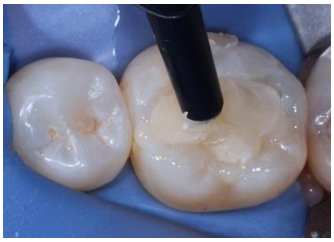
Filling materials

Filling material: can be defined as the material that is used to replace a missing part of the tooth which may result from dental caries, trauma or abrasion. It can be divided in to:

1.Direct filling materials: the filling that is placed directly into a cavity on a tooth, and shaped to fit it.
2.Indirect filling materials the dental impression is taken after tooth preparation and sent to a dental technician who fabricates the restoration that place in the prepared tooth.

Requirement of an ideal Filling material:-

1-Working time should be sufficiently long, to enable manipulation and placement of material before setting.

2-Setting time should ideally be short for comfort and convince of both the patient and clinician.
3.The material must withstand large variation in PH and a variety of solvents which may be taken into mouth in drink food stuffs and medicaments.
4-Filling should be good thermal insulator, protecting the dental pulp from the harmful effect of the hot and cold stimuli (low thermal diffusivity).
5.Materials should have values of coefficient of thermal expansion similar to those of enamel and dentine.
6-Metallic material should not undergo excessive corrosion, or be involve in the development of electrical currents which may cause " Galvanic pain " .
7-Should have satisfactory mechanical properties to withstand the force applied, abrasion resistance, compression and tensile strength, modulus of elasticity.
8-It should adhere well to the tooth walls and seal the margins to prevent ingress of fluid and bacteria.
9-It should be harmless to the operator and to the patient and should not be irritant to dental pulp and soft tissue.

10-It should be radiopaque.
11-It should bacteriostatic and anticariogenic .

Classification of filling materials:

1. **Metallic**
   a. Amalgam.
   b. Direct Gold filling.
   c. Indirect cast restorations.
2. **Non metallic which include**
   a. Polymeric
      - **Unfilled resin (acrylic)**
      - **Filled resin (composite, compomers)**
   b. Non polymeric
      - **Silicate cement**
      - **Glass ionomers cement**

Other classifications:

1. **Anterior filling material (tooth colored filling).**
2. **Posterior filling material.**

Composite materials : - The term composite may be defined as a compound of two or more distinctly different materials with properties that are superior or intermediate to those of the individual constituents. In dentistry, the term resin composite refers to a reinforced polymer matrix materials used as restorative materials.

Composition:

A resin composite is composed of four major components:

1. Organic resin matrix. (Bis- GMA or urethane dimethacrylate)
2. Inorganic filler particles (Quartz, colloidal silica glasses or ceramic containing heavy metals.
3. Coupling agent (organo silanes).
4. The initiator-accelerator system.

Also they contain

-Hydroquinone - inhibitor to prevent premature polymerization
-UV absorber - to improve color stability
-Opacifiers - e.g. titanium dioxide and aluminum oxide.
-Color pigments - to match tooth color

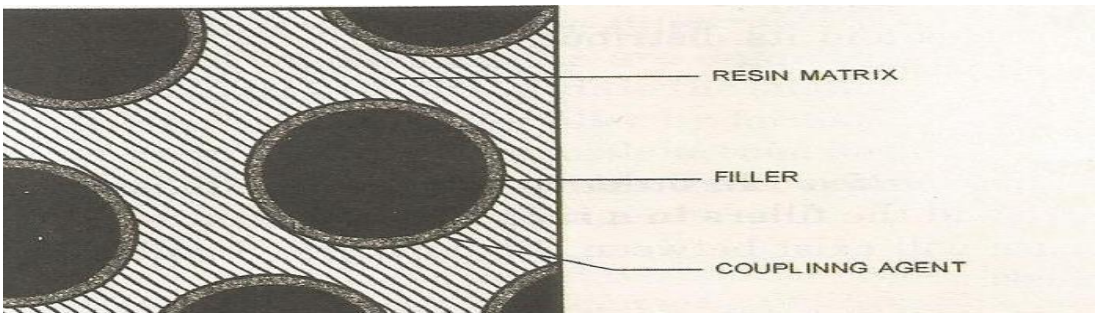
Organic resin matrix:- The nature of it may alter slightly from one product to another, essentially The monomers used for the resin matrix are **dimethacrylate** compounds. Its properties were superior to those of acrylic resins. The two monomers that have been commonly used are (**Bis- GMA**)

Inorganic Filler particles: Fillers have been obtained by grinding minerals such as quartz, glasses, or sol-gel derived ceramics. Composite resins use 3 types of fillers:

1-Ground quartz filler

2-Colloidal silica

3-Glasses / ceramics containing heavy metal



- **The function of the addition of filler particles into resin matrix are**

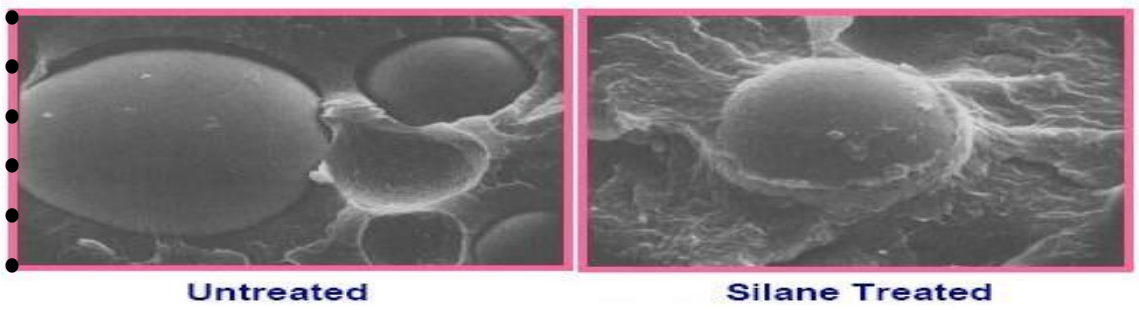
1. Reinforcement (Improves mechanical properties). Increased filler loading generally increases physical and mechanical properties such as compressive strength, tensile strength, modulus of elasticity.
2. Reduction of polymerization shrinkage/contraction.
3. Reduction in coefficient of thermal expansion and contraction.
4. Decreased water sorption. Absorbed water softens the resin and makes it more prone to abrasive wear and staining.
5. The radiopacity are improved

The Coupling agents: the composite to have successful properties, a good bond must form between the inorganic filler and the organic resin, The most commonly used coupling agents are organosilanes (often referred to as silane). Function of coupling agents:

1. They improve the physical and mechanical properties of resin.
2. They prevent water from penetrating the filler - resin interface.

3. Prevent the filler from being dislodged from the resin matrix.

and **urethane dimethacrylate(UDMA**).



- **The initiator-accelerator system:** is to polymerize and cross-link the system into a hardened mass. The polymerization reaction can be activated by light-activation, self-curing (chemical activation), and dual curing (chemical and light-curing).

Properties of the composite

1. Low polymerization shrinkage
2. Low water sorption
3. Coefficient of thermal expansion similar to tooth structure
4. High fracture and wear resistance
5. High radiopacity
6. Good bond strength to enamel and dentin (by using bonding)
7. Good color match to tooth structure
8. Easy to manipulation

Types of composite

Based on **curing mechanism** can be divided to:

1. Chemically activated composite or self cured composite.
2. Light activated composite.
3. Dual cured composite

Based on **size of filler particles** can be divided to:

1. Small particles composite.
2. Micro filled composite.
3. Hybrid composite.
4. Nanocomposites.

Chemically activated composite resins (self cured composite):

This is two paste system (base and catalyst) two tubes.

The base paste Contains **benzyl peroxide initiator**

The Catalyst paste contains **tertiary amine activator**

The properties of self cures composite are:

1. Activated by peroxide-amine system.
2. Chemical activation is accomplished at room temperature
3. Working time is limited.
4. Air may get incorporated during mixing resulting in reduction of properties.

Light activated composite resins:

UV activated systems: The earliest system used Ultra Violet light. Not used now a day because of the Limited penetration of the light into the resin.

Visible Light activated resins: They are widely used than the chemically activated resins. These are single paste system containing Photo initiator (**camphoroquinone**) and Amine accelerator.

The properties of light cures composite are:

1. Supplied as single component (light tight syringes) or unit-dose capsules.
2. Working time under control of Operator.
3. More Homogenous mix
4. Cure only where sufficient Intensity of light is received.
5. Less chance of air entrapment during manipulation



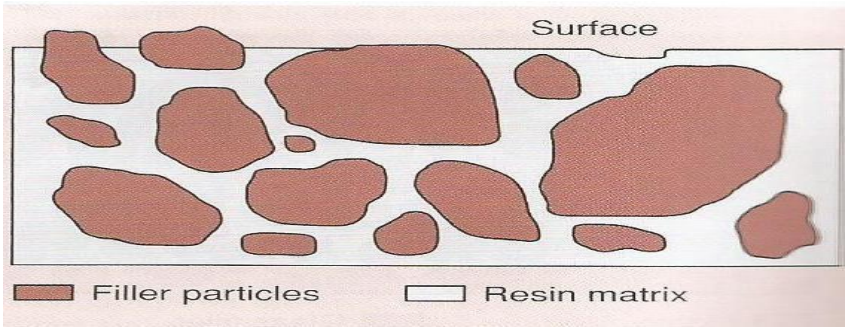
Dual cured composite: This formulation contained an initiator and accelerator that allow light activation follow by self curing. It consists of two light-curable pastes, one containing **benzoyl peroxide** and the other containing an **aromatic tertiary amine accelerator**. The major advantage of this system is assurance of completion of cure.



Classification based on size of filler particles

1. Conventional composite (Traditional or macrofilled composite): The early composites were macrofills, These composites contained large spherical or irregular shaped filler particles. they had certain disadvantages:

1. Surface finish was very poor and dull appearance (Polishing was difficult and results in a rough surface) this is due to selective wear of the softer resin matrix leaving the hard filler particles elevated.
2. Poor resistance to occlusal wear.
3. Tendency to discolor, the rough surface tends to stain.



The conventional composite after polishing

2. Micro filled composite: They were developed to overcome the problems of surface roughness of conventional composite. The microfilled

composite achieved the smoothness of unfilled acrylic direct filling resins and the advantages of having filler. The microfilled composite is the resin of choice for esthetics restoration of anterior teeth, especially in non-stress bearing Area.

3. **Small particles composite:** Small particles composite were introduced in an attempt to have good surface smoothness (like microfilled composite) and yet retain or improve the physical and mechanical properties of conventional composite.

4. **Hybrid composite: -** These were developed so as to obtain better surface smoothness than that of small particle, but yet maintain the properties of latter. The hybrid composites have a surface smoothness and esthetics competitive with microfilled composite for anterior restoration.

5. **Nanocomposite/ Nanofillers :**Nanofillers and Nanocomposites the latest advancement in composite technology has been the use of nanotechnology in development of fillers.

Manipulation of the composite: Composites used for restoring teeth are usually supplied in a kit containing the following:

- Syringes of composite resin paste in various shades.
- Etching liquid (37% phosphoric acid).
- Enamel dentin bonding agent.
- Shade guide.

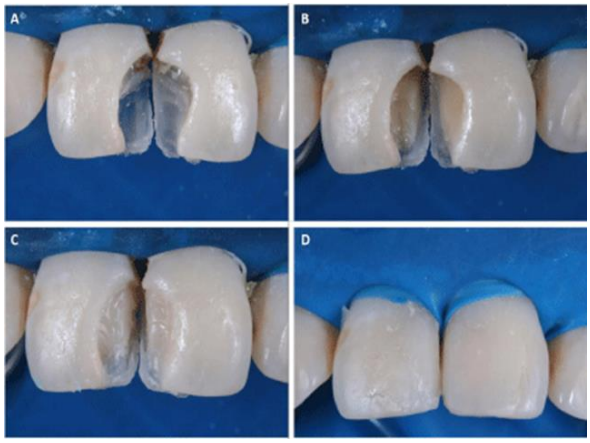




The manipulation is

1. **pulpal protection**: with cavity liner
2. **Etching:** the enamel at the cavity margins is acid etched with **37% phosphoric acid** solution or gel for 30 seconds. Flush the acid away with water, and gently dry the surface with a stream of air.

3. **Bonding agent** an enamel and dentin bond agent is applied and polymerized that provides micromechanical retention of the restoration. The cavity is now ready for the composite.
4. **dispensing:** For light-Cured Composites, dispense small increments and pack into the cavity preparation, while controlled setting time allows for the individual polymerization of small increments of composite which help in:
   A- Use of multiple shades of composite within a single restoration.
   B- Accommodating polymerization shrinkage within each increment.



For Self- and Dual-Cured Composites, Mix equal amount of base and catalyst pastes thoroughly for 20 to 30 seconds use plastic or wooden spatulas (avoid metal spatulas because the inorganic filler particles are abrasive and small amounts of the metal can abraded and discolor the composite.

5. **Insertion:** The composite can be inserted with a plastic instrument, which does not stick to the composite during insertion or It can be injected into the cavity preparation by a syringe
6. **Polymerization:** for light cure composite the exposure times vary from 20 to 60 seconds for a restoration **2 mm** thick depending on the type of light-curing unit and the (type, depth, and shade) of the composite.
   for Self-Cured Composites: After mixing, a working (or insertion) time is **1 to 1.5** minutes then the mix will begin to harden, the setting time is about **4 to 5** minutes from the start of the mix.
   For Dual-Cured Composites: They contain chemical accelerators and light activators, so polymerization can be initiated by light and then continued by the self-cured mechanism.
7. Finishing and polishing.