COMPOSITE RESTORATION

LEARNING OBJECTIVE

- To gain the knowledge about the composite as a novel restorative material.
- To know about the various techniques related to composite techniques .

CONTENT

- Introduction
- History
- Definition
- Classification
- Composition
- Indications
- Contraindications
- Advantages
- Disadvantages
- Properties
- Types of composites
- Clinical techniques
- Finishing & polishing

Introduction

- With increased patient demands for esthetic restorations, use of direct composites has been increased in recent years.

- Composite resins have thus advanced considerably over past 10 years and have become viable treatment option in many clinical conditions.

history

- During the first half of the twentieth century,

- Silicates were the tooth-colored material of choice for restoration as it

✓Releases fluoride and
✓Excellent for preventing caries

- But currently used almost exclusively for deciduous teeth.

- During late 1940s & early 1950s

- Acrylic resins[PMMA] replaced silicates because of their

✓Toothlike appearance
✓Insolubility in oral fluids
✓Ease of manipulation &
✓Low cost.

- In 1962, Dr. Ray L. Bowen developed a new type of composite material that largely overcame these problems.

✓Bisphenol-A glycidyl dimethacrylate (*bis*-GMA), a monomer that forms a cross-linked matrix and

✓An organic silane compound called a coupling agent to bond the filler particles to the resin matrix.

- Current tooth– colored restorative materials continue to use this technology.

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Definition

❑**Skinner's**

- Dental resin-based composites are structures composed of three major components: a highly cross-linked polymeric matrix reinforced by a dispersion of glass, mineral, or resin filler particles and/or short fibers bound to the matrix by coupling agents.

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❑Sturdevant's

- In materials & science, word composite refers to a solid formed from two or more distinct phases that have been combined to produce properties superior to or intermediate to those of individual constituents.

❑DCNA

- A 3-D combination of at least two chemically different materials with a distinct interface separating the components.

Classification

- **According to skinners:-**

Class	Particle size
Traditional	1 - 50 µm Glass
Hybrid (large particle)	1) 1 - 20 µm Glass
	2) 0.04 µm Silica
Hybrid (midifiller)	1) 0.1 - 10 µm Glass
	2) 0.04 µm Silica
Hybrid (minifiller)	1) 0.1 - 2 µm Glass
	2) 0.04 µm Silica

Packable hybrid	Midifiller/minifiller hybrid with lower filler fraction
Flowable hybrid	Midifiller hybrid with finer particle size
Homogeneous microfill	0.04 µm Silica
Heterogeneous microfill	1) 0.04 µm Silica
	2) Polymerized resin particle containing 0.04 µm Silica

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❑According to Marzouk:-

- **First generation composites:-**

- Consist of macroceramic reinforcing phases
- Highest mechanical properties.
- High surface roughness & wear.

Second generation composites:-

- Consist of colloidal & micro ceramic phases.
- Physical properties unfavourable as compared to 1st generation.
- Better wear resistance.

Third generation composites:-

- Hybrid variety
- Combination of micro & macro ceramic particles in ratio of 75:25.
- Properties are in between 1st & 2nd generation.

Fourth generation composites:-

- Hybrid variety
- Micro ceramic (colloidal) filler particles in combination with heat cured irregularly shaped highly reinforced macro ceramics particles.
- Technique sensitive.
- Highest polymerization shrinkage
- Good surface texture & esthetics
- Physical & mechanical properties between those of 1^{st} & 3^{rd} generations.

- **Fifth generation composites:-**

- Hybrid system
- Microceramics (colloidal) filler particles in combination with macro, spherical, highly reinforced heat cured composite particles.
- Improved wettability.

- **Sixth generation composites:-**

- Consist of combination of micro(colloidal) ceramics & agglomerates of sintered micro ceramics.
- Excellent physical & mechanical properties

❑According to sturdevant's (based on filler particle size)

- Macrofillers 10 to 100 µm
- Midifillers 1 to 10 µm
- Minifillers 0.1 to 1 µm
- Microfillers 0.01 to 0.1 µm (agglomerated)
- Nanofillers 0.005 to 0.1 µm*

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Based on methods of curing:-

- Chemical
- Light cure
  - UV
  - Visible
- Dual cure

Based on consistency:-

- Light body- flowable
- Medium body- homogenous microfills, macrofills & midfills
- Heavy body- packable hybrid, minifills.

❑Based on matrix:-

- Composites based on BisGMA
- Composites based on UDMA

❑Based on area of application:-

- Anterior
- posterior

composition

- 3 major components

Resin matrix

Coupling agents

Inorganic fillers

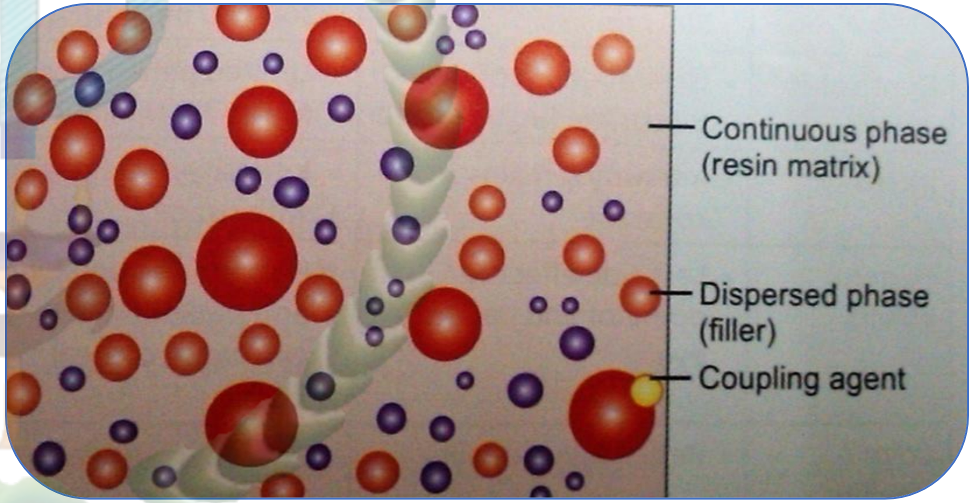
- Other components

- Inhibitors
- Activator-initiator system
- Optical modifiers
- Color stabilizers
- pigments

❑Resin matrix:-

- The resin matrix in most dental composites is based on a blend of aromatic and/or aliphatic di-methacrylate monomers.

- This matrix forms a continuous phase in which the reinforcing filler is dispersed.

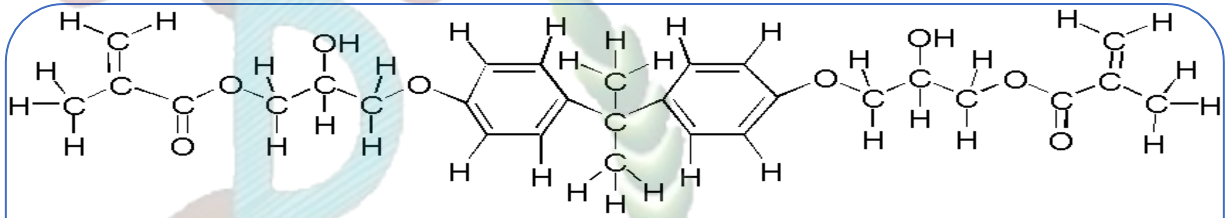


❖Principal Monomers:-

- **Bisphenol glycidyl methacrylate(BisGMA)**

- Bowen in 1962.

- Synthesized by reaction between bisphenol A & glycidyl methacrylate.



bisGMA

- Molecular formula $C_{29}H_{36}O_8$.

- It is long & rigid difunctional monomer provides viscosity & strength to resin matrix.
- It showed less shrinkage i.e. 4%.
- Due to its high viscosity it is usually mixed with a resin of low molecular weight, TEGDMA.
- BisGMA and TEGDMA in a ratio of 3:1 is preferred.

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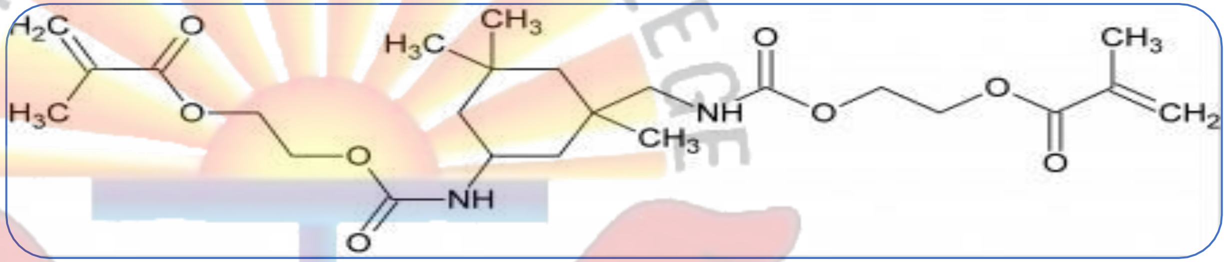
Urethane dimethacrylate (UDMA)

- Foster & walker 1974.



- Molecular formula $C_{23}H_{38}N_2O_8$
- Had low viscosity so no diluent monomer needed.
- But, more brittle & more shrinkage(5 – 9 %) due to shorter molecular length.

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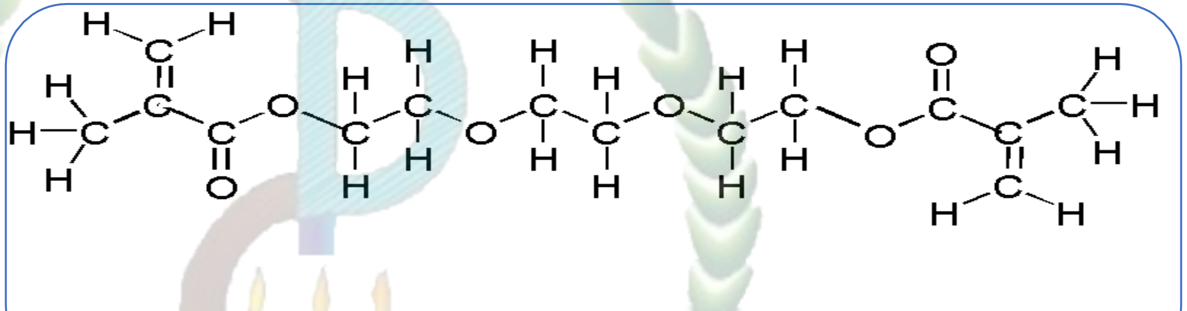
❖ Diluent monomer:-

- **Triethylene glycol dimethacrylate**

- It is a diester formed by condensation of two equivalents of methacrylic acid and one equivalent of ethylene glycol.



TEGDMA

- Molecular formula $C_{14}H_{22}O_6$

- It is smaller, more flexible & less viscous difunctional monomer hence added with BisGMA to lower its viscosity.

- A blend of 75 wt% BisGMA and 25 wt% TEGDMA has a viscosity of 400 centipoise.

- Viscosity of 50 wt% BisGMA and 50 wt% TEGDMA is 200 centipoise (like thin syrup).

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- TEGDMA makes resin more flexible, less brittle, improves marginal edge strength & reduces resin resistance to abrasion.

- It comprises of 10-35% of macrofilled & 30-50% of microfilled composites.

- Smaller size hence shows more shrinkage (15%).

- BisGMA + TEGDMA shows 3 to 5% shrinkage.

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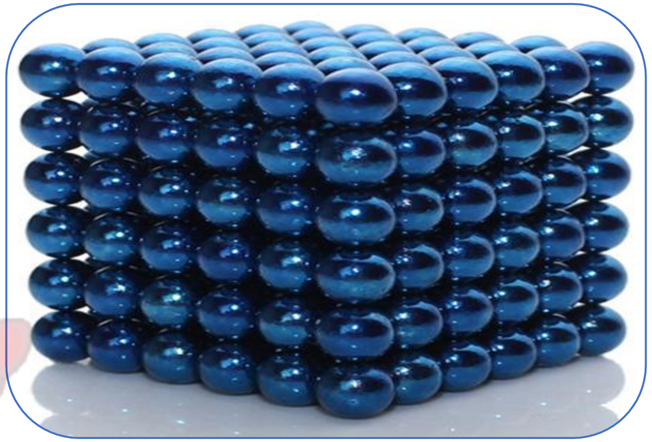
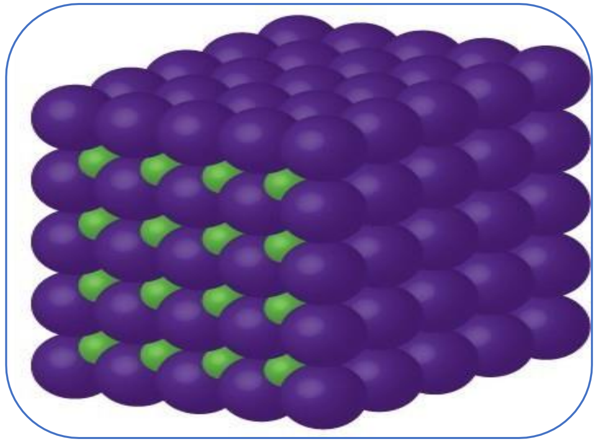
❑Fillers:-

- These are the reinforcing particles or fibres dispersed in the matrix.

- The filler particles used in composite resins varies in size from less than 0.04 um to over 100 um.

- Distribution of particle sizes is necessary to incorporate a maximum amount of filler.





- Functions of fillers:-

✓Reinforcement of matrix, resulting in increased hardness, strength, decrease wear

✓Reduction in polymerization shrinkage

✓Reduction in thermal expansion & contraction

✓Increase in viscosity thereby improving workability

✓Reduction in water sorption, softening & staining

✓Increased radiopacity & diagnostic sensitivity

- Types of fillers used

✓Colloidal/ submicron silica

✓Quartz

✓Amorphous silica

✓Glasses & ceramics containing heavy metals

✓Organic fillers (pulverized, precured resin)

- **Colloidal silica** particles, because of their extremely small size, have extremely large surface areas ranging from 50 to as much as 400m^2 per gram.

- The silica particles forms polar bonds with monomer molecules.

- This inhibits their flow, increases viscosity & thickens resin paste even in small amounts.

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- **Quartz**, a reinforcing crystalline filler is known to be chemically inert, less susceptible to erosion & hard.
- This causes difficult in grinding of particles & polishing of the composites.
- The silanes bind better with quartz thus making it more color stable.
- Radiolucent.

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- **Glasses & ceramics** that contain heavy metal such as barium, strontium, zirconium, zinc, ytterbium provides radiopacity to composites.

- Advantages of barium fillers:-

✓Good radiopacity

✓Fine particle size (average 0.4 to 0.6%) hence more polishable & wear resistant

✓Good refractive index

✓Ready availability in pre- ground form.

- Disadvantages are:-

✓More soluble, softer & deteriorate over time.

✓For many composites the flexural strength & flexural modulus is reduced upto 45% after being in water for 3 months.

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- Method of filler particle fabrication:-

- Grinding

✓Mill grinding
✓Air abrasion
✓Ultrasonic interaction
✓Erosion

- Precipitation

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- Filler loading :- 50-85% by wt

  30-70 % by volume

- Filler surface area :- 50- 400 m2/gm

- Refractive index:- 1.50 approx.

- Filler shapes:-

✓Large spherical particles

✓Large irregularly shaped particles

✓Blend of both.

Effect of filler loading on composites:-

- Decrease particle size- Increased polishability , improved wear resistance.

- Increase filler loading by volume- increased fracture durability.

- This implies:-

✓Fracture resistance increases as interparticle distance decreases by inhibiting crack formation & propagation.

❑Coupling agents:-

- Coupling agents bonds resin matrix & filler particles together & reduces gradual loss of filler particles from composite surface.
- Commonly used coupling agents are epoxy, vinyl & methyl silanes.
- Gamma methacryloxypropyl trimethoxysilane is the most common coupling agent used in dental composites.

- These are difunctional monomer that ionically bonds to inorganic filler & chemically with organic resin matrix.

- They act by reducing surface tension between filler & organic matrix.

- Advantages:-

✓Transfers load from resin matrix to fillers.

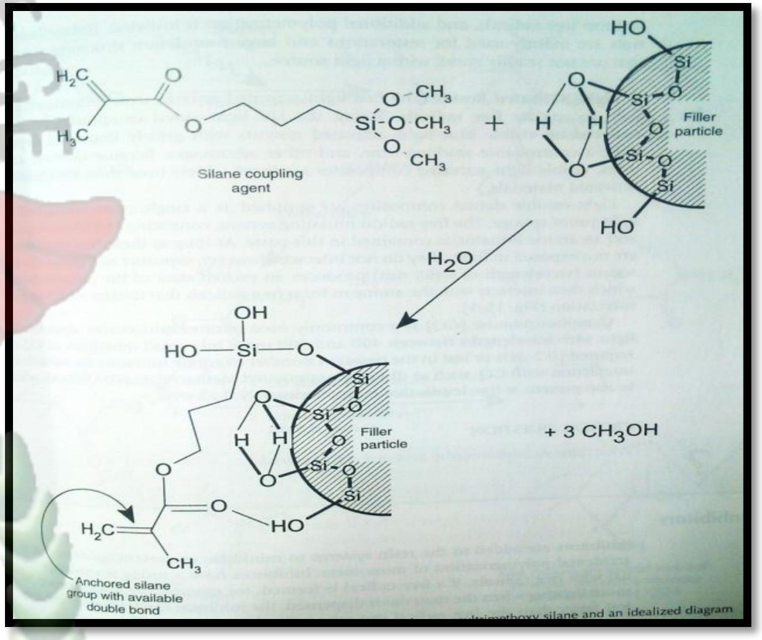
✓Adapts the resin to the irregularities of filler particles.

✓Inhibits leaching by preventing water from penetrating along filler resin interface.

- Methoxy group → (water) → silanol group

- This silanol group bond with other silanol group on filler surfaces via siloxane bond.

- The organosilane methacrylate groups form covalent bonds with resin when polymerized thus completing coupling process.



❑Activator – initiator system:-

- Both mono-methacrylate & di-methacrylate monomers polymerize by addition polymerization mechanism initiated by free radicals.

- This free radicals can be generated by

➢ Chemical activation

➢ Light activation

- **Chemically activated resins:-**

- Supplied as two pastes

✓ **Paste I**- Benzoyl peroxide (initiator)

✓ **Paste II**- aromatic tertiary amine activator (N,N- dimethyl toluidine)

- When two pastes are mixed, amine reacts with benzoyl peroxide to form free radicals & thus initiates polymerization.

- Used for restoration & large foundation structures (buildups) that are not readily cured with light source.

Disadvantages:-

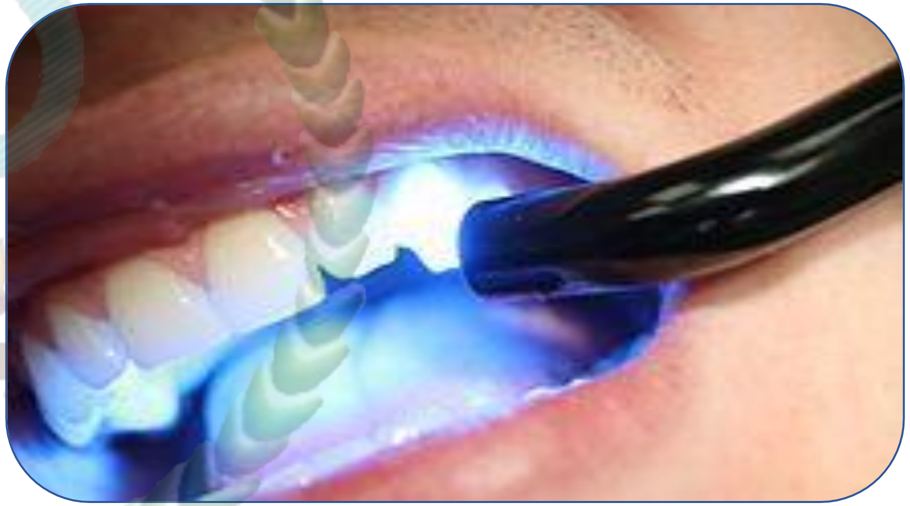
✓ Air incorporation during mixing

✓ No control over working time

- **Light activated resins:-**

- Single paste system

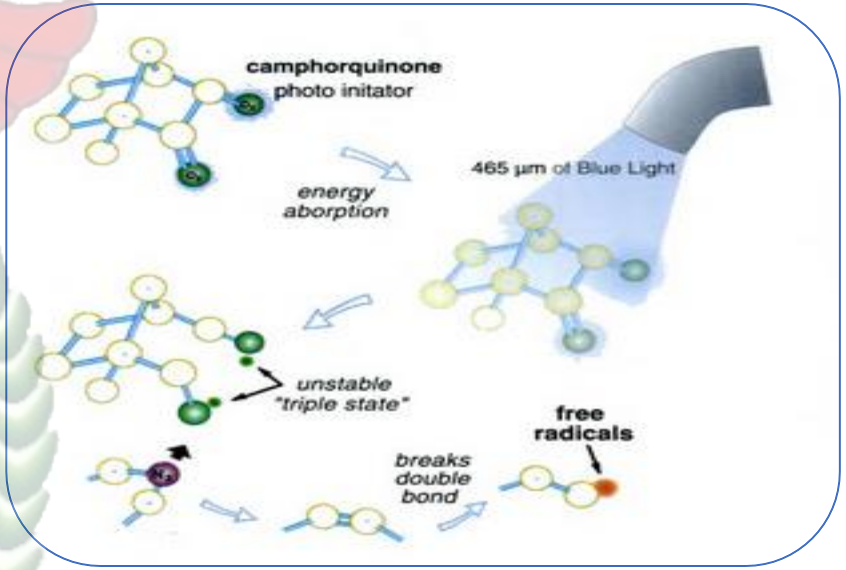
- Photosensitizer & amine initiators is contained in same paste.



- Exposure to blue light (468nm) produces excited state of photoinitiator which interacts with amine to form free radicals.

- Camphoroquinone (0.2 wt% or less) is commonly used photosensitizer that absorbs blue light with wavelengths between 400 & 500nm.

- Dimethylaminoethyl methacrylate (0.15 wt%) is the amine initiator generally used.



- Advantages:-

✓Less porosity & thus increased strength

✓Color stability as aliphatic amine is used.

✓Control over working time.

✓Better contouring & finishing can be done.

- Disadvantages:-

✓Limited curing depth.

✓Poor accessibility in inter-proximal areas

✓Variable exposure time

✓Sensitivity to room illumination(crust formation)

▪ Dual cure resins:-

- Combines chemical curing & visible light curing components in same resins.
- Used for cases that does not allow sufficient light penetration. Eg: cementation of bulky ceramic inlays.
- Two light curable paste available

✓Paste I- benzoyl peroxide

✓Paste II- aromatic tertiary amine

- The two pastes are mixed & exposed to light.

✓Light curing promoted by amine & CQ combination.

✓Chemical curing promoted by amine & BP interaction.

- Disadvantages:-

✓Porosities

✓Air inhibition.

❑Inhibitors:-

- Inhibitors are added to resin systems to minimize or prevent spontaneous or accidental polymerization of monomers.

- A typical inhibitor is butylated hydroxytoluene (BHT), which is used in concentrations on the order of 0.01% by weight.

- **Serves 2 purposes**

✓To extend the resin's storage life and

✓To ensure sufficient working time

❑Optical modifiers & pigments:-

- For a natural appearance, dental composites must have visual shading and translucency.
- Translucency and opacity are adjusted as necessary to simulate enamel and dentin.
- Shading is achieved by adding various pigments, usually consisting of minute amounts of metal oxide particles.
- To increase the opacity, titanium dioxide and aluminum oxide are added(0.001% to 0.007% by weight).

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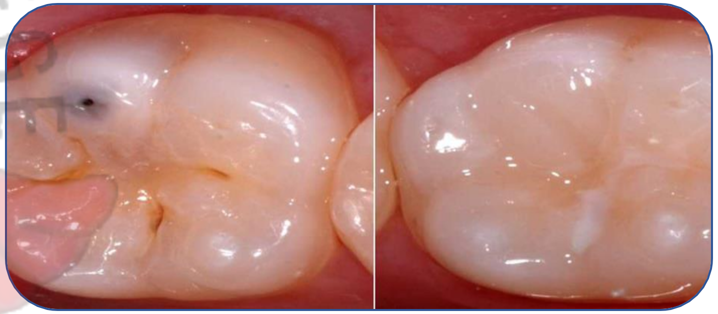
Indications of composite restoration

- Class I, II, III, IV, V restorations
- Core buildups
- Sealants and preventive resin restorations
- Veneers



- Tooth contour modifications
- Diastema closures
- Composite inlays
- Repair of old composite restoration
- Temporary restorations
- Periodontal splinting
- Patient allergic to metal restorations.

Contra-indications of composite restoration

- Difficulty in isolation of operating field
- Occlusion
- Subgingival areas/root surface
- Poor oral hygiene

- High caries index
- Bruxism
- Operator abilities

Advantages of composites

- Esthetic
- Conservative tooth structure removal.
- Less complex when preparing the tooth.
- Insulative , having low thermal conductivity.
- Used almost universally.
- Bonded to tooth structure, resulting in good retention, low microleakage, minimal interfacial staining.
- Repairable.

Disadvantages of composites

- Polymerization shrinkage
- Technique sensitive
- High coefficient of thermal expansion (2nd generation)
- Difficult & time consuming
- Low modulus of elasticity
- Lack of anticariogenic property
- Staining
- Cost

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Properties of composites

- **Working & setting time:-**

✓Chemical cure- 3 to 5 min

✓Light cure-

- Application of light source to the composite starts polymerization.
- 70 % of polymerization takes place during first 10 minutes.
- The polymerization reaction continues for a period of 24 hrs.

Wear:-

- Composite restoration wear more than natural enamel & slightly less than amalgam.
- Posterior composite wear 0.1 to 0.2 mm more than enamel.
- The normal wear rate for composite recorded is 10 to 20 µm/year.

- Two principle mechanism of wear of composites

✓Two body wear (contacting areas)

✓Three body wear (non contact areas)

- Two body wear is more common phenomenon.

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Linear co-efficient of thermal expansion:-

- The LCTE of improved composites is approximately 3 times that of tooth structure.
- It is in range of 15-50 ppm / k
- Bonding a composite to etched tooth structure reduces the potential negative effects of high LCTE.

- **Surface texture:-**

- Restorations in close approximation to gingival tissues require surface smoothness for optimal gingival health.

- The size and composition of the filler particles primarily determine the smoothness of composite restoration.

- Nanofill composites offer the smoothest restorative surface.
- Hybrid composites also provide surface textures that are esthetic and compatible with soft tissues.

- **Color stability:-**

- Composites are not as color stable as tooth enamel
- Discolouration can be brought either intrinsically or extrinsically.

- Intrinsic stains can be due to chemical changes or deterioration of one or more of the component phases of the material with coloring byproducts.

- Extrinsic discolouration is most common type and could be due to various factors:-

✓Stress cracks

✓Plaque accumulation

✓Food stains

✓Secondary caries

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Radiopacity:-

- Most composites contain radiopaque fillers, such as barium glass, to make the material radiopaque.
- This allows for diagnosis of caries below the restoration more easily on radiographs.

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CHARACTERISTIC PROPERTY	Unfilled acrylic	Traditional	Small particle	Hybrid	Micro filled
Size (µm)	-	8-12	0.5-3	0.4-1.0	0.04-0.4
Inorganic filler (vol%)	0	60-70	65-77	60-65	20-59
Inorganic filler (wt%)	0	70-80	80-90	75-80	35-67
Compressive strength (MPa)	70	250-300	350-400	300-350	250-350
Tensile strength (MPa)	24	50-65	75-90	40-50	30 -50
Elastic modulus (GPa)	2.4	8-15	15-20	11-15	3-6
TEC (ppm/ ° C)	92.8	25-35	19-26	30-40	50-60
Water sorption (mg/cm^2)	1.7	0.5-0.7	0.5-0.6	0.5-0.7	1.4-1.7
Curing shrinkage (vol%)	8-10	-	2-3	2-3	3-4
Radio opacity(mm\Al)	0.1	2-3	2-3	2-4	0.5-2

Biocompatibility:-

- Adequately polymerized composites are relatively biocompatible.
- Inadequately cured composite materials at floor of cavity can induce long term pulp inflammation.
- Polymerization shrinkage of composite and subsequent marginal leakage can cause pulpal reactions.

- Bisphenol A , a precursor of bis-GMA is an xenoestrogen and mimics its effect.

- It can lead to:-

✓Reproductive anamolies

✓Increased cell proliferation

✓Delayed & sustained hyperprolactinemia in estrogen receptors in hypothalamus & pituitary glands.

- Still ??

Types of composites

- **Traditional composites:-**

- Large filler particles
- Finely ground amorphous silica & quartz are most common fillers.
- No longer used.

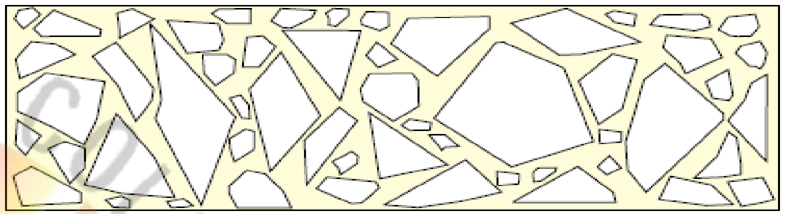
- Disadvantages:-

✓Have rough surface

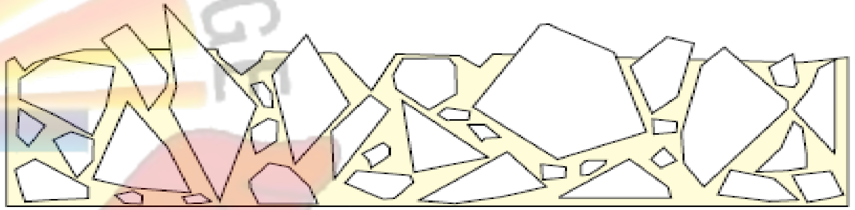
✓Difficult to polish

✓Poor resistance to occlusal wear

✓Discolouration- poor esthetics



Before polishing



After polishing

- **Small particle filled composites (SPF):-**

- Filler particles are grounded to a size range of 0.5 to 3µm
- Primary filler used is silane coated silica particles.
- Most of them consist of glasses with heavy metals for radiopacity.
- Superior physical & mechanical properties than traditional composites.

- Advantages:-

✓Can be used in high stress & abrasion prone areas

✓Attains reasonably smooth & polished surface.

✓Less shrinkage

✓Radiopaque

- Disadvantages:-

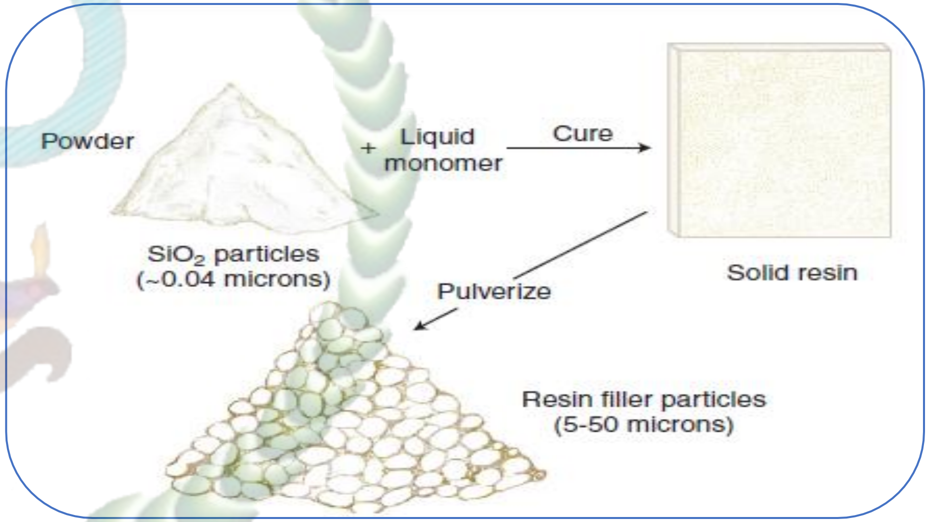
✓More prone to wear & deterioration over time as it contains heavy metal glass fillers.

✓Reduced long term durability.

▪ Microfilled composites:-

- Contains agglomerates of colloidal silica particles blended with organic pre-polymerized fillers.

- This cause more filler particles to be incorporated without disturbing rheology of material.

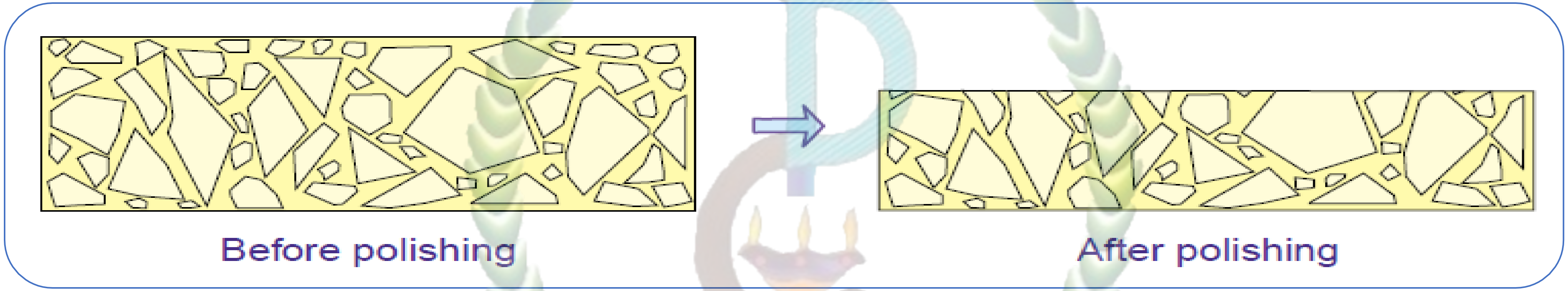


- Advantages:-

✓Smooth polished surface is obtained.

✓Can be used non stress bearing & subgingival areas.

✓Anterior teeth restoration.



- Disadvantages:-

✓Greater tendency to fracture hence cannot be used in stress bearing areas.

✓Marginal chipping due to debonding of prepolymerized composite fillers.

✓Shrinkage

Hybrid composites:-

- Contains blend of two filler particles.
- Colloidal silica with grounded glass particles containing heavy metals.
- Colloidal silica represents 10- 20 wt% of total filler content.
- Used widely for anterior restorations due to surface smoothness and reasonably good strength.

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Clinical technique

- Complete **examination, diagnosis & treatment planning is done.**
- **Local anaesthesia** may be required
- **Preparation of operating field:-**

- Cleaning the operating site with a slurry of pumice to remove plaque, pellicle and superficial stains
- Calculus if any should be removed.

Shade selection:-

- Normally, teeth are predominantly white, with varying degrees of gray, yellow, or orange tints.
- The color also varies with the translucency, thickness, and distribution of enamel and dentin and the age of the patient.
- Other factors such as fluorosis, staining and endodontic treatment, also affect tooth color.

- VITA Shade Guide a universally adopted shade guide is mostly used for shade selection.

- To choose accurate color small amount of selected color shade material is placed on tooth in close proximity to area to be restored.

- **Factors to be considered while shade selection:-**

✓Natural light should be preferred for selection of shades.

- The shade of the tooth should be determined before the teeth are subjected to any prolonged drying.

- The selection should be made as rapidly as possible i.e. within30 seconds.

- If more time is needed, the eyes should be rested by looking at a blue or violet object for a few seconds.

- **Isolation of operating field:-**

- Contamination of etched enamel or dentin by saliva results in a significantly decreased bond.

- Moreover, contamination of the composite material during insertion results in degradation of physical properties.

- Hence proper isolation is to be achieved

- This can be achieved by:-

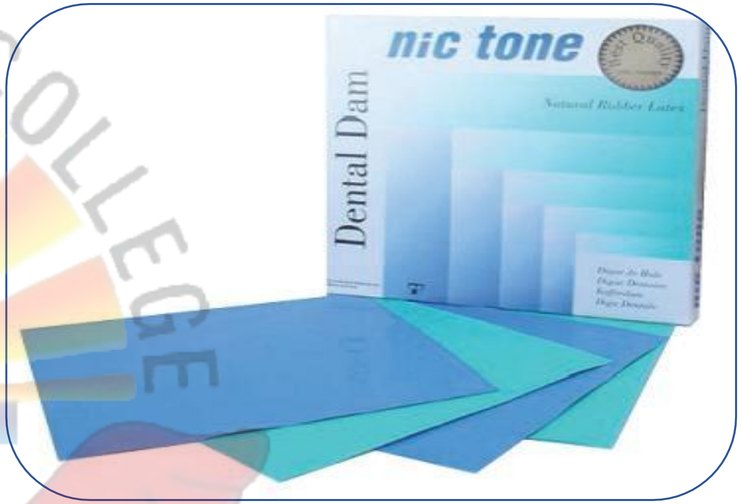
✓Rubber dam

✓Cotton rolls

✓Retraction cords

✓Suction

✓Preoperative wedging



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- **Tooth preparation:-**

- The tooth preparation for a composite restoration includes the following:-

✓Removing the fault, defect, old material, or friable tooth structure

✓Enamel margins of 90 degrees or greater

✓90-degree (or butt joint) cavosurface margins on root surfaces.

- **Types of composite tooth preparations:-**

- 5 designs:-

✓Conventional

✓beveled conventional

✓Modified

✓box-only

✓slot preparation.

- **Conventional design:-**

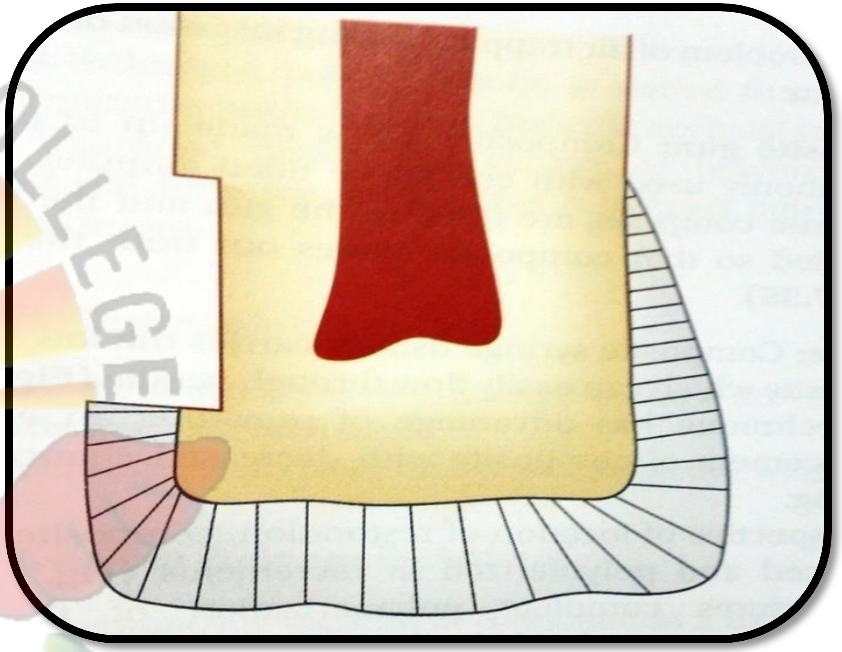
- Less outline extension

- Butt joint junction (90 degrees).

- The primary indications are

✓Preparations located on root surfaces (non-enamel areas) and

✓Moderate to large Class I or II restorations



Beveled conventional:-

- Beveled conventional tooth preparations are similar to conventional preparation but with some beveled enamel margins.

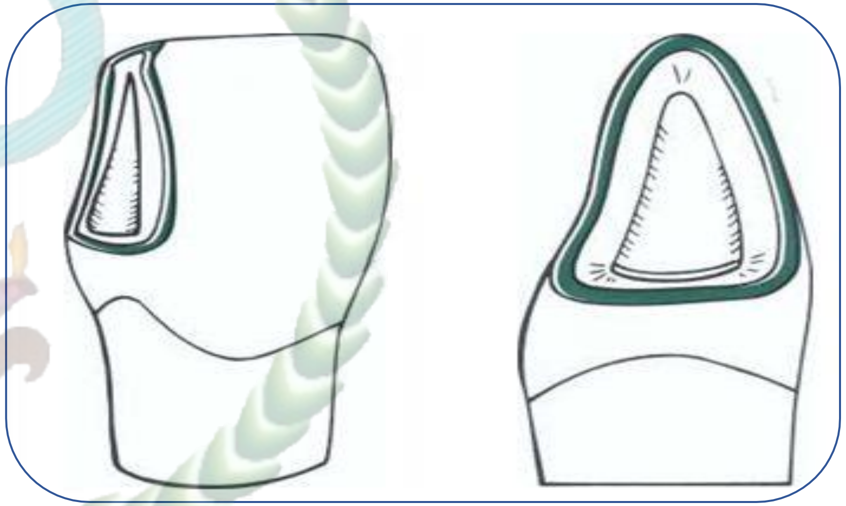
- Indicated when a composite restoration is being used to replace an existing restoration (usually amalgam)

- This design is most typical for Classes III, IV, and V restorations

- Advantages:-

✓More effective etching as more surface area is covered.

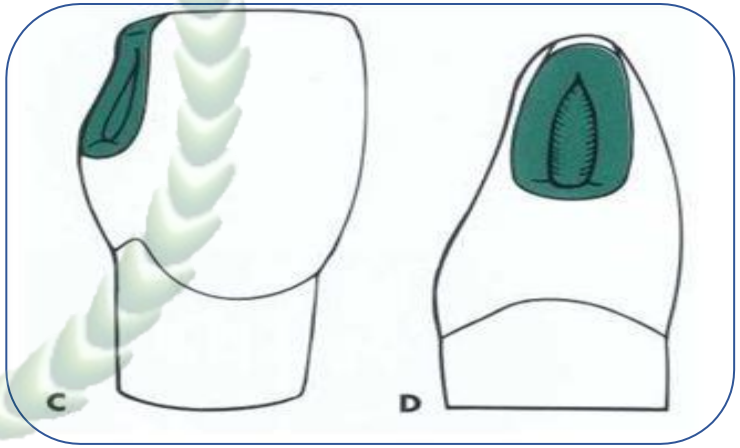
✓Restoration blend more esthetically with the color of the surrounding tooth structure.



Modified design:-

- The extension of the margins and the depth of a modified tooth preparation are dictated solely by the extent (laterally) and the depth of the carious lesion or other defects.

- The objectives of this preparation design are to remove the fault as conservatively as possible.



Box preparation:-

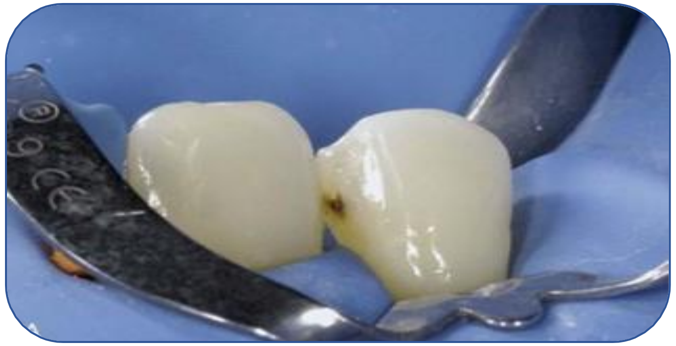
- Indicated when only the proximal surface is faulty.

- A proximal box is prepared with an inverted cone or round diamond bur held parallel to the long axis of the tooth crown.

- The initial proximal axial depth is prepared 0.2 mm inside the DEJ.

▪ Facial / lingual slot:-

- Lesion on the proximal surface



- Access to the lesion can be obtained from either a facial or a lingual direction.

- Usually a small round diamond stone or bur is used to gain access to the lesion.

- This preparation is similar to a Class III preparation for an anterior tooth.

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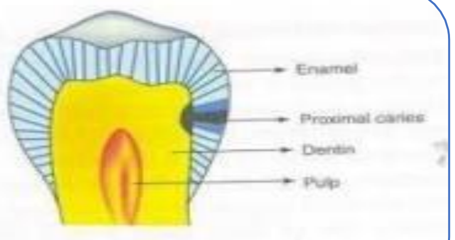
TUNNEL PREPARATION

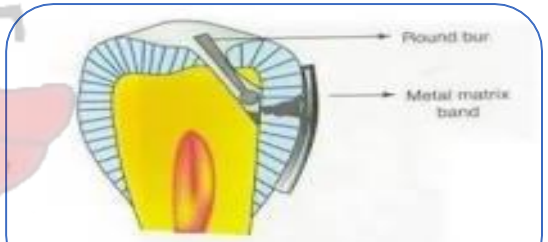
- Jinks in 1963 introduced this as a conservative approach for class II cavities.

- In this preparation the marginal ridge is kept intact.

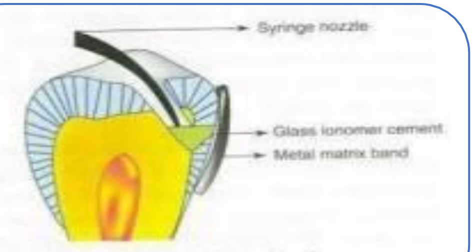
- Through the occlusal surface access is gained to the proximal carious lesion and tunnel is thus prepared without involving the marginal ridges.



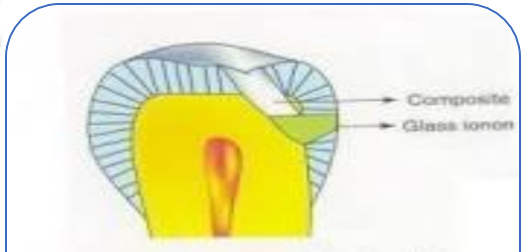
a. Initial proximal caries



b. Tunnel preparation using a round bur



Glass ionomer cement being placed



d. Completed tunnel restoration with composite resin on the surface

- Advantage:-

- Marginal ridge is preserved
- More conservative & esthetic
- Reduced microleakage
- Adjacent tooth is preserved

- Disadvantages:-

- Poor visibility
- Marginal ridge may be undermined
- Prep. May extend closer to pulp than desired.

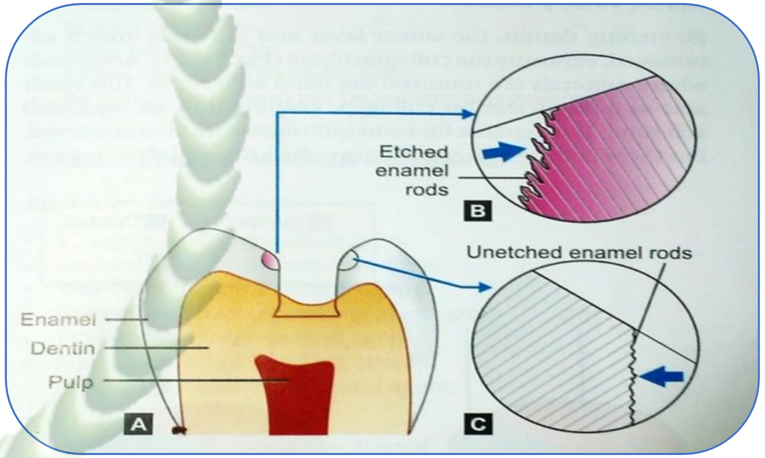
Restorative techniques

- Etching
- Bonding
- Matrix placement & insertion of composites
- Light curing of composites
- Finishing & polishing

- Acid etching:-

- Etching is the process of increasing the surface reactivity by demineralizating the superficial calcium layer and thus creating enamel tags.

- It removes 10 µm surface enamel and creates a microporous layer of 5-50 µm.



- Materials used are:-

- ✓Phosphoric acid 37% (most common)
- ✓Citric acid 10%
- ✓Polyacrylic acid 40%
- ✓Maleic acid 10%
- ✓Nitric acid 2.5%
- ✓Pyruvic acid+ glycine
- ✓HCl

- The etchant is left untouched for 15 to 30 seconds.

- The area is then rinsed for approximately 5 seconds and dried with cotton pellets.

- The etched enamel appears frosty.

- If both enamel and dentin are etched, the area is left slightly moistened

- This allows the primer and the adhesive materials to form a hybrid layer, which is the basis for the micromechanical bond.

- Three patterns of etching:-

✓Type I – Removal of rod core only

✓Type II – Removal of rod periphery only

✓Type III - Irregular pattern

- **Effects of etching:-**

✓Dissolution of interprismatic enamel

✓Increase in surface area 2000 times

✓Exposes the organic collagen

✓Removes smear layer and increases surface energy

✓Removes deposits, plaque

- All of this enhances proper bonding of restoration with tooth.

- Bonding agent:-

- Bonding: the forces or energies between atoms or molecules at an interface that hold two phases together.

- Supplied in a separate bottle.

- Disposable brushes, microbrushes or applicator tips are provided for their application.

- Cured for 10 seconds.

- Enamel bonding agent:-

✓ Consists of BisGMA or UDMA resins with a diluent like TEGDMA.

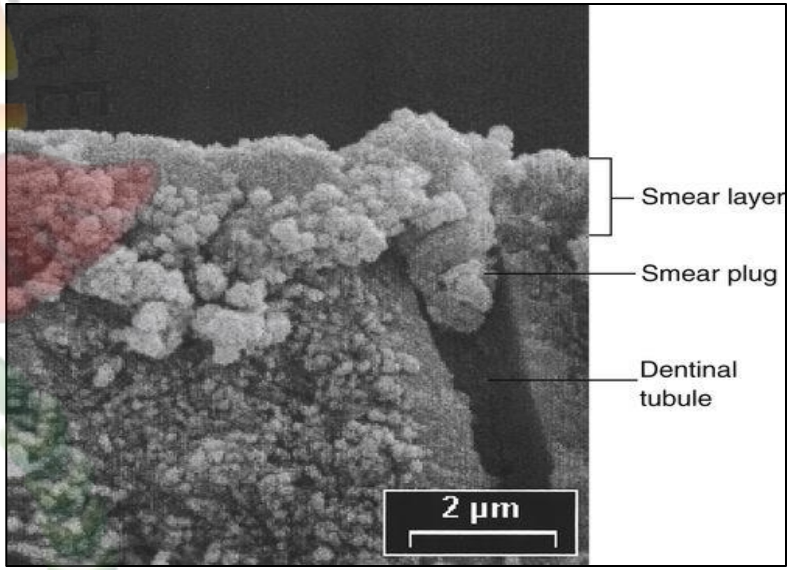
✓ A uniform layer is applied on the etched surface that flows into etched enamel pores to form resin tags.

- Dentin bonding:-

- Adhesion to dentin is a **CHALLENGE ….**

- Due to increased organic content and presence of dentinal fluid.

- It is further complicated by presence of smear layer.



Matrix placement :-

- A matrix band is placed before insertion of composite material in the cavity.

- This allows for:-

✓Confinement of material to axial surface.

✓To provide appropriate proximal contacts & contours.

- Can be placed prior or after the application of etchant, primer & bonding agents.

- Along with matrix band a wedge may be applied to:-

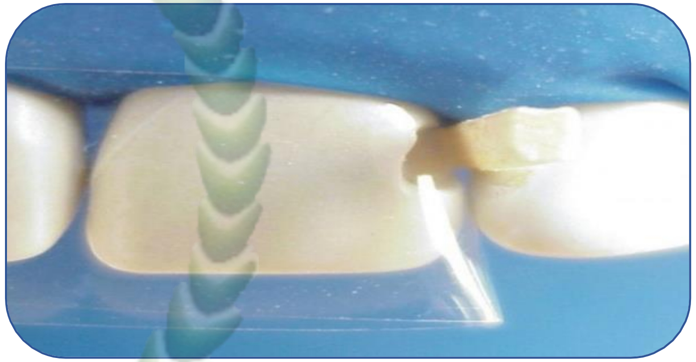
- Separate the teeth (which helps to compensate for the thickness of the matrix material)
- Hold the matrix in place and
- Prevent or reduce any excess of restorative material at the gingival margin

- Commonly used matrix:-

✓Palodent

✓Tofflemire

✓Polyster strips



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- **Insertion of composites:-**

- Can be inserted with help of teflon coated hand instruments or syringe or guns.

- Material is inserted in increments in thickness of 1-2mm.

- Each layer is cured completely before insertion of second increment.

▪ Layering techniques:-

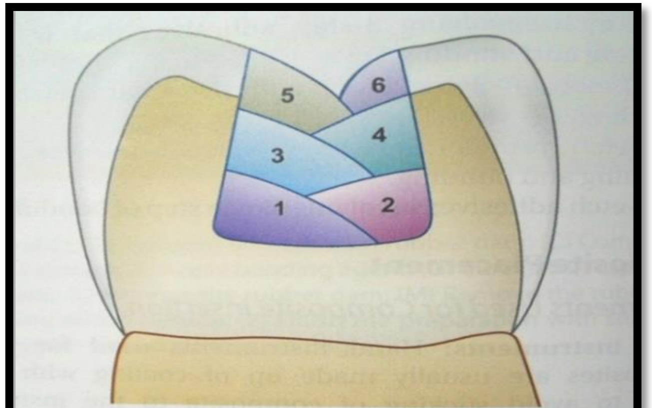

Figure 17.37: Schematic representation of incremental layering technique

Figure 17.38: In horizontal layering technique, occlusogingival layering of composite resin is done

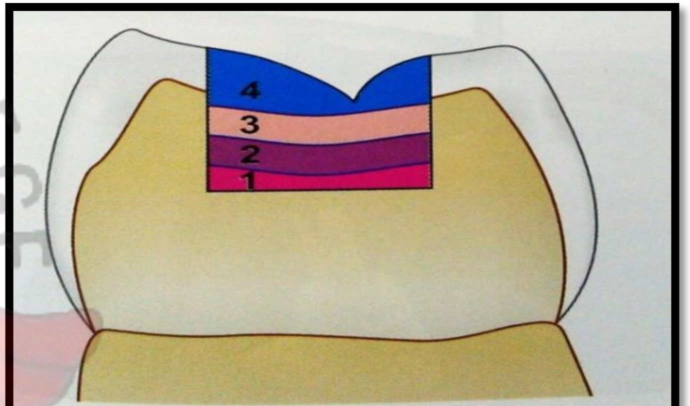

Figure 17.39: Schematic representation of U-shaped layering technique

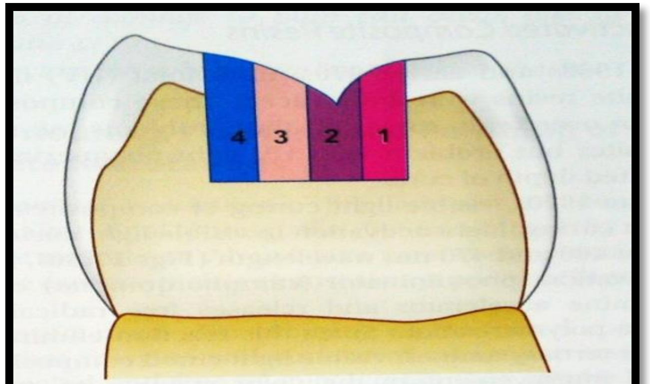

Figure 17.40: In vertical layering technique, increments are placed from one wall to another

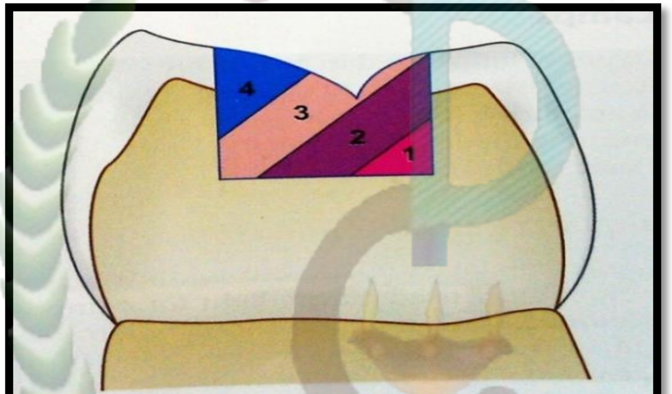

Figure 17.41: In oblique technique, wedge-shaped increments are placed

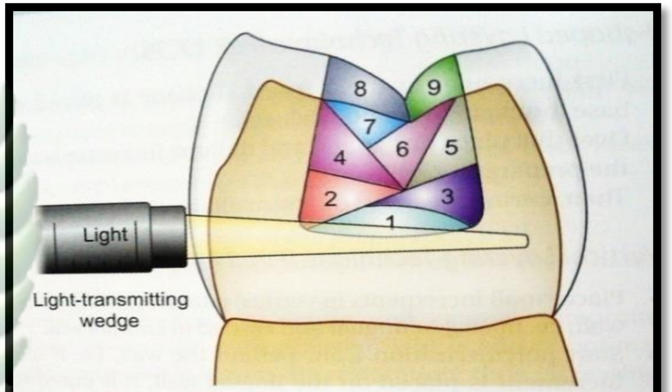

Figure 17.42: Use of light transmitting wedges for better curing at gingival margins

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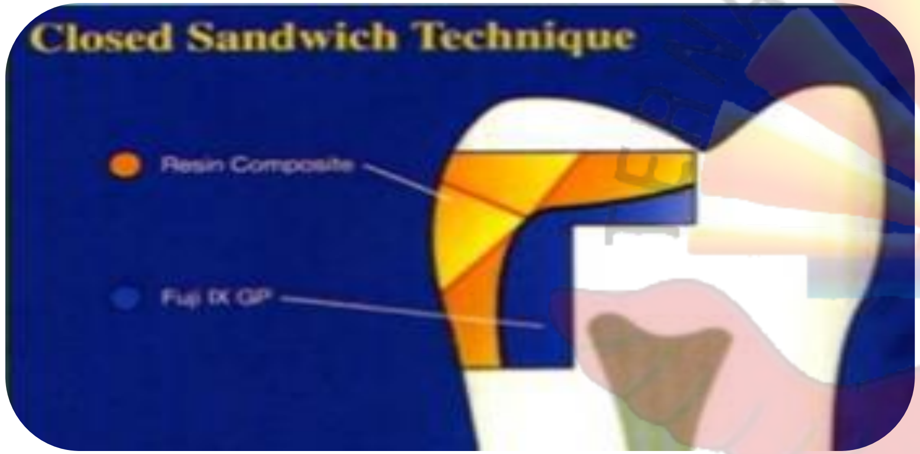
Sandwich technique

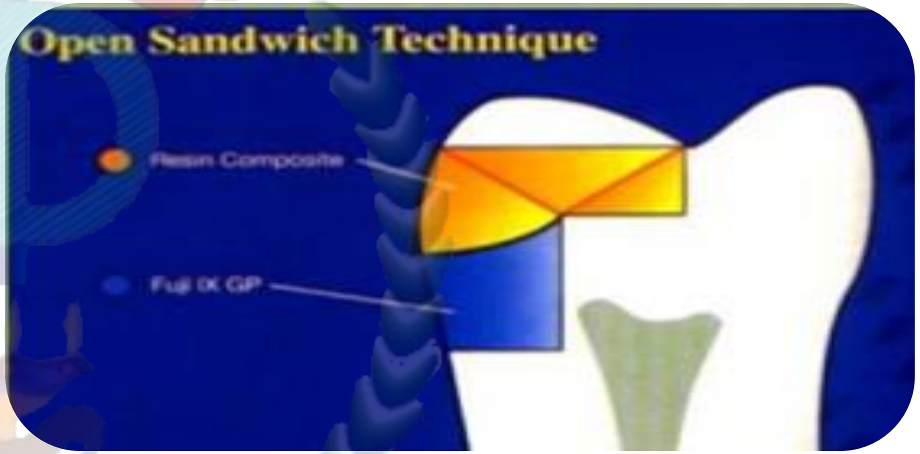
- Developed be Mclean.
- Also k/a laminate or bilayered technique

▪ Indications:-

✓When one or more margins are in dentin.
✓Extensive class I, II cavities.
✓Gingival floor deep on root surface.

- Two types:-


Closed Sandwich Technique
Resin Composite
Fuji IX GP


Open Sandwich Technique
Resin Composite
Fuji IX GP

- Advantages:-

✓Favorable pulp response.
✓Fluoride release
✓Less composite so less shrinkage.

- Disadvantages:-

✓Time consuming
✓Technique sensitive
✓Adhesion of composite to GIC is a worry.

Light curing of composites

- Light activation
  - UV light
  - Visible(blue) light

UV light curing:-

- Introduced in 1970.
- Benzoyl ether was used as photoinitiator
- It had shorter depth of cure
- Harmful for cornea due to short wavelength energy.

▪ Curing lamps:-

- Most curing lamps are hand held devices that contain the light source either

✓ Equipped with a relatively short, rigid light guide made up of fused optical fibers.

OR

✓ A few have the power unit connected to the dental handpiece by a long flexible liquid-filled light guide.

- Four types of lamps may be used for photoinitiation of the polymerization process.

✓Light emitting diode (LED) lamps

✓Quartz tungsten halogen (QTH) lamps

✓Plasma arc curing (PAC) lamps

✓Argon laser lamp

- The most widely used light source is a quartz bulb with a tungsten filament in a halogen environment,

▪ LED lamps:-

- Uses a solid-state electronic process

- Consists of combination of two semiconductors

✓n doped- excess of electrons

✓p doped- holes

- When voltage is applied electrons & holes combines resulting in emmission of light

- Gallium nitride electrodes are used.

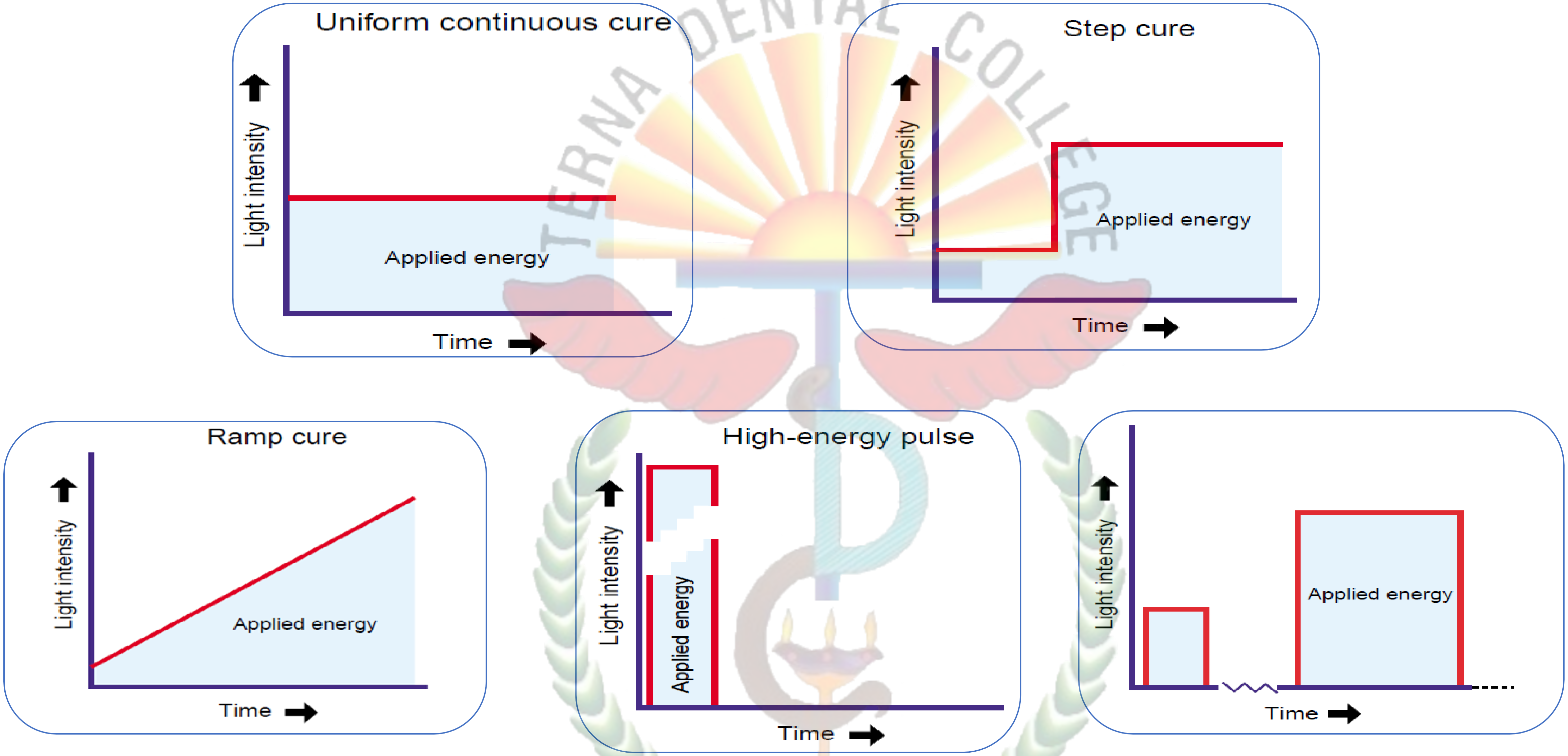
- **Techniques of light curing:-**

- Continuous curing techniques:-

✓Uniform continuous curing
✓Step cure
✓Ramp cure
✓High intensity pulse cure

- Discontinuous curing technique:-

✓Pulse delay cure



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Polymerization of composites

- Polymerization is initiated when a critical concentration of free radicals is formed.

- This requires that a particular number of photons be absorbed by the initiator system.

- Degree of conversion:-

- It is %age of C-C double bonds that have been converted to single bond to form polymeric chain.

- Directly related to intensity of light & duration of exposure.

- The higher the DC, better the wear resistance, strength & other properties of resin composites.

- Conversion values of 50% to 70% are achieved at room temperature for both curing systems.

- Factors affecting polymerization of composite:-

✓Wavelength

✓Intensity of light source (irradiance* time)

✓Time of exposure

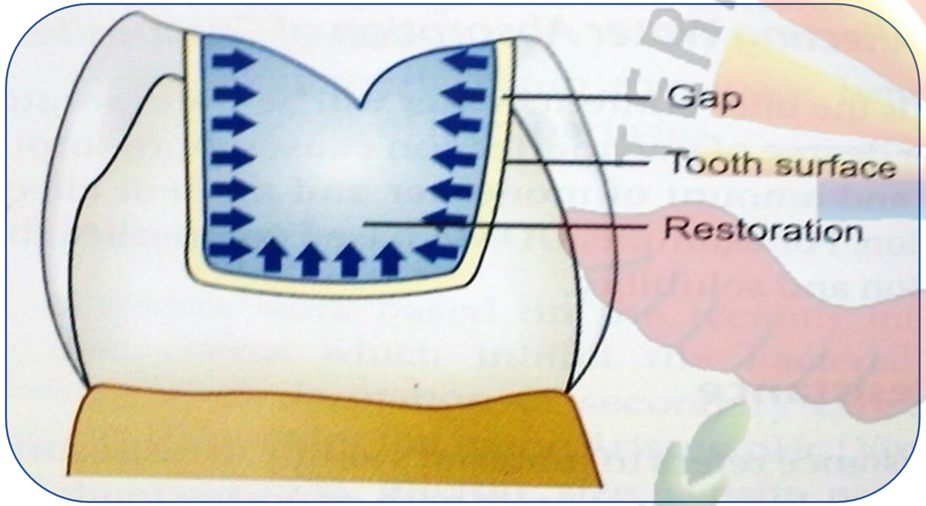
✓Distance of light source

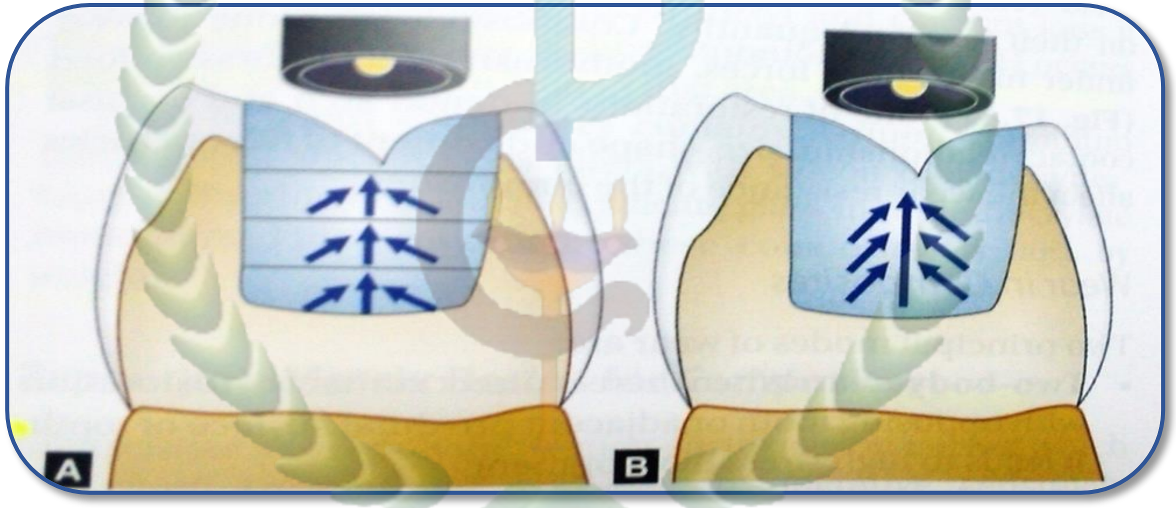
✓Type of composite

Polymerization shrinkage:-

- Initially, the distance between the monomer molecule is app. 4 A .
- During polymerization process, these forces are substituted by covalent bonds with distance of 1 A
- This volumetric contraction when small monomer units are converted to a single long polymer change is called polymerization shrinkage.

- Typical resin composites used in dentistry exhibit volumetric shrinkage values from 1 to 6%.





- Polymerization shrinkage stresses:-

- The exothermic reaction is generated when monomer converts into polymer creating shrinkage stresses.

- This can be attributed to:-

✓Decrease in flow

✓Increase in rigidity of composite after polymerization.

- **Factors affecting amount of polymerization contraction stress:-**

- ✓Cavity volume & configuration of cavity
- ✓Amount & quality of residual mineralized tooth
- ✓Bond strength of adhesive
- ✓Composition (filler content)
- ✓Flow
- ✓Shade & opacity of composite
- ✓Curing mode
- ✓Water sorption.

C- factor:-

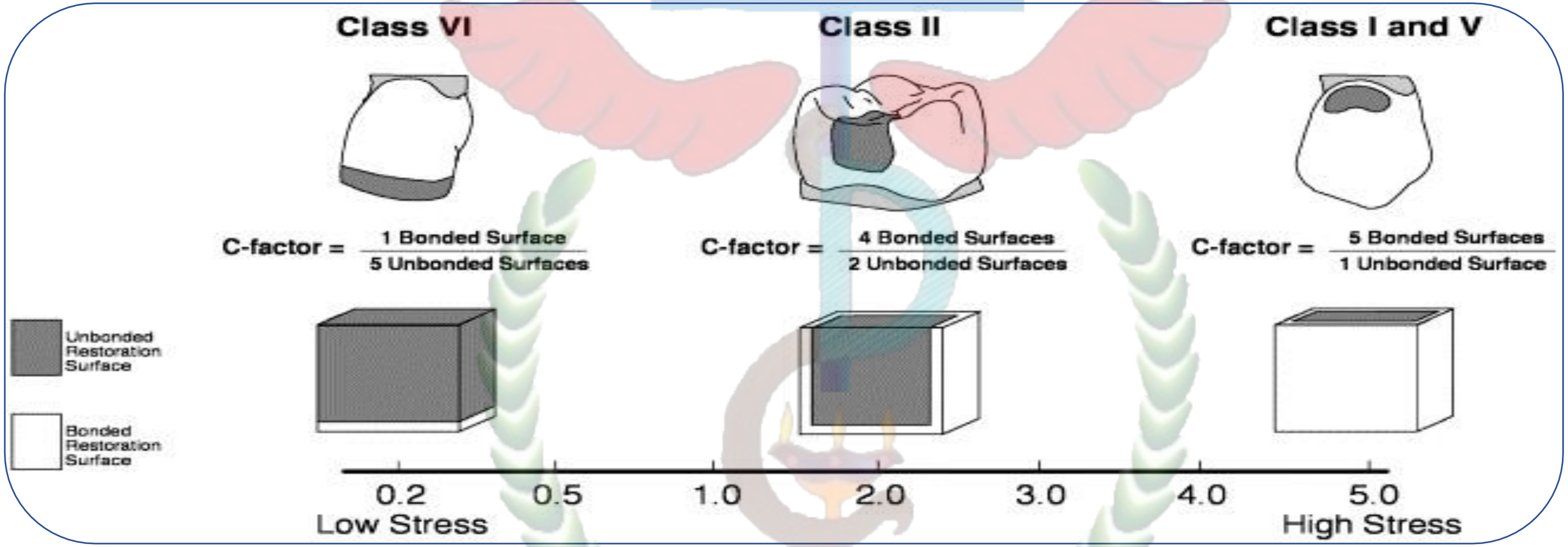
- Related to cavity preparation geometry & is represented by ratio of bonde to nonbonded surface areas.

- Polymerization stress varies directly with this ratio.

- During curing, shrinkage leaves the bonded cavity surfaces in a state of stress

- The non-bonded, free surfaces relax some of the stress by contracting inward toward the bulk of the material.

- C-factor is the ratio of bonded surfaces to the unbonded, or free, surfaces in a tooth preparation.



- **Strategies to reduce polymerization shrinkage:-**

✓Altering composite formulations

✓Incremental layering techniques (reduces C- factor)

✓Light curing procedures

✓Stress absorbing layers with low elastic modulus

✓Preheating of composites.

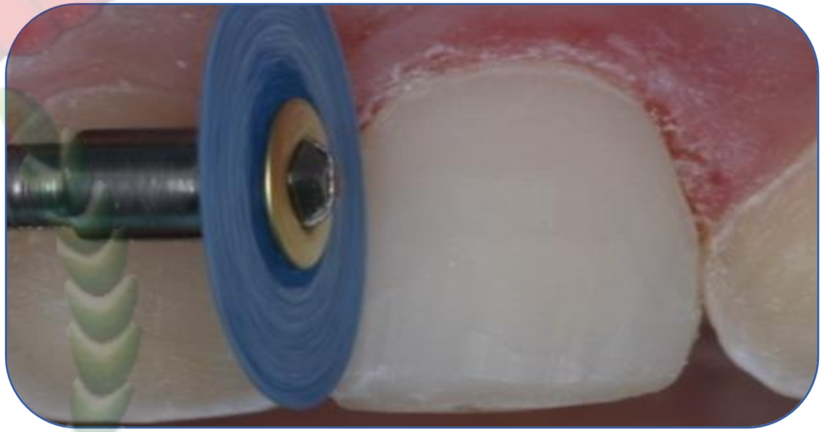
Finishing & polishing of composites

- Optimal finishing and polishing of resin-based composites is a very important step in the completion of a restoration.
- Use of a scalpel blade or any thin, sharp-edged instrument to remove flash on the proximal areas is recommended.
- Trimming forces should be applied either parallel to the margin or toward the gingival tissue.

- Coarse to ultrafine aluminum oxide discs for areas with difficult access.

- Tungsten carbide burs or fine diamond tips- to adjust occlusal surfaces and blend the composite to the surfaces of the teeth.

- Fine and extrafine polishing pastes, silicone-based systems, and silicon carbide–impregnated polishing brushes and points can also be used.



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Repair of composites

- Can be repaired by placing new material over old composites.
- If the repair is needed just after finishing procedure a new composite is directly placed.
- This is because of presence of oxygen inhibited layer at the surface.

- As the restoration ages this layer is removed & fewer unreacted methacrylate groups remains.

- The strength of bond between original material & new resin decreses in direct proportion to the time elapsed from polymerization.

- In such cases, re-etch and bond.

- The strength of repaired composite is less than half the strength of original material.

Failures of composite restorations

- **Poor isolation of the operating area:-**

- Causes includes:-

✓No rubber dam or leaking rubber dam

✓Inadequate cotton roll isolation

✓Preparation so deep gingivally it cannot be isolated

CONCLUSION

Dental composites are versatile materials whose usage has continued to grow since their introduction to the profession over 50 years ago. Composites have unquestionably acquired a prominent place among the filling materials employed in direct techniques. Nonetheless, it should not be forgotten that they are highly technique-sensitive.

With hundreds of millions of restorations performed each year, continuing research into practical advances and successful clinical implementation of composite restoratives are both critical to oral care, aesthetics, and functional restoration.

TAKE HOME MESSAGE

As far as composite are concern the objective of this seminar is to know about the detailed chemistry and the wide uses of composites in field of restorative dentistry and endodontics.

PROBABLE SAQS AND LAQS

1. Write classification , clinical application and steps in composite restoration ?
2. Elaborate Failures in composite ?
3. Classify composite and its clinical use for the same?