DENTAL MATERIAL

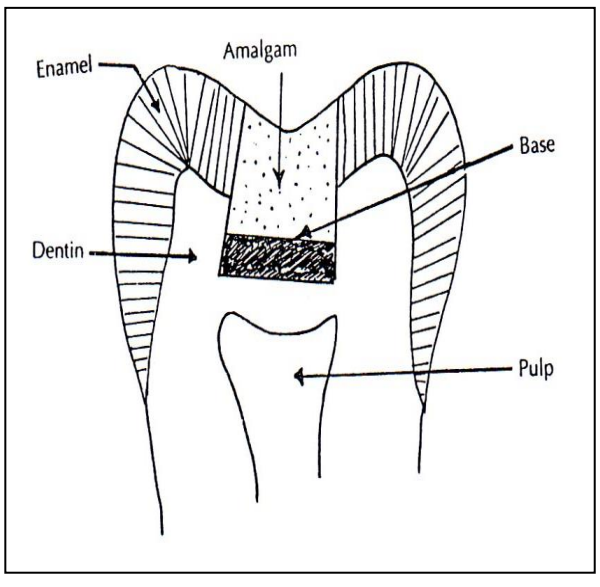
FILLING MATERIALS

Lecture 16

Loss of tooth structure by dental caries (fig. A), trauma (fig. B) or abrasion (fig.C) can be replaced by filling material but it is very important to know that there is no single filling material could be used as a substitute for all cases because in some cases the strength & abrasion resistance are more important than appearance while appearance would be more important than strength in other cases. (Because there is no ideal material)

Requirements of an ideal Filling material:-

1. Should be dimensionally stable, no contraction or expansion occurs after use.
2. Should have good abrasion resistance & compression and tensile strength.
3. Coefficient of thermal expansion of the filling should be similar to those of enamel and dentine.
4. Should adhere well to the tooth walls and seal the margin prevent ingress (entrance) of fluid and bacteria.
5. Should have the same color of the natural teeth, also should not change color by time.
6. Should be bacteriostatic and anti-cariogenic and easily polished.
7. Should be harmless to the patient and to the dentist and should not be irritant to dental pulp and soft tissue.
8. Should withstand large variation in PH and a variety of solvents which may be taken into mouth.
9. Should be good thermal insulator; protecting the dental pulp from the harmful effect of the hot and cold stimuli.
10. Metallic material should not undergo excessive corrosion
11. Should not be involved in the development of electrical currents which may cause galvanic pain.
12. Working time should be sufficiently long, to enable manipulation and placement of material before setting. But setting time should not so long for comfort of patient.



Classification of Filling materials

1- Non-metallic.

A. ***Polymeric***: unfilled(acrylic) and filled (composite)
B. ***non-polymeric*** (glass inomer cement and Silicate cement)

2- Metalic (Amalgam and Gold).

Silicate cement filling material:

Filling material for anterior teeth, supplied as a powder and liquid of phosphoric acid, **not used nowadays because:**

1- Low PH (5 - 3.5) of phosphoric acid cause Pulp irritation.
2- Week mechanical properties.
3- Shrinkage on setting.
4- High solubility and disintegrate in the mouth.

Acrylic resin:

At 1930 silicate was neglected due to development of acrylic .The unfilled acrylic materials composed of powder (Polymethyl methacrylate, initiator) and liquid (methyl methacrylate, activator). It has good resistance to solubility.

The undesirable qualities of unfilled acrylics were:

- Discolouration and Porosity.
- Large dimensional change on setting
- high coefficient of thermal expansion and contraction
- Percolation of saliva at margins.
- Low mechanical strength.
- Low resistance to wear and problems with recurrent caries.
- Eugenol lining material inhibits the polymerization reaction.

Composite

Composite refers to compound of two or more different materials with properties that are superior or intermediate to those of the individual constituents. Composite filling is polymeric filling material reinforced with filler particles. It was developed to overcome the disadvantages of acrylic filling and of silicate cement. It is most popular anterior filling material. Now days, composite are used as anterior and posterior filling materials.

Composite is used as:

1. Anterior restorations
2. Posterior restorations

Composite is <u>not</u> used in the following cases:

1. Large posterior restorations (composite fillings are not strong enough to withstand forces of mastication)
2. Bruxism (composite fillings are not strong enough to withstand such force)
3. Poor isolation (composite can't adhere well to tooth structure if there is saliva)

Advantages of composite

1. Esthetics
2. Conservation of tooth structure
3. Adhesion to tooth structure
4. Low thermal conductivity

5. Substitute to amalgam

***Disadvantages** of composite*

1. Technique sensitivity (excellent isolation to the tooth)
2. Polymerization shrinkage that cause:
   a- marginal leakage
   b- secondary caries
   c- post-operative sensitivity
3. Decreased wear resistance

Composition of composite:

The essential components of a composite are:

1- ***Resin matrix (binder)***

2- ***Filler*** (Quartz, colloidal silica or heavy metals glasses)

3- ***Coupling agent*** (organo silanes)

Resin matrix:

A blend of monomers & their properties are superior to the properties of acrylic resins.

Filler particles:

Addition of filler particles into resin matrix improves its properties by:

1- Improves mechanical properties like strength and hardness and abrasion resistance.

2- Reduced water sorption and coefficient of thermal expansion

3- The amount of resin in the composite is less, so the curing shrinkage is reduced, so marginal leakage is reduced as well.

4- Radiopaque.

Types of filler:

1- Quartz filler: They are obtained by grinding the quartz. They are mainly used in conventional composites. They are chemically inert and very hard & this makes the restoration more difficult to polish and can cause abrasion of opposing teeth and restoration.

2- ***Colloidal silica:*** they're micro fillers. They are added in small amount (5 wt%) to modify the viscosity of the composite. Colloidal silica particles have large surface area thus even small amount of micro fillers thickens the resin.

3- glasses / ceramic* containing *heavy metal:- These fillers provide ***radiopacity*** to resin restoration.

Filler Particles size and distribution:

If a single particle size is used, a space will exist between particles so particles of different sizes are added so that the smaller particles can then fill up these spaces.

Coupling agents: Coupling agents bond the filler particles to the resin matrix. This allows the more plastic resin matrix to transfer stress to stiffer filler particles. Most commonly used coupling agent is **Organo silane.**

Function of coupling agents:

l - 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.

Types of composite:

A) ***Based on curing mechanism****:*

1- Chemically activated composite

2- Light activated composite

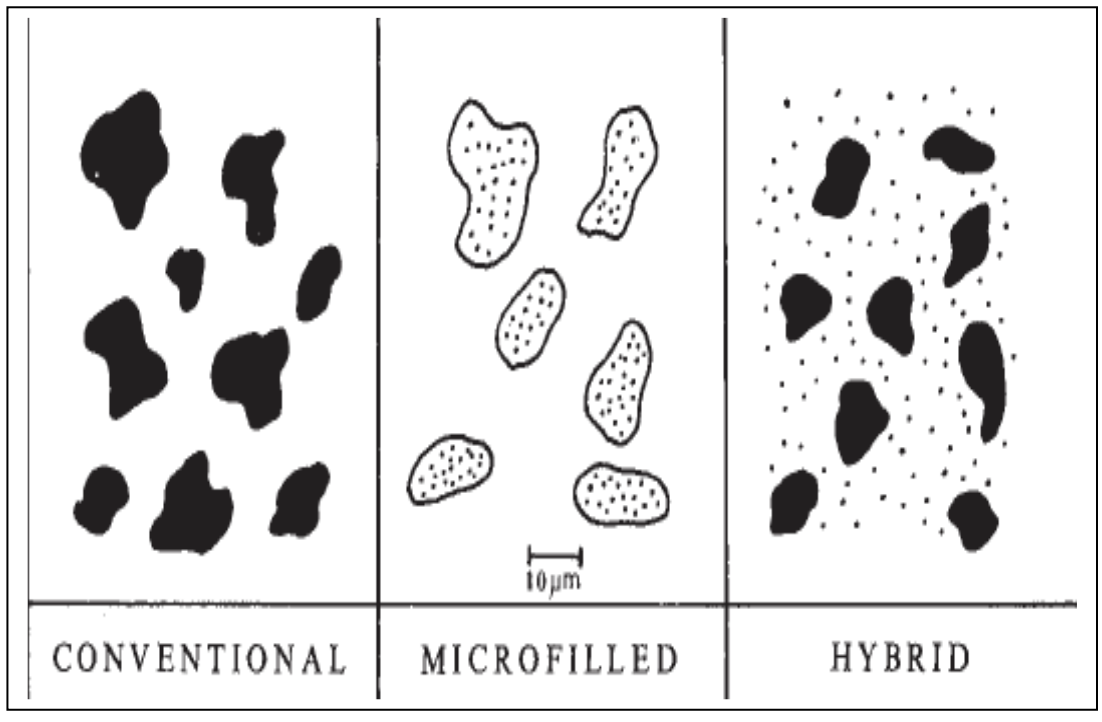
B***) Based on size of filler particles***:

1 - Conventional composite

2- Small particles composite

3-Micro filled composite

4- Hybrid composite



1-Chemically activated, composite resins:

This is two - paste system:

1- Base paste : Contains benzoyl peroxide initiator

2- Catalyst paste : Tertiary amine activator

Setting: When two pastes are spatulated the amine reacts with the benzoyl peroxide to form free radical which starts the polymerization.

2-Light activated composite resins:

They are widely used than the chemically activated resins ; these are single paste system containing Photo initiator.

Setting

Under normal light they don't interact. However, when exposed to light of the correct wave length the photo initiator is activated. The photo initiator has an absorption range of light between 400 and 800 nm. This is in the blue region of visible light spectrum & this is why the blue light is used in the clinic.

Comparison of light activated and chemically activated resins

Light activated	**Chemical activated**
Required light of correct wave Length for its activation	Activated by peroxide-amine system
Cure only where sufficient Intensity of light is received	Cures when the two pastes are mixed together
Working time under control of Operator	working time is limited because it starts as the two pastes are mixed
Supplied as single component in Light tight syringes	supplied as two paste system
Less chance of air entrapment during manipulation	Air may get incorporated during mixing resulting in reduction of properties.

Classification of composite based on size of filler particles: -

-Conventional composite (Traditional or macro filled composite): Quartz is most commonly used as filler. Average size is 8 - I2μm.

disadvantages:

1. Polishing is difficult and results in a rough surface; this is because when we polish the filling, wear of the softer resin matrix will take place leaving the hard filler particles elevated.
2. Tendency to discolour because the rough surface tends to stain.

2- Micro filled composite:

They were developed to overcome the problems of surface roughness of conventional composite.

Colloidal silica is used as micro filler and its surface area is large so only small amount of silica is used.

Their mechanical properties are inferior to other type**???** This is because of their higher resin content.

Their biggest advantages-is their esthetics. The micro filled composite is the resin of choice for esthetics restoration of anterior teeth especially when strength is not required.

3- ***Small Particles composite***:

Small particles composite were introduced in an attempt to have good surface smoothness (Like micro filled composite) and the physical and mechanical properties of conventional composite. This type of composite use fillers that have been ground to smaller size. Due to the higher filler content, the best physical and mechanical properties are observed with this type. Heavy metal glasses are used here.

4-Hybrid composite

These are developed so as to obtain better surface smoothness than that of small particle and also maintain the properties of small particle composite.

The hybrid composites are widely used for anterior filling where esthetic is required & for posterior filling where strength is required.