ranges from only 2 to 15%. The matrix is the primary load bearer while the particles serve to block dislocation movement and cracking in the matrix.

Dispersion Strengthening

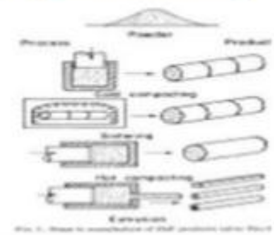
The process which produces dislocation pining sites due to the presence of second phase particles in the matrix of the first phase.

Normally Hard particles size rang .1nm up to 1µm



Examples:

- 14%Al2O3 in Al- "SAP" Composite
- 1-2%ThO2 in Ni-20%Cr-TD nickel
- WC in CO- Cemented Carbide cutting tools



Mechanism

Orownan Model

Dislocation Bypass by the Orowan Bowing Mechanism:

- The shear stress required to bow a two particles separated by λ

  $\tau \sim Gb/\lambda$

- Straight dislocation line approaching two particles.
- Initially line to bend.
- Reached to critical curvature.
- Leaving a dislocation loop around each particle.

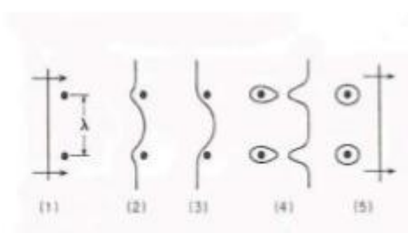
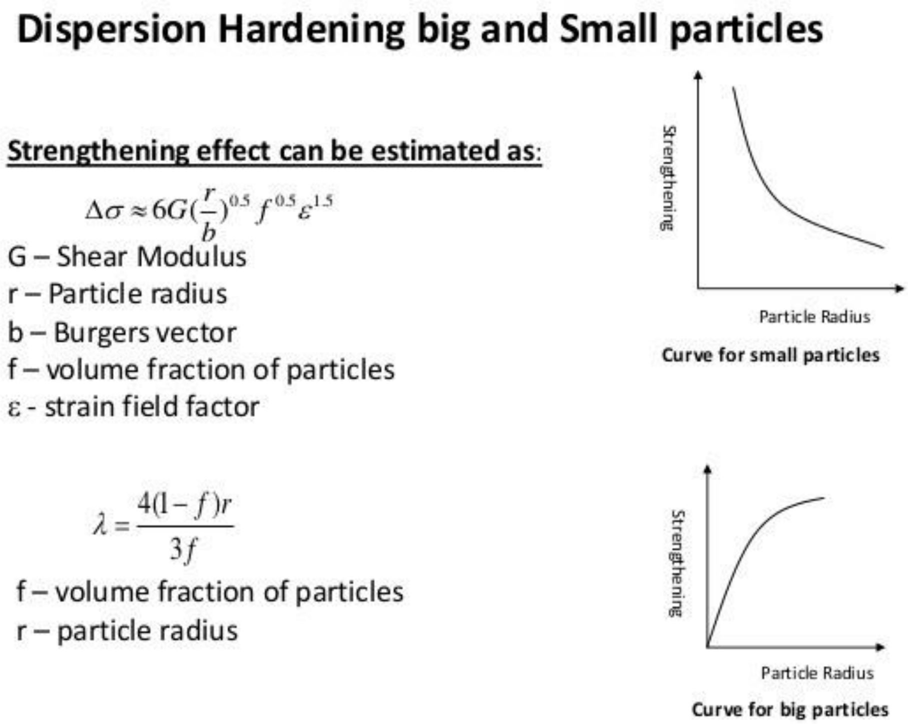
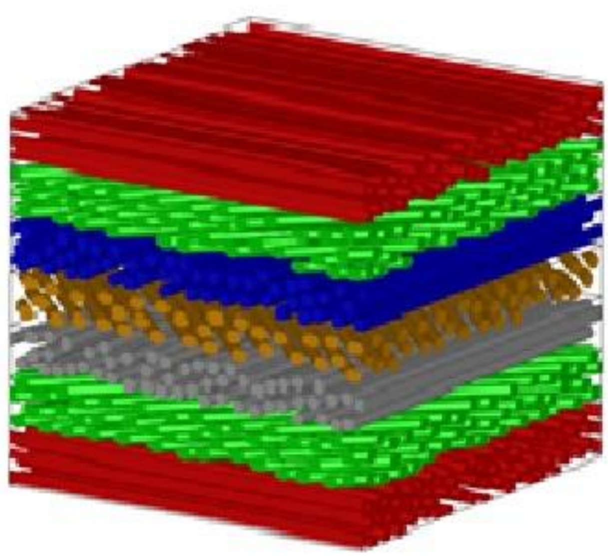


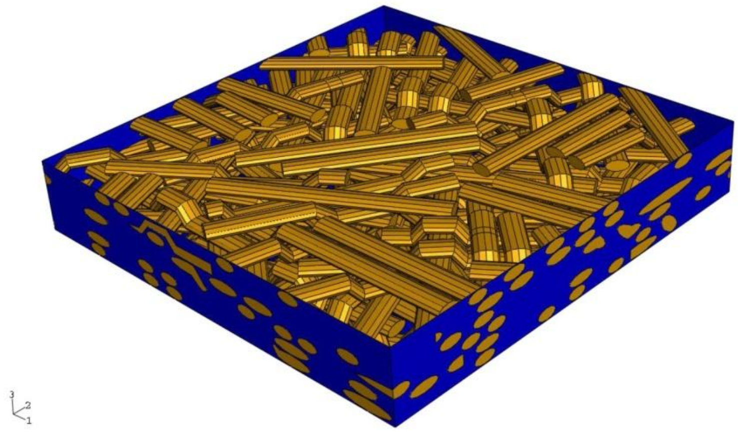
fig: 2 Stages in passage of a dislocation



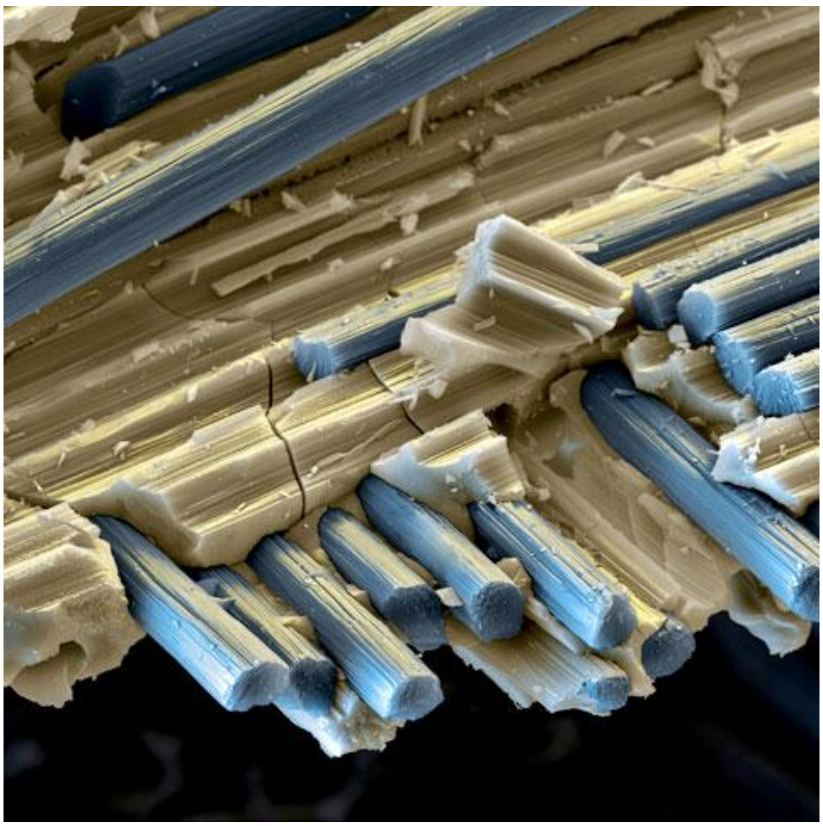
FIBER-REINFORCED COMPOSITES :



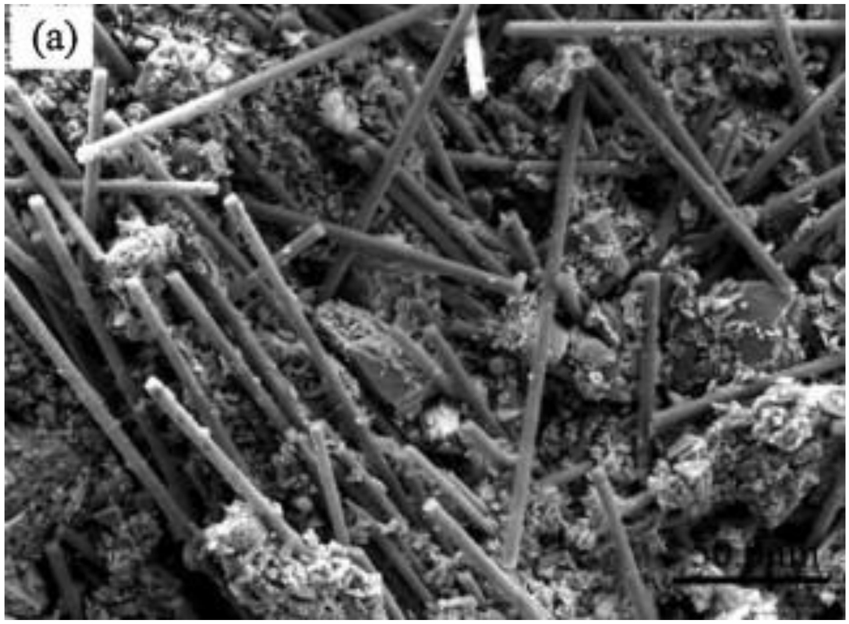
Microscopic Representative Volume Element



Random chopped fiber composite



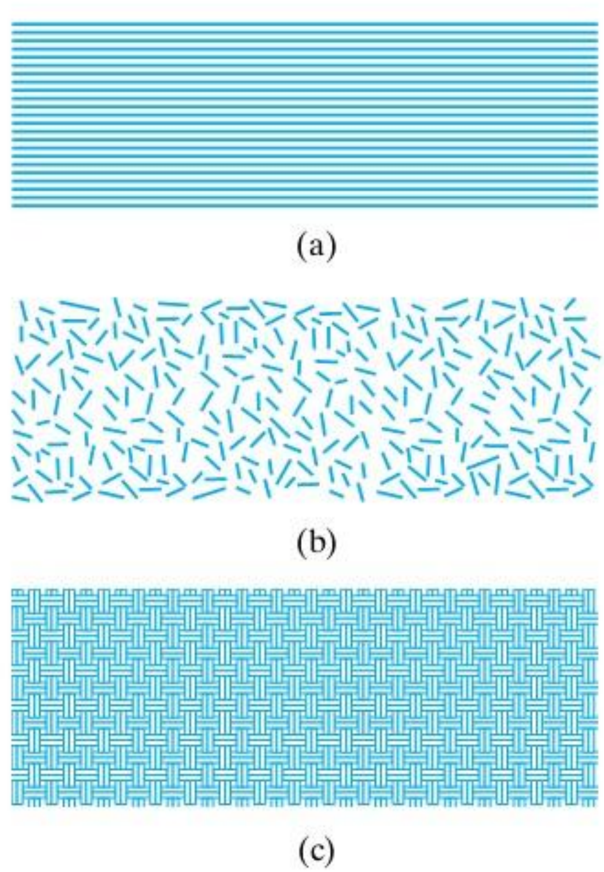
Microscopic View of Glass Fiber Polymer Matrix Composite Laminate



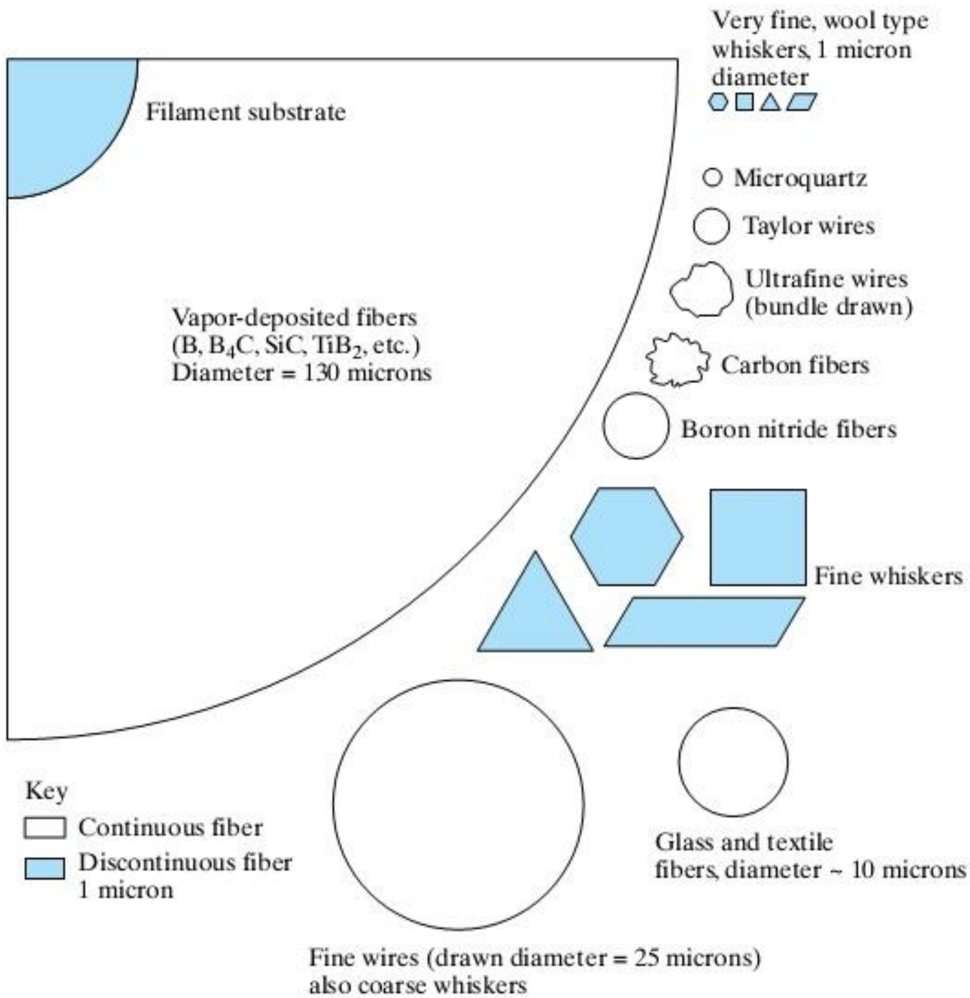
Microscopic View of Short Chopped Fiber Polymer Composite

Chopped Carbon Fiber

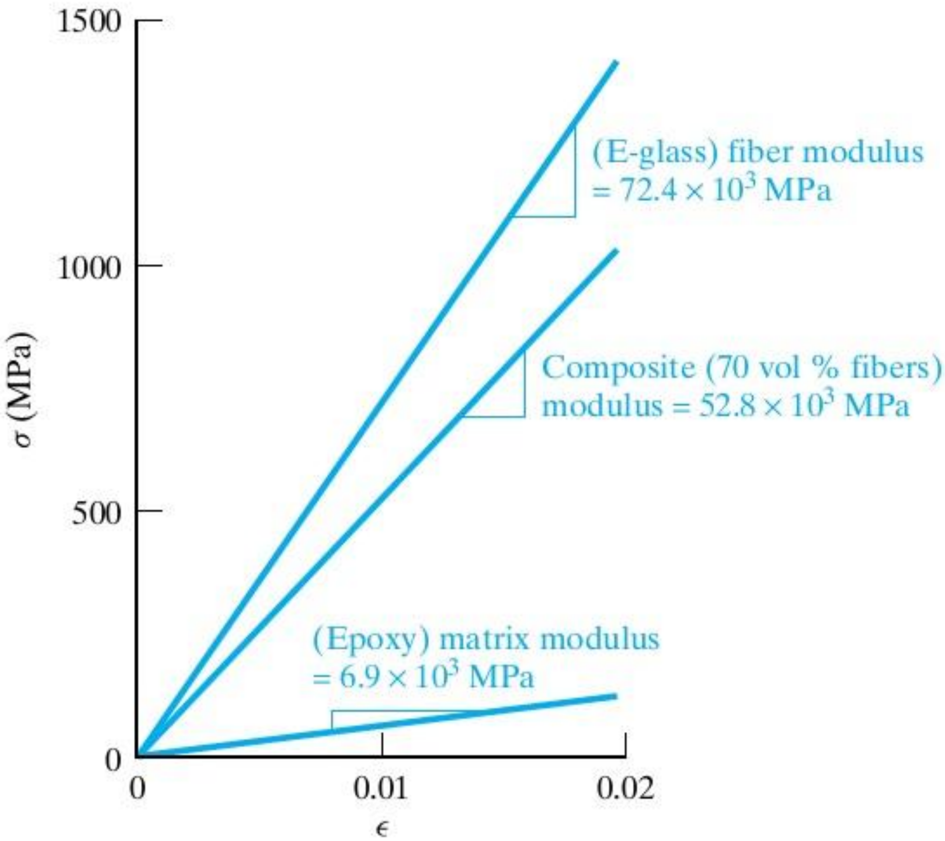
Carbon Fiber Polymer Matrix Composite



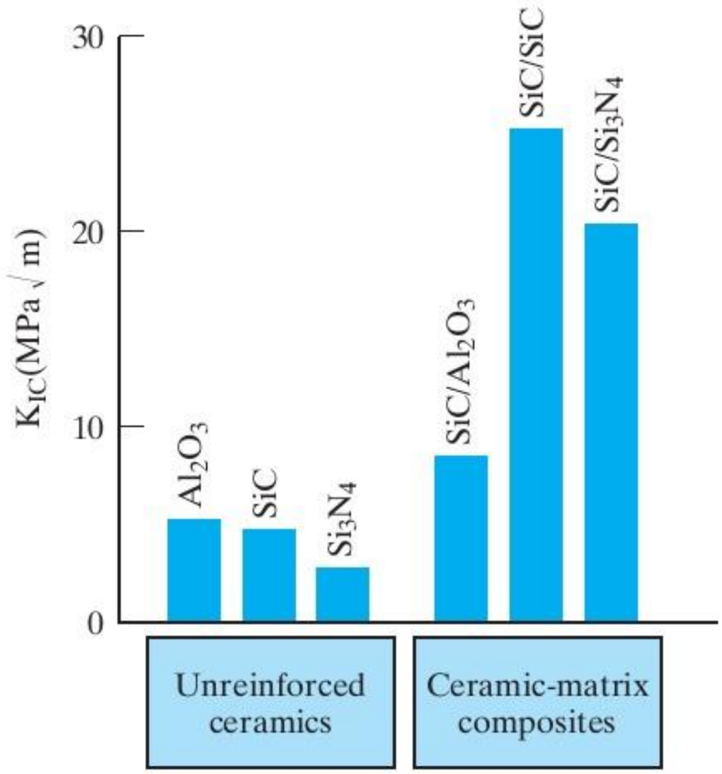
Three common fiber configurations for composite reinforcement are (a) continuous fibers, (b) discrete (or chopped) fibers, and (c) woven fabric, which is used to make a laminated structure.



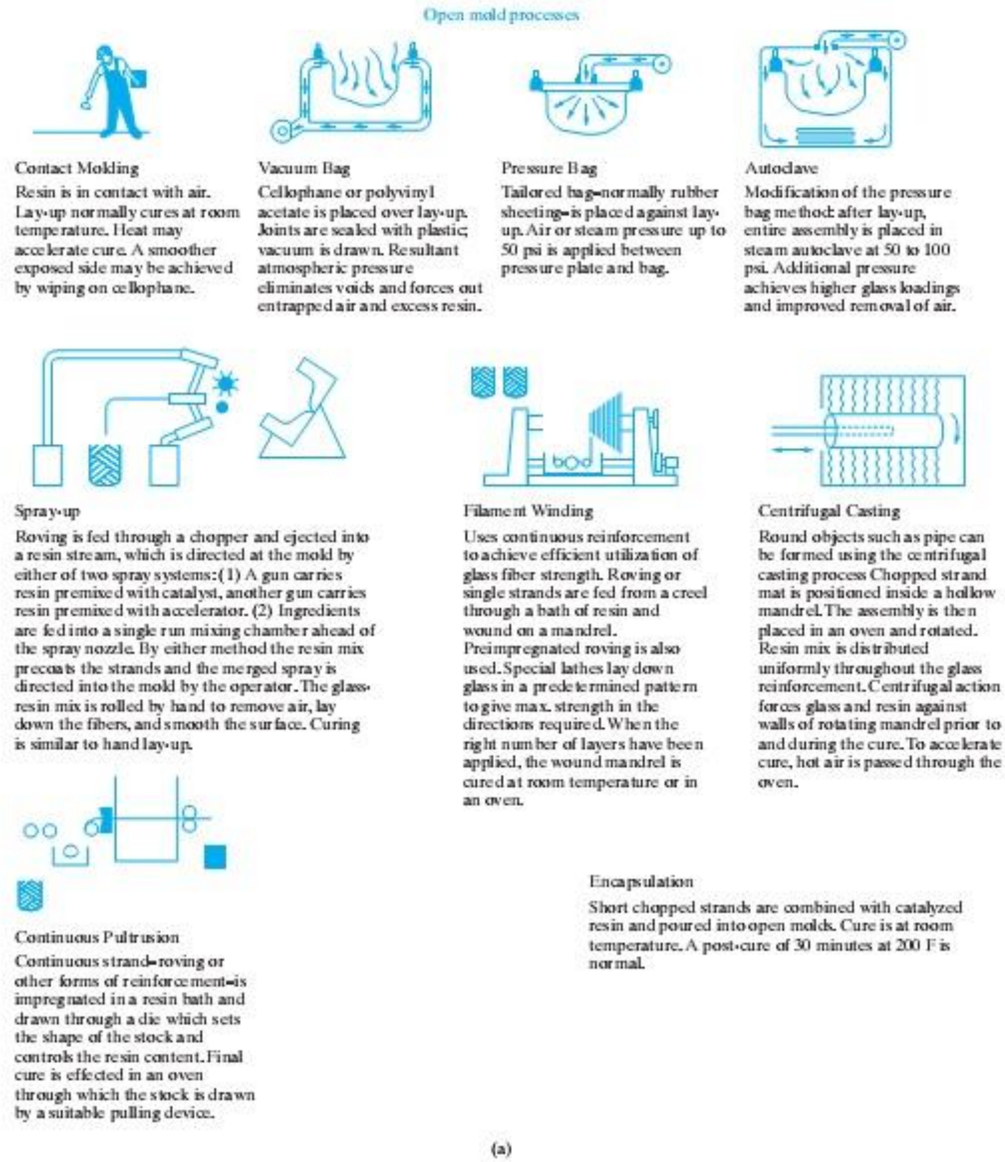
Relative cross-sectional areas and shapes of a wide variety of reinforcing fibers.



Simple stress–strain plots for a composite and its fiber and matrix components. The slope of each plot gives the modulus of elasticity.

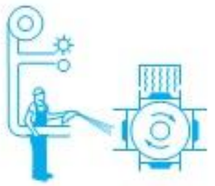


The fracture toughness of these structural ceramics is substantially increased by the use of a reinforcing phase.



Summary of the diverse methods of processing fiberglass products: (a) open-mold processes.

Preforming methods



Directed Fiber

Roving is cut into 1 to 2 inch lengths of chopped strand which are blown through a flexible hose onto a rotating preform screen. Suction holds them in place while a binder is sprayed on the preform and cured in an oven. The operator controls both deposition of chopped strands and binder.

Plenum Chamber

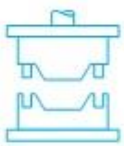
Roving is fed into a cutter on top of plenum chamber. Chopped strands are directed onto a spinning fiber distributor to separate chopped strands and distribute strands uniformly in plenum chamber. Falling strands are sucked onto preform screen. Resinous binder is sprayed on. Preform is positioned in a curing oven. New screen is indexed in plenum chamber for repeat cycle.

Water Slurry

Chopped strands are pre-impregnated with pigmented polyester resin and blended with cellulosic fiber in a water slurry. Water is exhausted through a contoured, perforated screen and glass fibers and cellulosic material are deposited on the surface. The wet preform is transferred to an oven where hot air is sucked through the preform. When dry, the preform is sufficiently strong to be handled and molded.

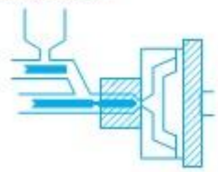
(b)

Closed mold processes



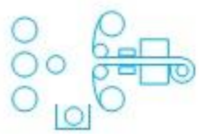
Premix/Molding Compound

Prior to molding, glass reinforcement, usually chopped spun roving, is thoroughly mixed with resin, pigment, filler, and catalyst. The premixed material can be extruded into a rope-like form for easy handling or may be used in bulk form.
The premix is formed into accurately weighed charges and placed in the mold cavity under heat and pressure. Amount of pressure varies from 100 to 1500 psi. Length of cycle depends on cure temperature, resin, and wall thickness. Cure temperatures range from 225 F to 300 F. Time varies from 30 seconds to 5 minutes.



Injection Molding

For use with thermoplastic materials. The glass and resin molding compound is introduced into a heating chamber where it softens. This mass is then injected into a mold cavity that is kept at a temperature below the softening point of the resin. The part then cools and solidifies.



Continuous Laminating

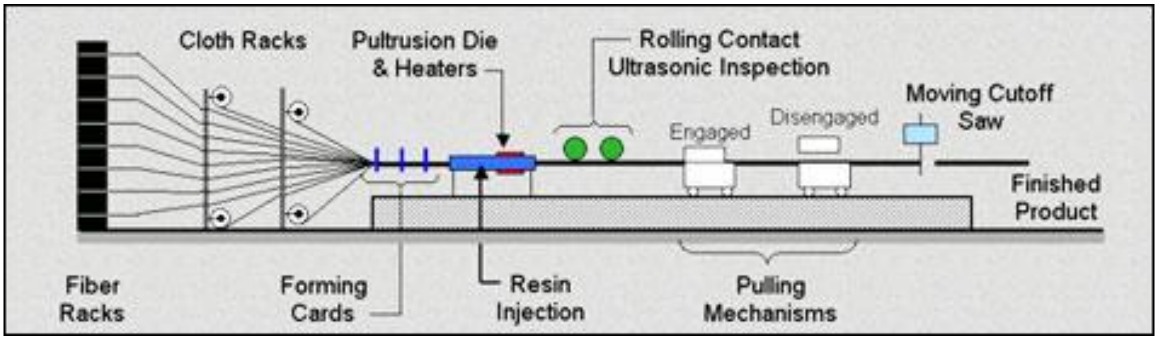
Fabric or mat is passed through a resin dip and brought together between cellophane covering sheets; the lay-up is passed through a heating zone and the resin is cured. Laminate thickness and resin content are controlled by squeeze rolls as the various plies are brought together.

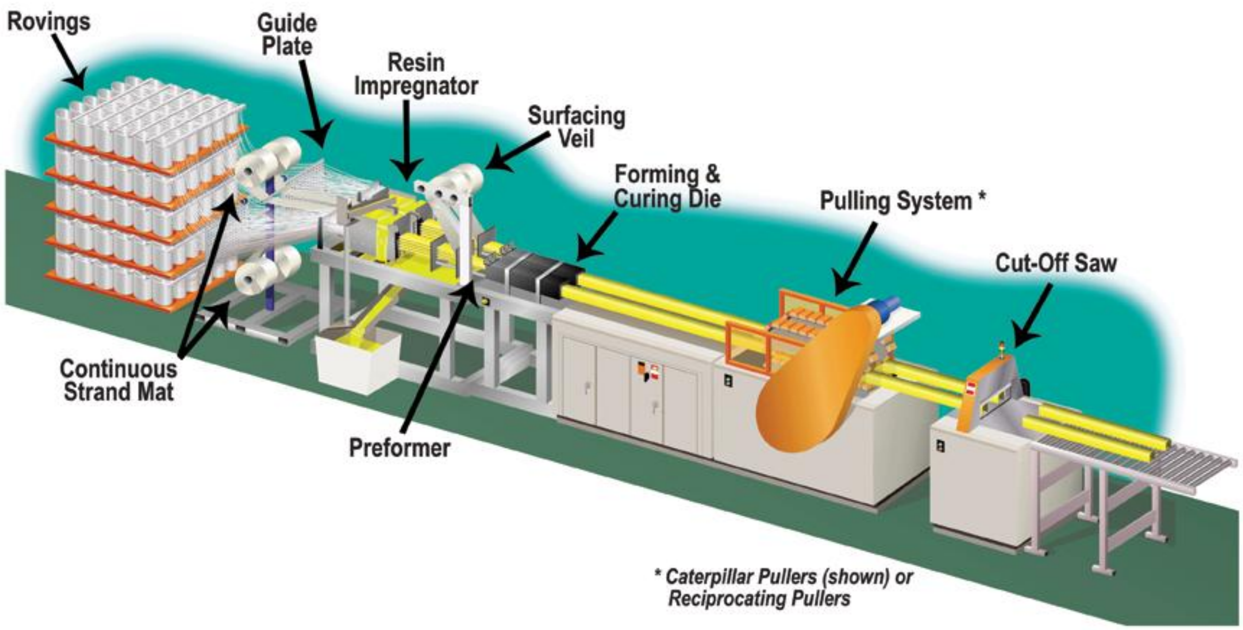
(c)

(Continued) (b) preforming methods, (c) closed-mold processes.

Processing of Continuous Fiber-Reinforced Plastics with Uniformly Distributed Fibers Oriented in the same Direction

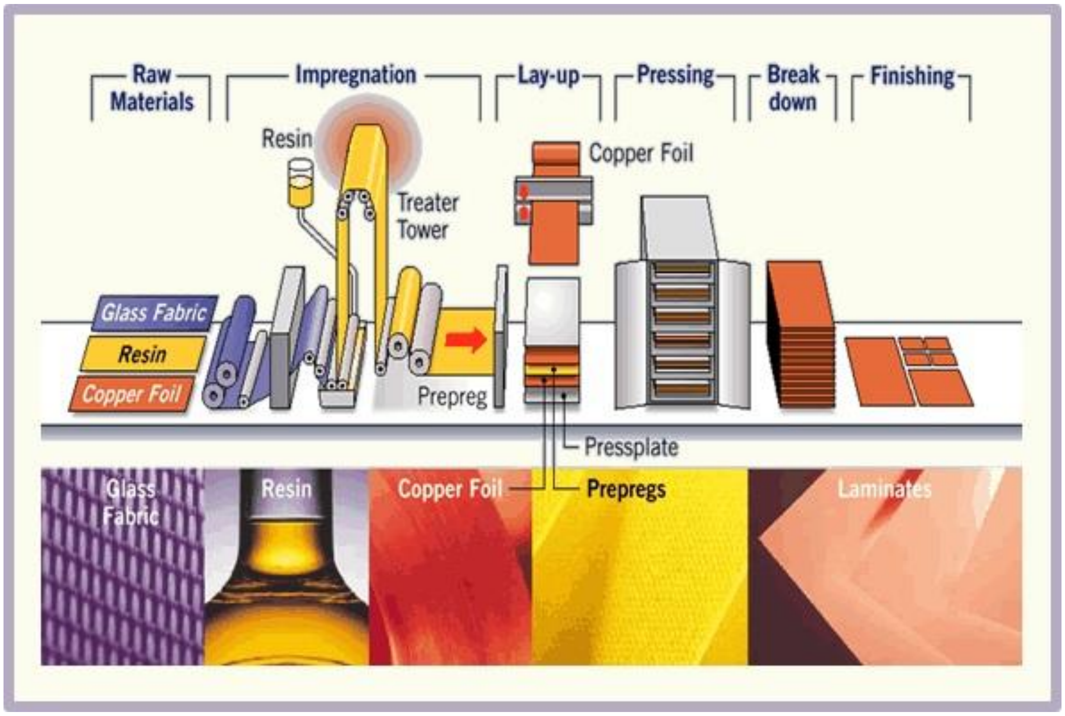
Pultrusion Process





Pultruded Profiles

Prepreg Production Process



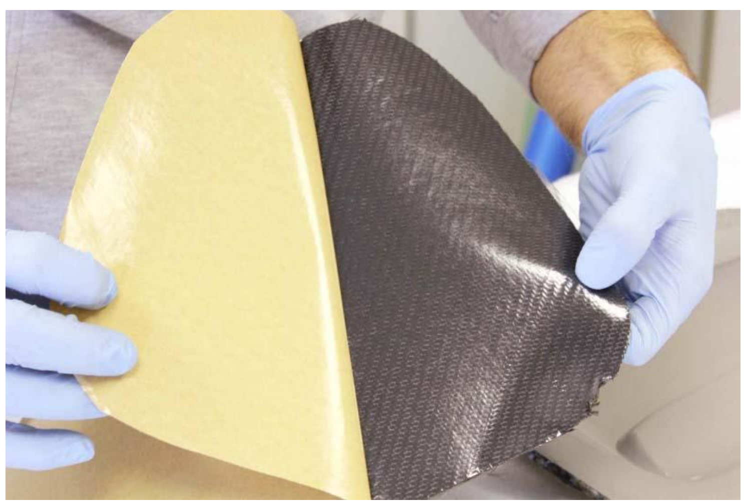
Schematic of process and materials used in laminate production

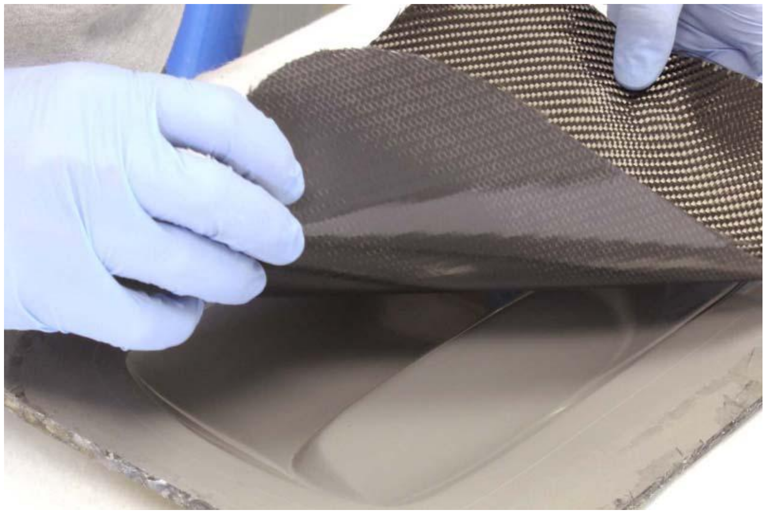
An example of a Prepreg Lay Up Process

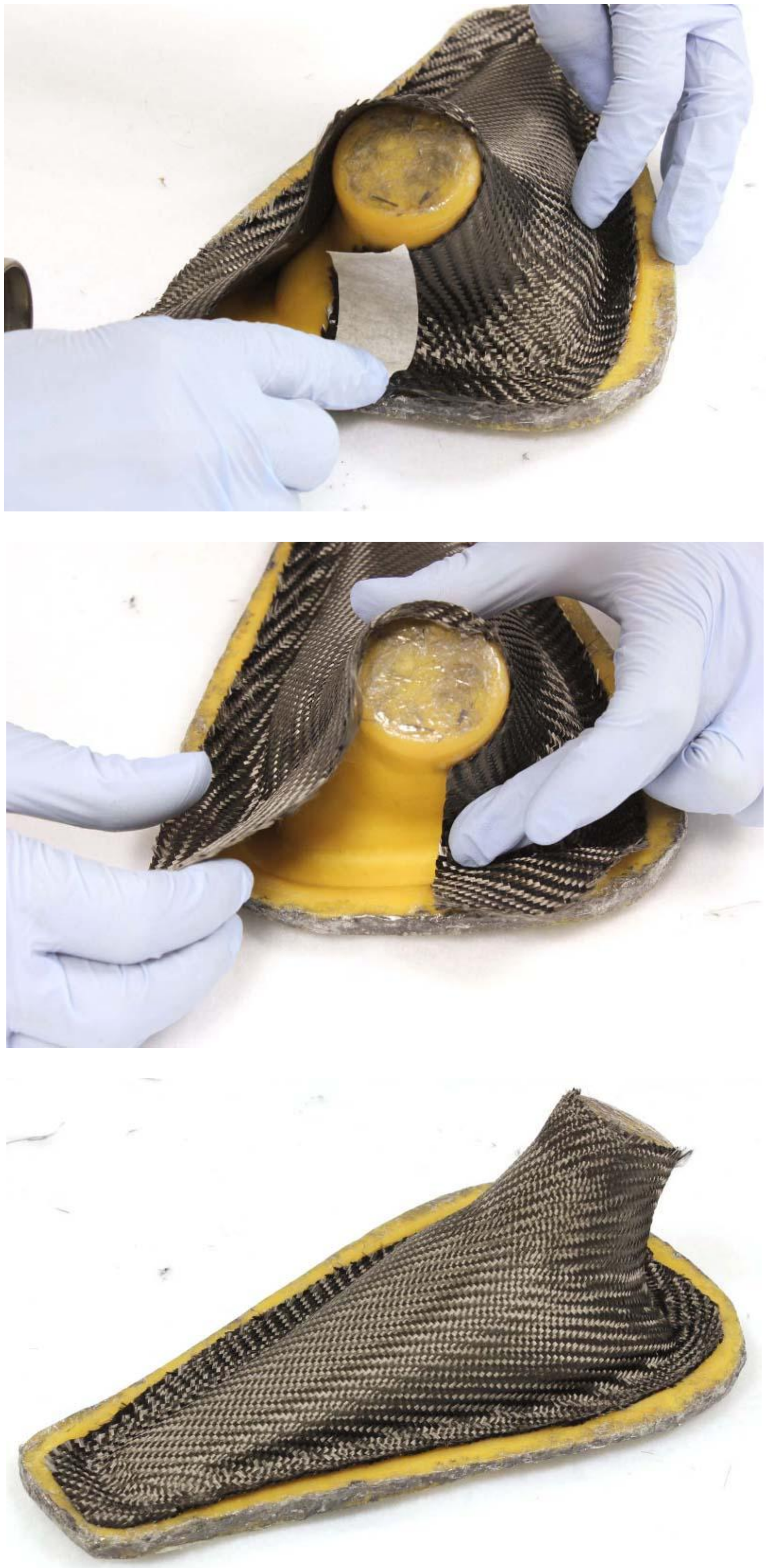
Mould Preparation

Creating Cutting Templates

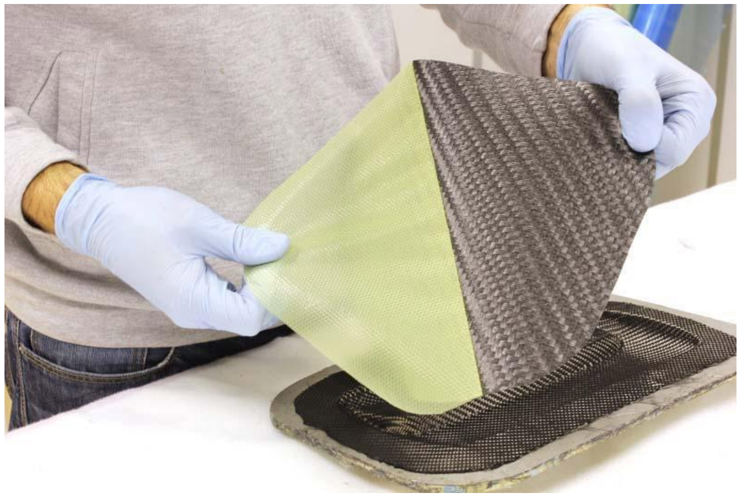
Cut Prepreg Material



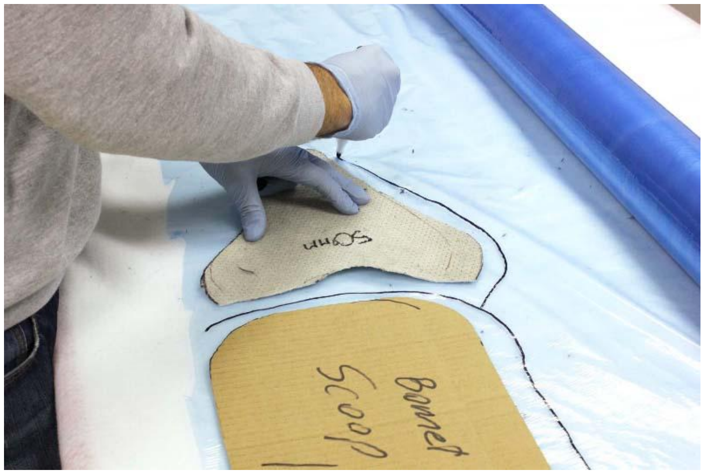




Putting Down the Surfacing Ply



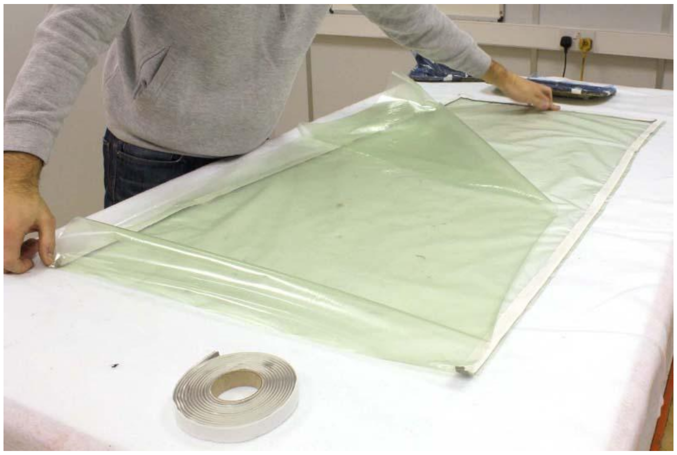
Putting Down the Backing Ply


Bonnet Scoop

Release Film

Breather Cloth

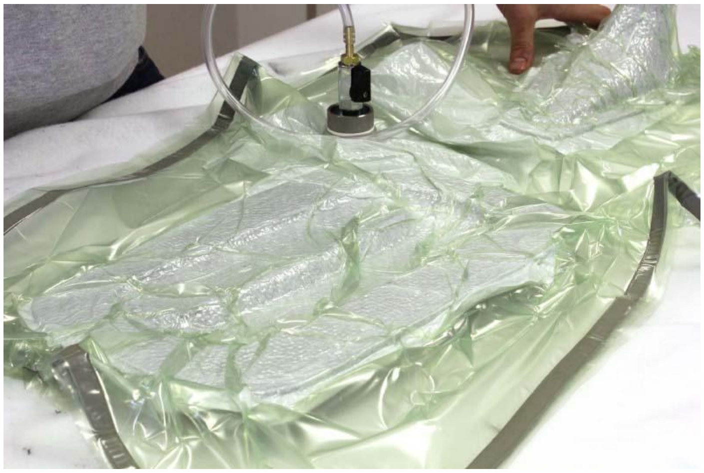
Make the Vacuum Bag



Bagging

Loading the Parts and Positioning the Through-Bag Connector

Complete the Vacuum Bag



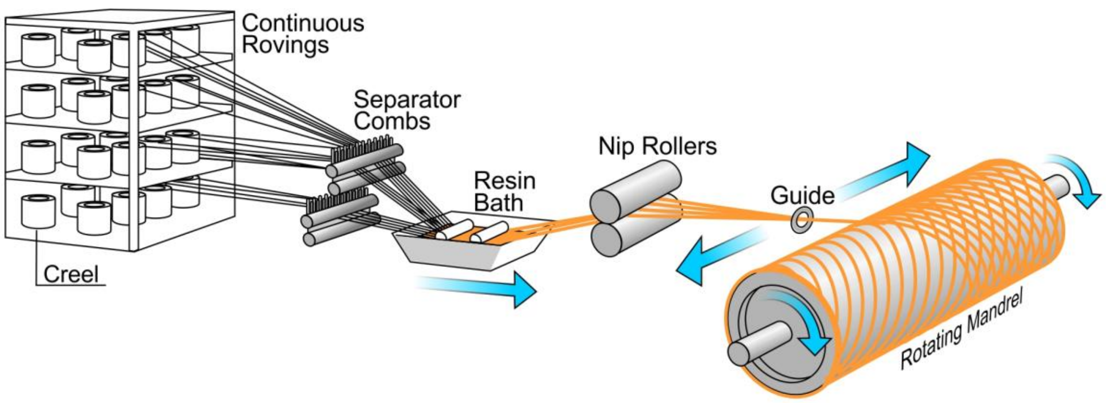
Vacuum Bag Pull-down

Loading into the Oven for Curing

De-moulding

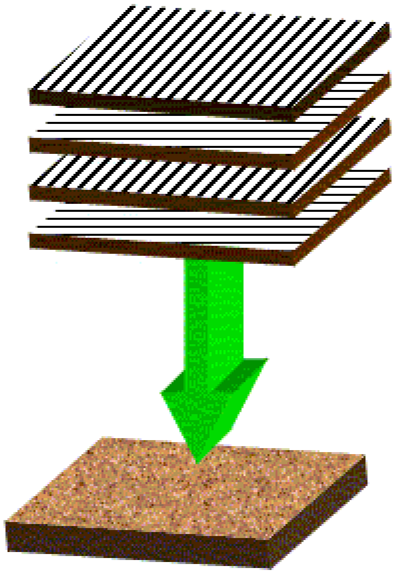
Fine plates manufactured by automated prepreg process

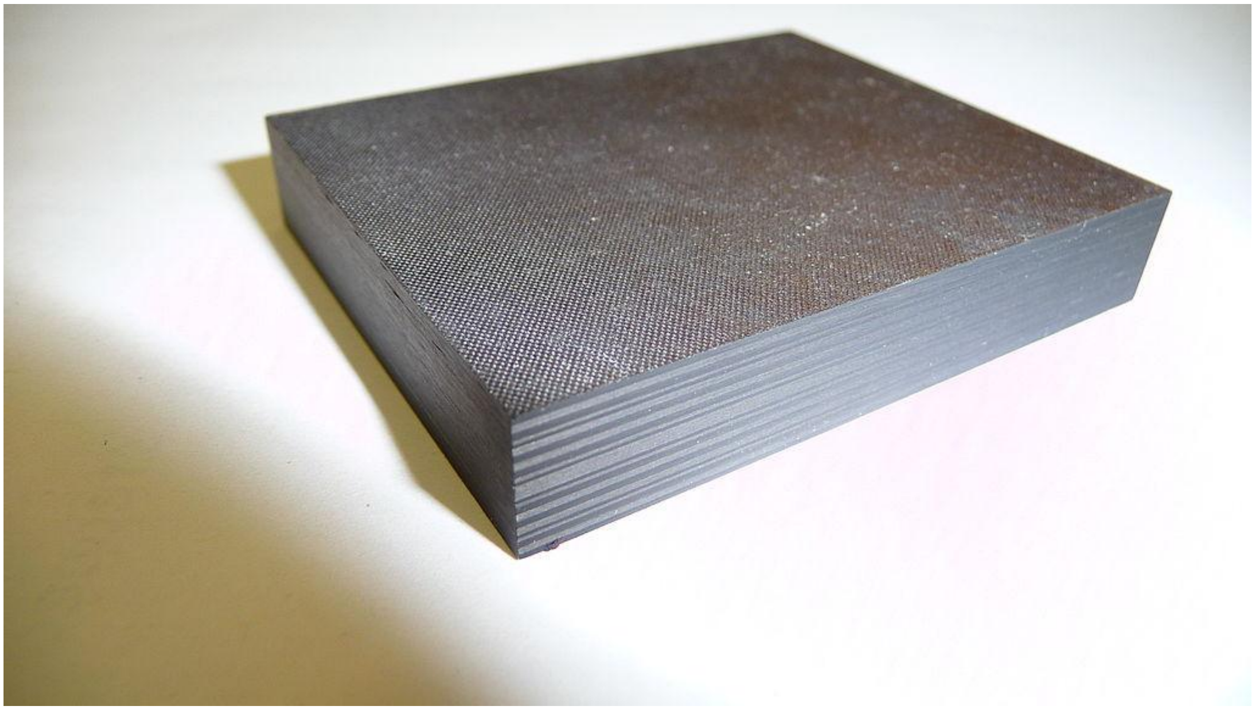
Filament Winding



STRUCTURAL COMPOSITES:

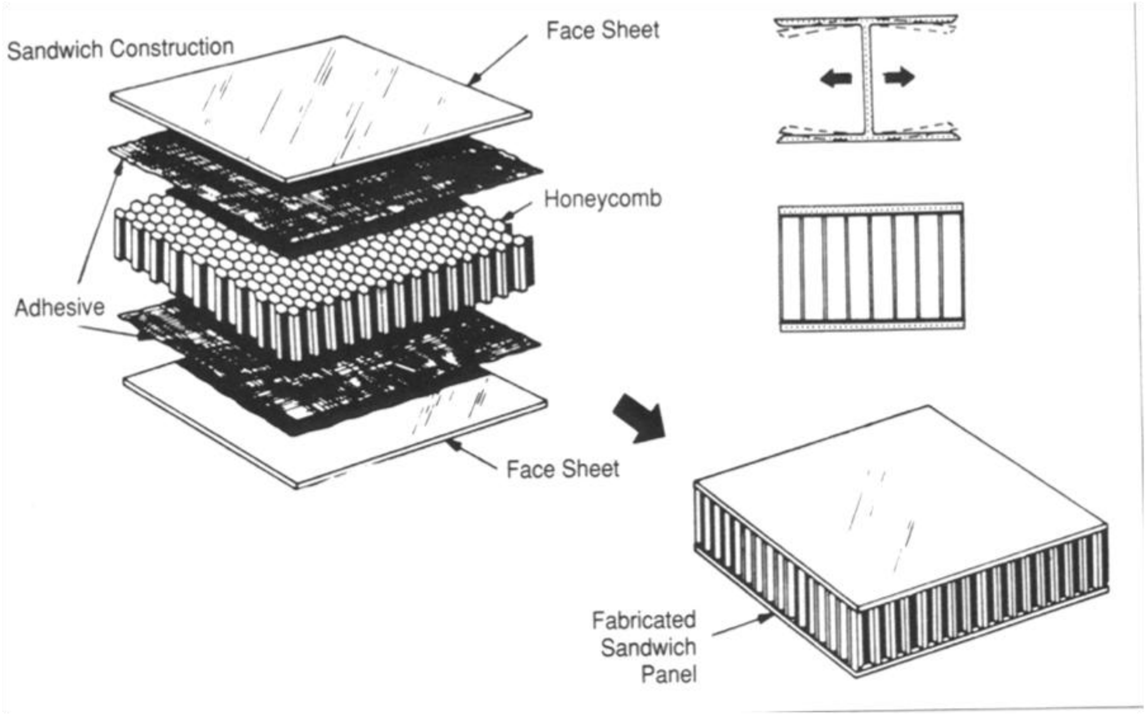
Laminar Composites





Sandwich Panels

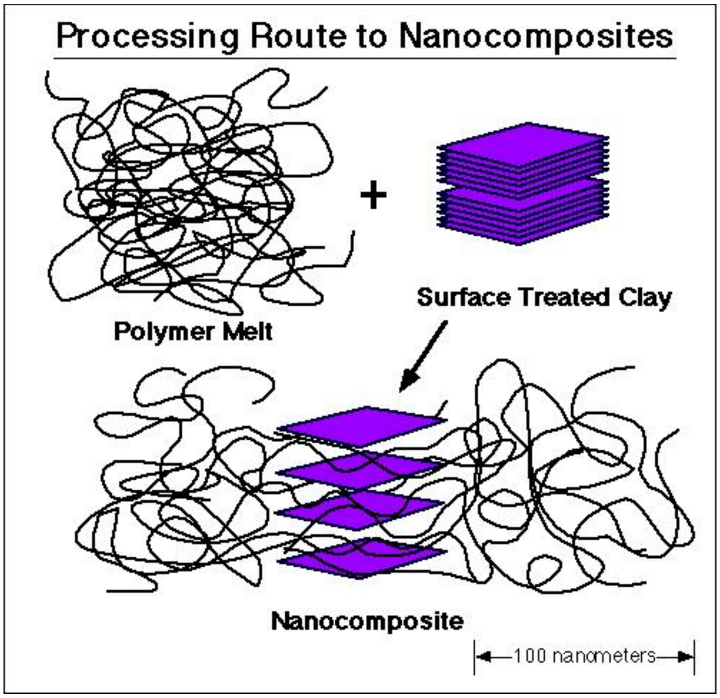
A honeycomb carbon fibre sandwich panel

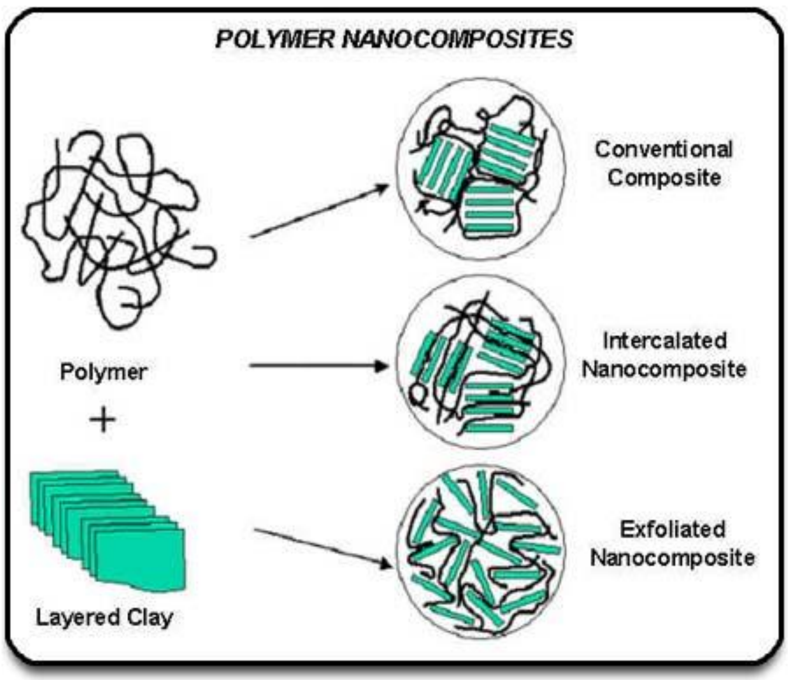


Sandwich panel components and construction

Composite thermoplastic oil pan is more impact-resistant than aluminium or sheet steel oil pans.

NANOCOMPOSITES:

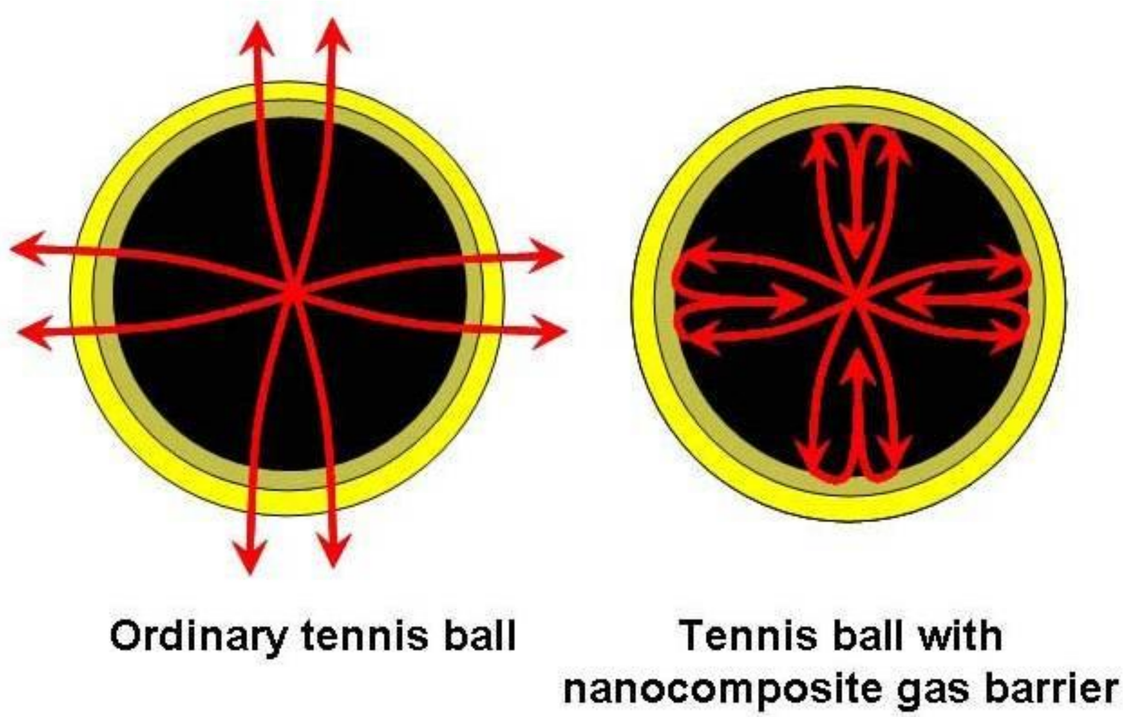




From a structural point of view a composite material made by a polymer and a lamellar filler can be:

- a microcomposite that is a conventional composite in which the two phases are separated with low interaction between lamellae and polymer chains;
- an intercalated nanocomposite in which polymeric chains are partially intercalated into the interlamellar region and the filler shows a regular lamellar structure yet;
- an exfoliated nanocomposite in which lamellae are completely and casually dispersed into polymeric matrix.

The exfoliated structure offers the highest interaction between the polymer and the lamellae and it produces the maximum effect on the final nanocomposite properties., The dispersion of a small quantity of nanometric size inorganic particles (about 5 wt. %) into organic polymers produces new composite materials with enhanced mechanical, gas and liquid barrier, flame retard, chemical stability properties than a neat polymer properties. Some particular metals can also induce optical, catalytic, electric and magnetic properties in polymers.



Double Core Tennis balls

Clay coating keeps the air in tennis balls. Double Core tennis balls with a composite made from butyl rubber and vermiculite. The clay nanoparticles spread out like sheets of paper scattered across a floor and keep air molecules from escaping, which keep the balls firm for an unusually long time.