Posterior Composite Restoration

Lecture 10

Prepared By :

Dr. Maitham Yahya Altufaili

Specialist In Restorative Dentistry

National university of science and technology

Restorative department

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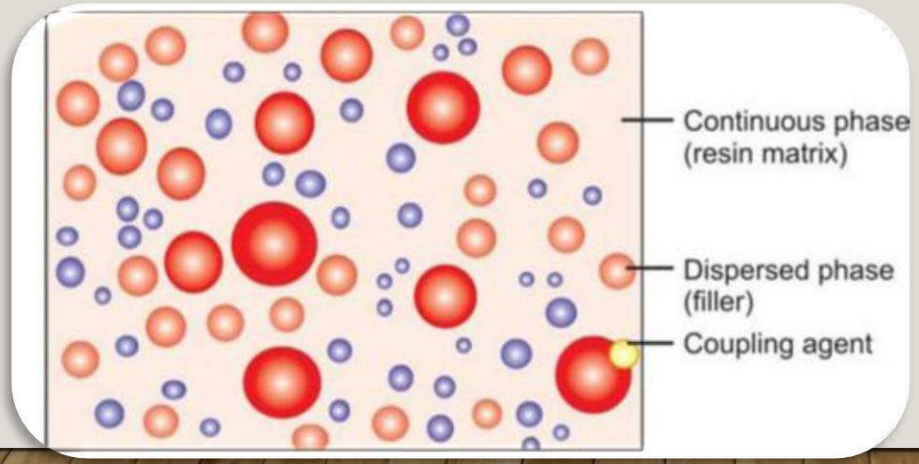
Fourth stage

COMPOSITION OF DENTAL COMPOSITES

1. Organic Matrix

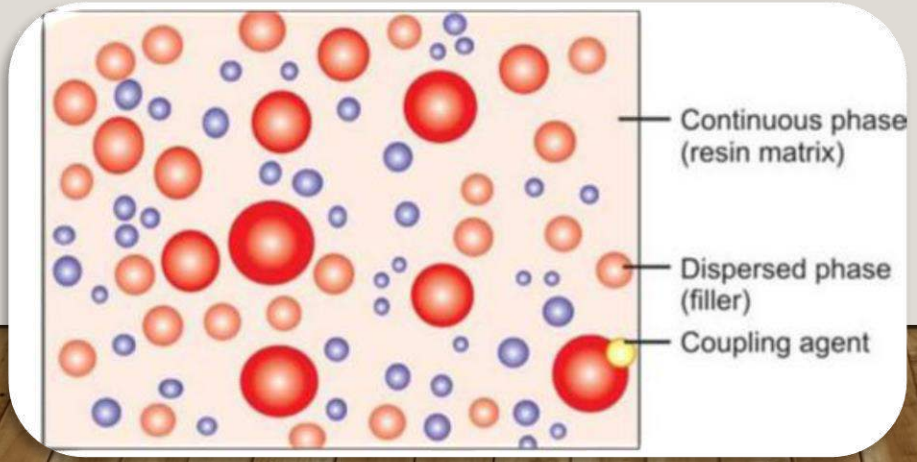
- Resin matrix represents the backbone of the composite resin system.
- Monomers are Bis-GMA, Urethane dimethacrylate UDMA, or a combination of them.
- Since these resins are very viscous, to improve handling and control viscosity, they are diluted with low-viscosity monomers like triethylene glycol dimethacrylate (TEGDMA).





2. Fillers

- Commonly used inorganic fillers are silicon dioxide, boron silicates and lithium aluminum silicates.
- Quartz is partly replaced with heavy metal particles like zinc, aluminum, barium, strontium or zirconium in some composites nowadays calcium metaphosphate is also used because it is softer than glass, so causes less wear of the opposing tooth.
- Filler content ranges from 30% to 50% by volume and 50% to 85% by weight.

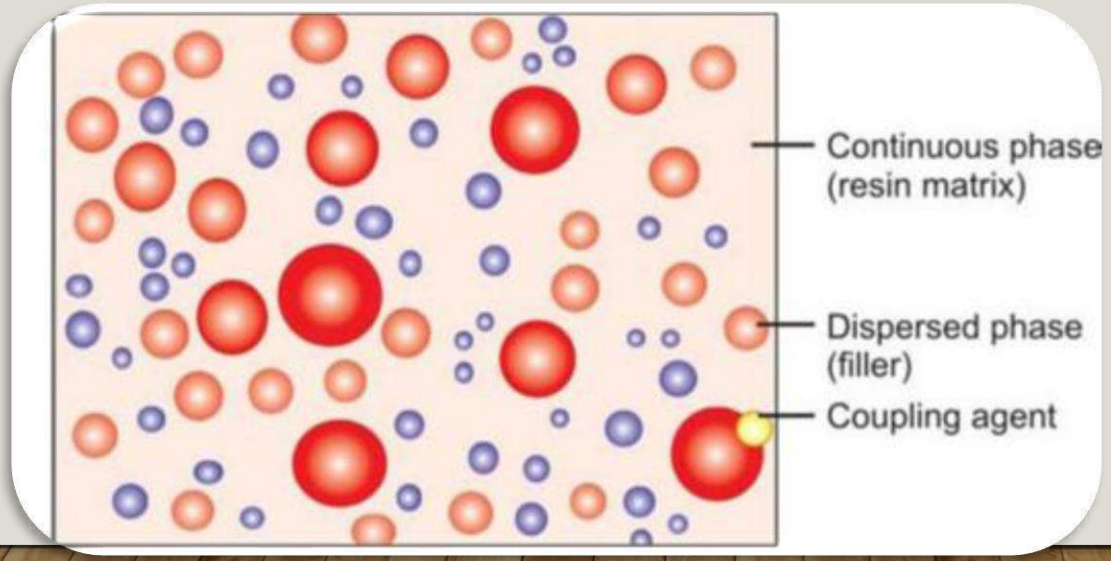


Advantages

1. Reduces the coefficient of thermal expansion
2. Reduces polymerization shrinkage
3. Increases abrasion resistance
4. Decreases water sorption
5. Increases tensile and compressive strengths
6. Increases fracture toughness
7. Increases flexure modulus
8. Provides radiopacity
9. Improves handling properties
10. Increases translucency

3. Coupling Agents:

- A coupling agent binds the hydrophilic filler particles to the hydrophobic organic resin.
- Interfacial bonding between the matrix phase and the filler phase is provided by coating the filler particles with silane coupling agents.



4. Initiator Agents:

- These agents activate the polymerization of composites.
- The most common photoinitiator used is camphorquinone.
- Currently, most recent composites are polymerized by exposure to visible light in the range of 410 to 500 nm.
- The initiator varies with the type of composite whether it is light-cured or chemically cured.

5. Inhibitors:

- These agents inhibit the free radicals generated by the spontaneous polymerization of the monomers. For example, butylated hydroxyl toluene (0.01%).

6. Colouring Agents:

- They are used in a very small percentage to produce different shades of composites. Mostly metal oxides such as titanium oxide and aluminum oxides are added to improve the opacity of composite resins.

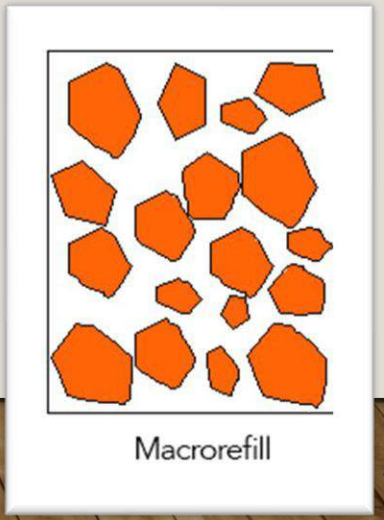
7. Ultraviolet Absorbers:

- They are added to prevent discolouration, in other words ,they act like a "sunscreen" to composites. A commonly used UV absorber is benzophenone.

TYPES OF COMPOSITES

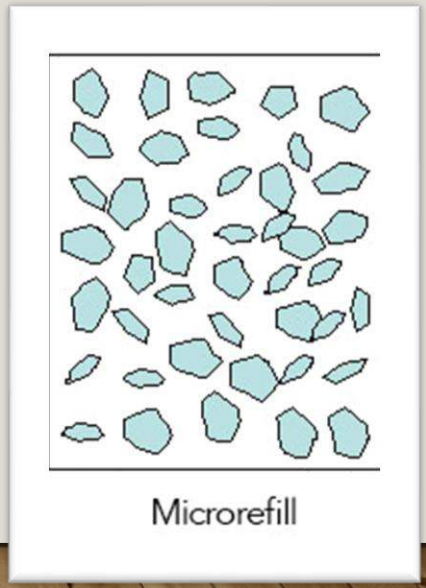
1. Macrofilled Composite

- These were developed during the early 1970s. The average particle size of macro fill composite resins ranges from 8–12 um. Filler content is approximately 60–65% by weight. It exhibits a rough surface texture because of the relatively large size and extreme hardness of the filler particles. Due to roughness, discolouration and wearing of occlusal contact areas and plaque accumulation takes place more quickly than in other types Of composites.
- **Advantage**: Physical and mechanical performance is better than unfilled acrylic resin.
- **Disadvantages**: Rough surface finish, Poor polishability, More wear.



2. Micro filled Composites Resins

- These composites were introduced in the early 1980s. The average particle size ranges from 0.04 to 0.4 micrometres. Filler content is 30 to 40% by weight. Small particle size results in a smooth polished surface which is resistant to plaque, debris and stains. But because of less filler content, physical properties are inferior. They are indicated for the restoration of anterior teeth and cervical lesions.
- **Advantages** Highly polishable, Good esthetic.



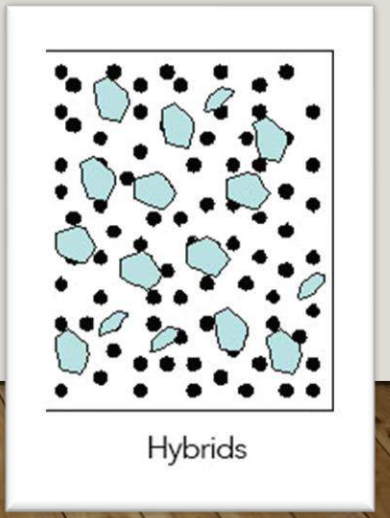
Disadvantages

- Poor mechanical properties due to more matrix content
- Poor color stability
- Low wear resistance
- Less modulus of elasticity and tensile strength
- More water absorption
- High coefficient of thermal expansion.

3. Hybrid Composite Resins

- They are composed of glasses of different compositions and sizes, with particle size diameters of fewer than 2 μm and containing 0.04 μm sized fumed silica.
- This mixture of fillers is responsible for their physical properties similar to those of conventional composites with the advantage of smooth surface texture.

Disadvantages: Not appropriate for heavy stress-bearing areas, and loss of gloss occurs when exposed to tooth brushing with an abrasive toothpaste.



4. Microhybrid, Nanohybrid, and Nanofill

- Microhybrid composites have evolved from traditional hybrid composites.
- Filler content in microhybrids is 56 to 66% by volume with an average particle size of 0.4 to 0.8 μm.
- The incorporation of smaller particles makes them better to polish and handle than their hybrid counterparts.
- Nanofill and nanohybrid composites have an average particle size less than that of micro-filled composites.
- The use of these extremely small fillers and their proper arrangement within the matrix results in physical properties equivalent to the original hybrid composite resins.

Advantages

- Highly polishable
- Tooth-like translucency with excellent esthetic
- Optimal mechanical properties
- Good handling characteristics.
- Good colour stability
- Stain resistance
- High wear resistance
- Can be used for both anterior and posterior restorations

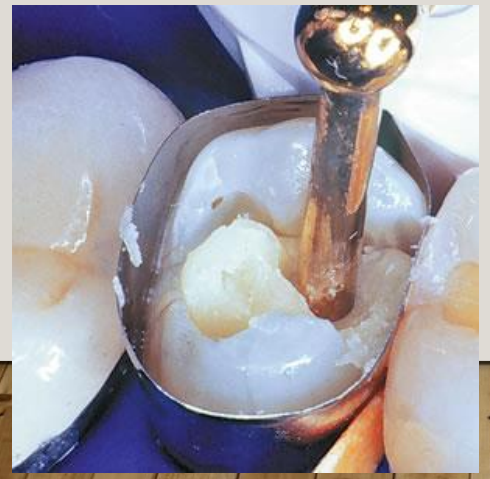
Flowable Composite Resin

- Flowable composites were introduced in dentistry in late 1996.
- Filler content is 60% by weight with particle size ranging from 0.02 to 0.05 μm.
- Low filler loading is responsible for decreased viscosity of composites, which allows them to be injected into small preparations,



Condensable (Packable) Composites

- Condensable/packable composites have improved mechanical properties and handling characteristics.
- The main basis of packable composites is Polymer Rigid Inorganic Matrix Material (PRIMM).
- Here components are resin and ceramic inorganic fillers which are incorporated in silanated network of ceramic fibres.
- These fibres are composed of alumina and silicon dioxide which are fused at specific sites to form a continuous network of small compartments.
- Filler content in packable composites ranges from 48 to 65% by volume with average particle size ranging from 0.7 to 20 μm.



PROPERTIES OF COMPOSITE

Coefficient of Thermal Expansion

- Coefficient of thermal expansion of composites is approximately three times higher than normal tooth structure.
- This results in more contraction and expansion than enamel and dentin when there are temperature changes resulting in loosening of the restoration.
- It can be reduced by adding more filler content.

Wear resistance

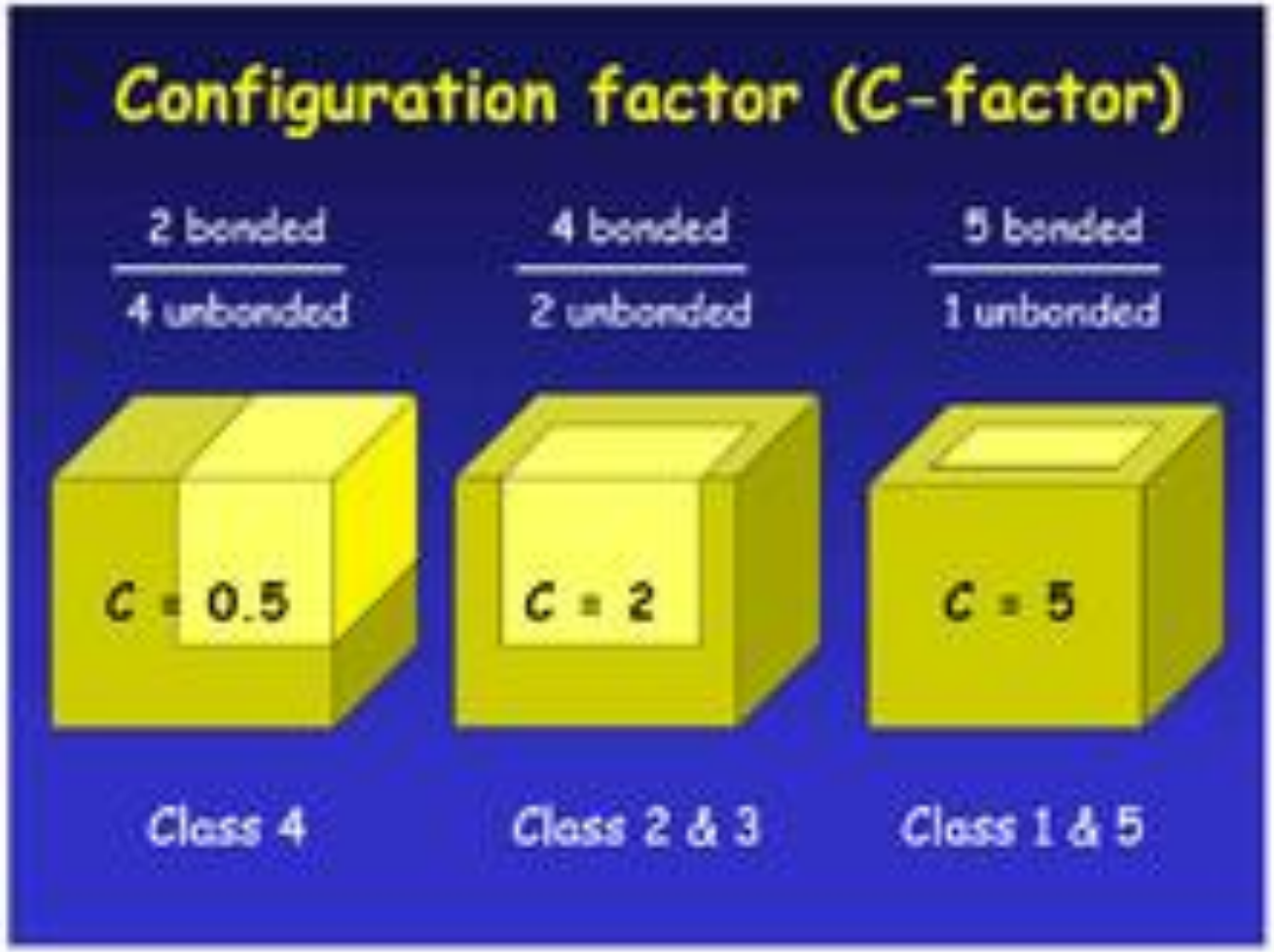
- Composites are prone to wear under masticatory forces, tooth brushing and abrasive food.
- Site of restorations in the dental arch and occlusal contact relationship, size, shape and content of filler particles affect the wear resistance of the composites.

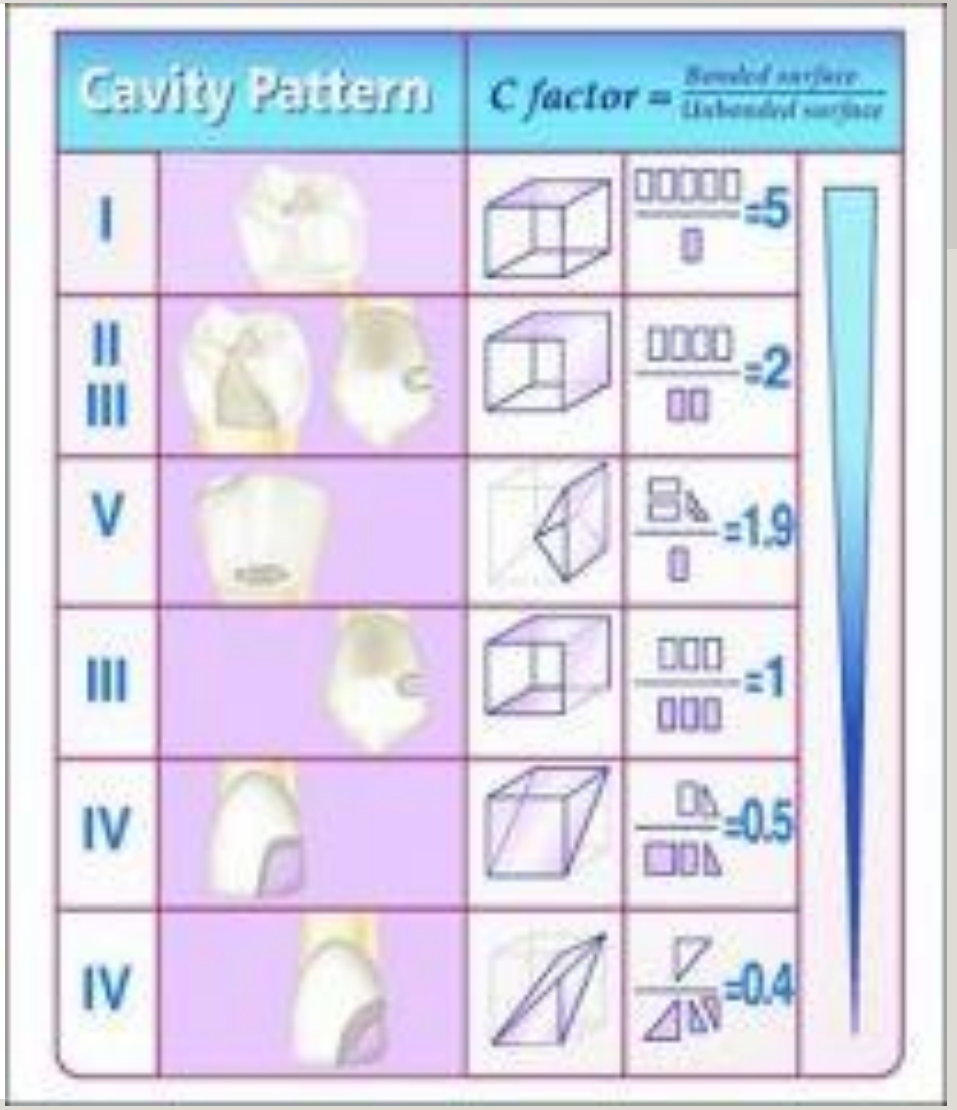
Polymerization Shrinkage

- Composite materials shrink while curing which can result in the formation of a gap between resin-based composite and the preparation wall.
- It accounts for 1.67 to 5.68 % of the total volume.

Configuration or C-factor

- Cavity configuration or C-factor is the ratio of the bonded surface of restoration to unbonded surfaces.
- The higher the value of the ‘C’-factor, the greater the polymerization shrinkage.
- Three-dimensional tooth preparations (Class I and V) have the highest (most unfavourable) C-factor and thus are at more risk of the effects of polymerization shrinkage.
- C-factor plays a significant role when tooth preparation extends up to the root surface causing a ‘V-shaped gap formation between the composite and root surface due to polymerization shrinkage.


Configuration factor (C-factor)
2 bonded
4 unbonded
4 bonded
2 unbonded
5 bonded
1 unbonded
C = 0.5
C = 2
C = 5
Class 4
Class 2 & 3
Class 1 & 5


Cavity Pattern
C factor = Bonded surface / Unbonded surface
I
5/0=5
II
III
4/2=2
V
1.9/0=1.9
III
3/3=1
IV
0.5/1.5=0.5
IV
0.4/0.6=0.4

- **Microleakage**
- It is the passage of fluid and bacteria in micro-gaps (10–6 µm) between restoration and tooth. It can result in damage to the pulp.
- **Microleakage can occur due to:**

1) Polymerization shrinkage of composites.

2) Poor adhesion and wetting.

3) Thermal stresses or mechanical loading.

- Microleakage results in 1) Bacterial leakage, 2) Recurrent caries, 3)Pulpal infection and 4)Tooth discolouration.

Advantages Of Composite Resin:

1. Conservation of tooth structure.
2. Esthetically acceptable
3. Low thermal conductivity: thus no insulation base is required to protect underly the pulp.
4. Mechanical bonding to tooth structure: Restorations are bonded with enamel and dentin, hence showing good retention.
5. Immediate finishing and polishing: Restoration with composite resins can be finished immediately after curing.
6. It can be repaired rather than replaced.
7. Restoration can be completed in one dental visit.
8. No galvanism because composite resins do not contain any metals.

DISADVANTAGES

1. Polymerization shrinkage.

2. Time-consuming: composite restorations require good isolation and a number of steps for their placement.

3. Composite restorations are more difficult to place.

4. Expensive: more expensive than amalgam.

5. Technique sensitive: It is more technique sensitive than amalgam because composite placement requires careful attention to all steps of placement.

6. Low wear resistance: composites have low wear resistance than amalgam.

Tooth Preparation For Composite Restoration

general concepts for tooth preparation for composite restorations:

1. Conservation of tooth structure:

- Tooth preparation is limited to extent of the defect. For composite restorations, rule extension for prevention and proximal contact clearance is not necessary unless it is required to facilitate proximal matrix placement.

2. Variable depth of pulpal and axial wall depth:

- Pulpal and axial walls need not be flat.

3. Preparation of operating site:

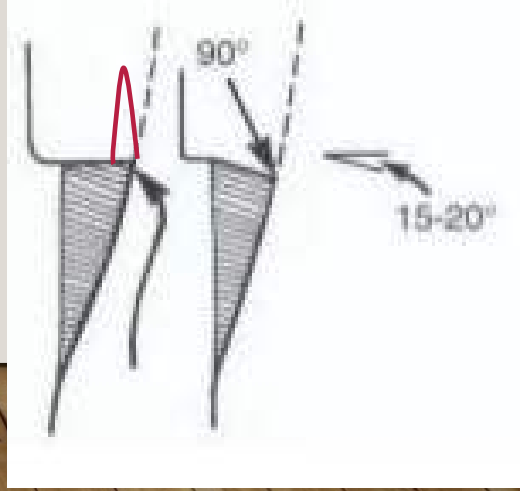
- To facilitate bonding, the tooth surface is made rough by using diamond abrasives.

4. Enamel bevel:

- Enamel bevel is given in some cases to increase the surface area for etching and bonding.

5. Butt joint on root surface:

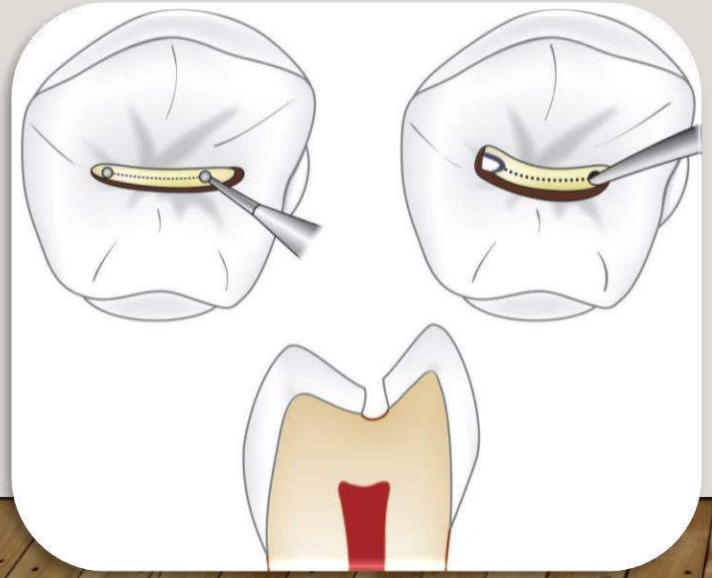
- The cavosurface presents on root surfaces has to be the butt joint.



Designs of Tooth Preparation for Composites

1. Conventional preparation

- Conventional design is similar to the tooth preparation for amalgam restoration, except that there is less outline extension and in tooth preparation, walls are made rough. Indicated in moderate to large class I or class II restorations and in preparations located on the root surface.



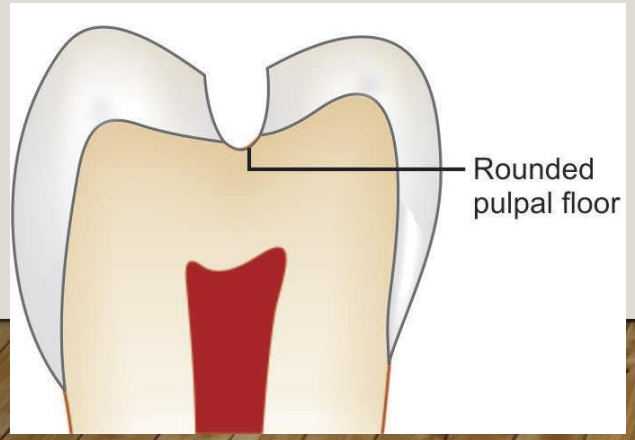


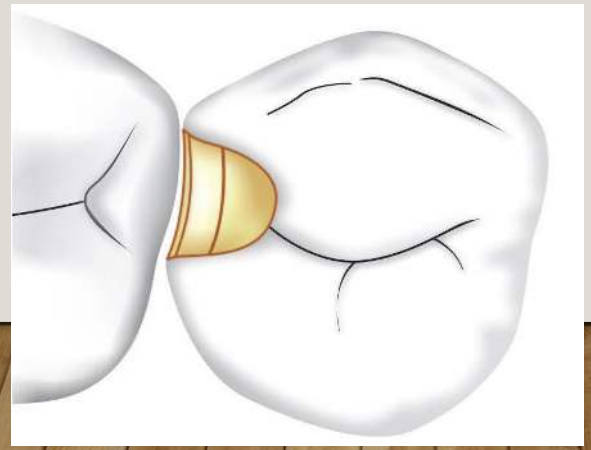
2. Bevelled conventional tooth preparation

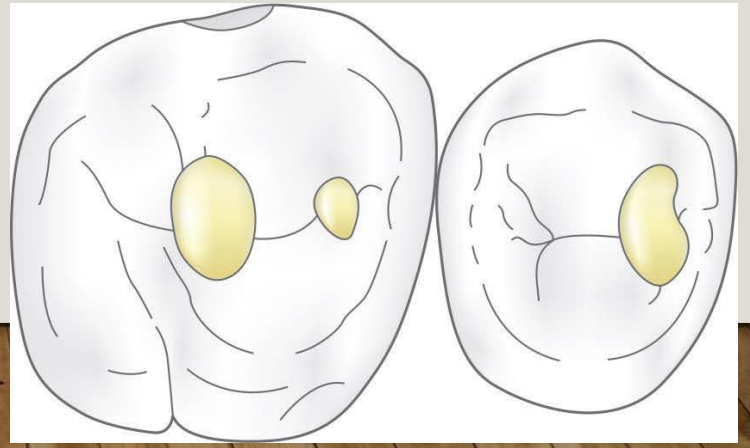
- Bevelled enamel margins are indicated for classes III, IV, V and VI restorations.

3. Modified (conservative tooth preparation)

- It is more conservative in nature since retention is achieved by micromechanical bonding to the tooth. It does not have a specified wall configuration or pulpal and axial wall depth.
- The extent and depth of the preparation depend upon the extent and the depth of the carious lesion. Indicated for initial or small carious lesions.



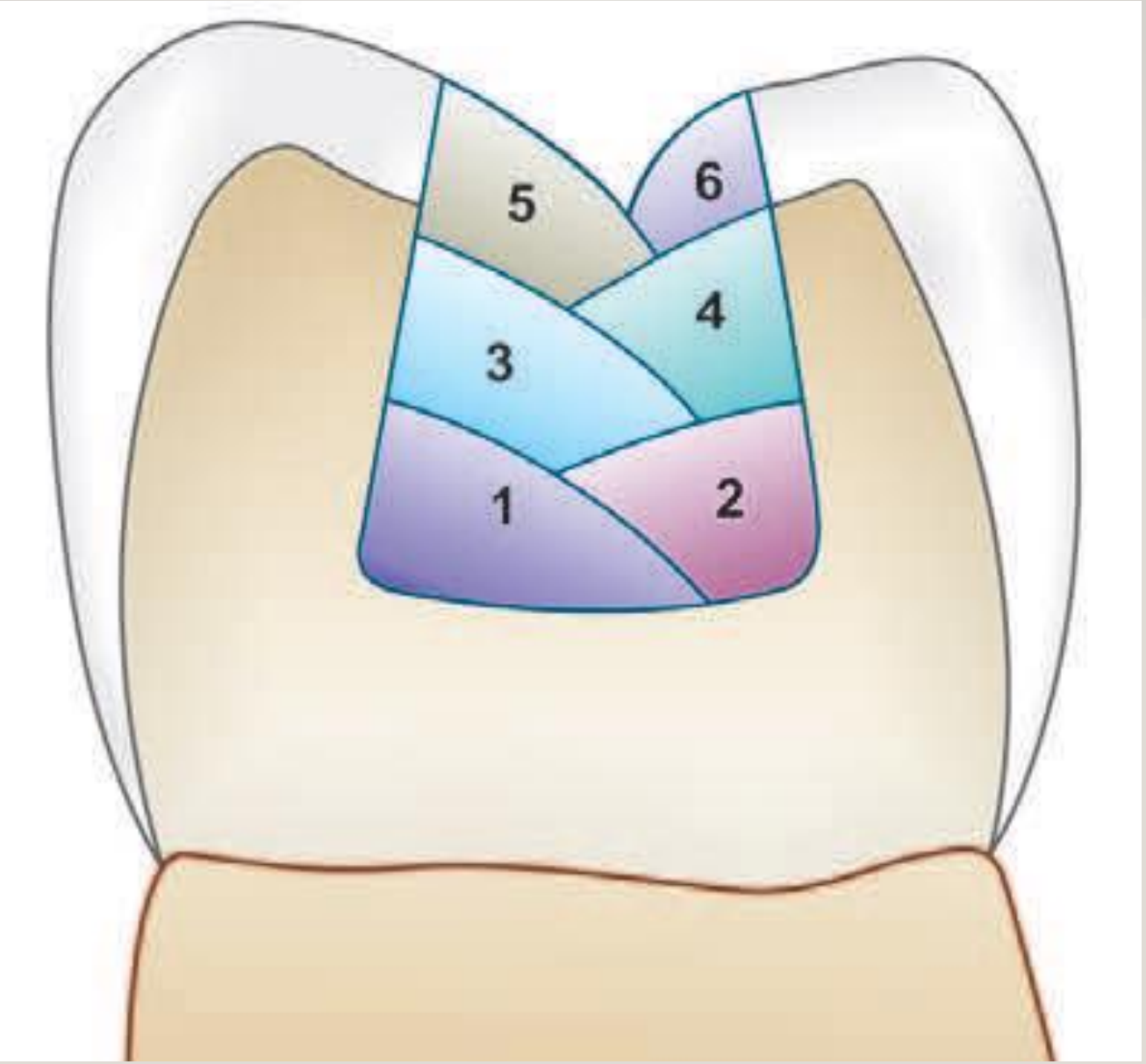




COMPOSITE PLACEMENT

Incremental Layering Technique

- It is advocated for use of medium to large posterior composite restorations to avoid the limitation of the depth of cure.
- It is based on the polymerization of resin-based composite layers of less than 2 mm thickness.
- It helps to attain good marginal quality.
- It prevents the deformation of the preparation wall.
- It ensures the complete polymerization of the resin-based composite.
- It creates layers with high diffusion which allows optimal light transmission within the restoration, thus increasing esthetics.


5
6
4
3
1
2

Bulk Technique

- The composite is placed in a bulk mass of 4-5 mm thickness.
- It is done to reduce stress at the cavosurface margins.

It is usually recommended with packable composites.

Final Contouring, Finishing and Polishing of Composite Restorations:

- For composite restorations, the amount of contouring required after final curing can be minimized by careful placement technique.
- Always take care to remove the composite excess which is almost always present.
- Decrease the need for contouring of the cured composite ensures that margins and surface of composite restoration remain sealed and free of microcracks that can be formed while contouring.

Main objectives are to:

- Attain optimal contour
- Remove excess composite material
- Polish the surface and margins of the composite restoration.

- For removal of composite excess, usually burs and diamonds are used.
- A surgical blade is used to remove proximal overhangs in the accessible area. For areas which have poor accessibility, composite strips can be used.
- Contact areas may be finished by using a series of abrasive finishing strips threaded below the contact point so as not to destroy the contact point.

THANK YOU