Estethic direct restorative material

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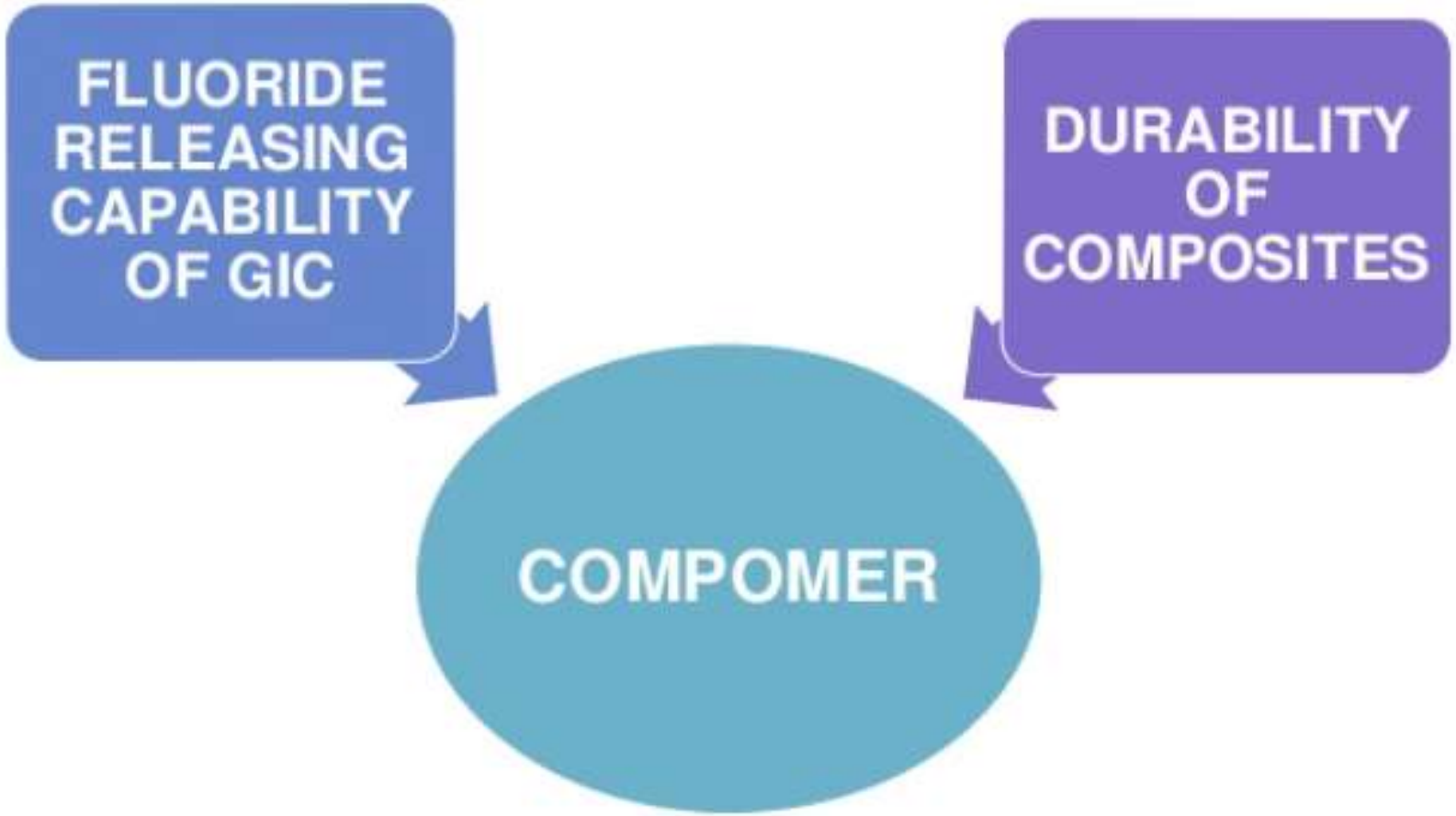
Direct Tooth Colored Material

- Composite Resin
- Compomer (Polyacid Modified Resin)
- Glass Ionomer
- Resin Modified Glass Ionomer

Dental restorative materials other than amalgam

- Glass ionomer cements (GIC)
- Resin composites
- Hybrid of GIC and Resin composite
  - Resin modified GIC
  - Poly acid modified resin composite (compomer)

POLYACID MODIFIED COMPOSITE RESIN / COMPOMER



COMPOSITION

- Resin matrix: Dimethacrylate monomers with two carboxylic group present in their structure
- Filler: Reactive silicate glass containing filler
- Photoinitiators and Stabilizers
- There is no water in composition and ion leachable glass is partially silanized to ensure bonding to matrix.

SETTING REACTION

These materials set by free radical polymerization reaction.

There are two stages are polymerization reaction.

STAGE I : Typical light activated composite resin polymerization reaction occurs which help in forming resin networks enclosing the filler particles. This reaction causes hardening of products.

STAGE II: It occurs after initial setting. The restoration absorbs water and carboxyl groups present in the polyacid and metal ions in the glass ionomers show slow acid-base reaction. This results in formation of hydrogel. It is like glass ionomer cement within the set resin structure. Slow release of fluoride also occurs

MANIPULATION

- For single component system: The tooth is etched and bonding agent applied. The material is injected into the cavity and cured by light.
- For powder/liquid system: The powder and liquid is dispensed and mixed according to the manufacturer instructions for 30secs.
- For the automixing system: The material comes out mixed when it is forced through special mixing tips.

Properties

- Adhesion –Micromechanical, absence of water thus no self adhesion
- Fluoride release minimal.
- Physical properties better than conventional GIC but less than composite.
- Optical properties superior to conventional GIC.

Uses

Pit and fissure sealant

- Restoration of primary teeth
- Liners and bases
- Core build up material
- For class III & V lesions
- Cervical erosion / abrasion
- Repair of defective margins in restorations
- Sealing of root surfaces for over dentures
- Reterograde filling material.

Contraindications

- Class IV carious lesions
- Large areas of labial surfaces
- Class II cavities where conventional cavity is prepared
- Lost cusp areas
- Under full crown or PFM crowns.

Advantages

- Ease of use
- Easy adaptation to the tooth
- Good esthetics
- More working time than RM GIC

- To summarize the differences between the three types of materials:

- *Fluoride Release ability*
  GICs>RMGICs>PAMCRs
- *Wear Resistance*
  PAMCRs>GICs>RMGICs
- *Strength*
  PAMCRs>RMGICs>GICs
- *Ease of Handling*
  PAMCRs>RMGICs>GICs
- *Polishability and Esthetics*
  PAMCRs>RMGICs>GICs

1. Dental Composites

- Dental composite are manufactured in two different forms: self-curing (auto-curing) and light-curing composite
- Self-curing composite have limited the fixed working time, material will harden within several minutes.
- Light curing composite have benefit to the clinician lay in the ability to place the material without time constraints.

  - the visible light traveled more deeply into the composite than UV –light
  - the restoration should be built up in succession of thin layer to ensure adequate hardening.
  - the visible light-curing have become the choice for modern composites

Composite Resin

- A highly cross-linked polymeric material reinforced by a dispersion of amorphous silica, glass, crystalline, or organic resin filler particles and/or short fibers bonded to the matrix by a coupling agent.

Filled Composite Resin: Composition

Resin Matrix (Organic Phase)	Fillers (Inorganic Phase)	Coupling agent (Interfacial Phase)
Bis-GMA (Bowen's resin)	Silica(quartz) Glass Fibers	Silane
UDMA TEGDMA DEGDMA	Lithium Barium Strontium	Gamma methacryloxy propyl silane

Filled Composite Resin:

Composition

Role of each constituent

Resin Matrix (Organic Phase)	Fillers (Inorganic Phase)	Coupling agent (Interfacial Phase)
1. Protect Fillers 2. Cushion transferring loads to strong fibers 3. Hold fillers together	1. Strength 2. Hardness 3. Abrasion resistance	Bond matrix to fillers
Responsible for: Physical Properties	Responsible for: Mechanical properties	Responsible for: Filler to matrix bond

Polymerization

- Initiation
  - production of reactive free radicals
    - typically with light for restorative materials
- Propagation
  - hundreds of monomer units
  - polymer network
  - 50 – 60% degree of conversion
- Termination

Clasification composite resin

Class of composite	Particle size	Clinical Use
Traditional composite	1-50 µm glass	High stress area
Hybrid composite	(1) 0.1-10 µm glass (2) 0.04 µm silica	High-stress areas requiring improved polishability (Classes 1, II, **III**, IV)
Small praticle filled	(1) 0.1-2 µm glass (2) 0.04 µm silica	Moderate stress areas requiring optimal polishability (Classes 111, 1V)
Microfilled composite	(1) 0.04 µm silica (2) Prepolymerized resin particles containing 0.04 µm Silica	Low-stress and subgingival areas where reduced shrinkage is essential
Packable hybrld	Midifiller/minifiller hybrid, but wilh lower filler fraction	
Flowable hybrid	Midifiller hybrid, but with finer particle size distribution	Situations in which improved flow is needed and/or where access is difficult

Newer Classification System

- Based on particle size
  - megafill
    - 0.5 - 2 millimeters
  - macrofill
    - 10 - 100 microns
  - midifill
    - 1 - 10 microns
  - minifill
    - 0.1 - 1 microns
  - microfill
    - 0.01 - 0.1 microns
  - nanofill
    - 0.005-0.01 microns
- Most new systems
  - minifillers
- Newest trend
  - nanofillers
  - trimodal loading
    - prepolymerized

Traditional composite

- A major clinical disadvantage of traditional composites is the rough surface that develops during abrasive wear of the soft resin matrix, thus exposing the more wear resistant filler particles, which protrude from the surface
- Finishing of the restoration produces a roughened surface, as does toothbrushing and masticatory ear over time.

Small particle filled (SPF) composite

- To improve surface smoothness and retain or improve the physical and mechanical properties of traditional composites
- SPF composites are indicated for high-stress and abrasion-prone applications, such as in Class 1V sites.
- The particle sizes of some SPF composites make it possible to attain reasonably smooth suifaces fol anterior applications, but they cannot form as smooth a polished surface as microfilled composites.

Microfilled composite

- microfilled composites are widely used today
- Because of their smooth sulfare, they have become the resin of choice for aesthetic restoration of anterior teeth, particularly in non-stress-bearing situations and for restoring subgingival areas
- Microfilled composites are used where esthetics is a dominant concern.

Hybrid composite

- The hybrid composites are viewed by some as having surface smoothness and aesthetic characteristics that are competitive with these properties for microfilled composites used in anterior restorative applications.
- hybrid composites contain two kinds of filler particles. Most modern hybrid fillers consist of colloidal silica and ground particle of glasses, Containing heavy metals, constituting a filler content of approximately 75 to 80 w/t
- Because of their surface smoothless and reasonably good strength, these composites are widely used for anterior restorations, including Class IV sites. composites are widely used today

Flowable composite

- A modification of the SPF and hybrid composites results in the so-called **flowable** composites.
- These resins have a reduced filler level so as to provide a consistency that enables the material to flow readily, spread uniformly, and intimately adapt to a cavity form to produce a desired dental anatomy.
- Difficult access and poor manipulation usually rcsults in open Contacts for class II composite restoration (proximal surface of second prernolar tooth).

Packable composite

- resin composites with filler chalacteristics that increase the strength
- resin composites with filler chalacteristics stiffness the uncured material and that provide a consistency similar amalgams.

Nanofill vs. Nanohybrid

- Nanofills
  - nanometer-sized particles throughout matrix
- Nanohybrids
  - nanometer-sized particles combined with more conventional filler technology

Composite bond to tooth structure

Before application composite resin on the tooth, dentist must be applied:

1. Acid etch: phosphoric acid
2. Primer : A hydrophilic, low-viscosity resin that promotes bonding to a substrate, such as dentin.

3. Dentin bonding agent: A thin layer of resin between conditioned dentin and the resin matrix of a composite.

Acid etch technique

- Dentist etched the enamel surface with acids and then placed composite resin restorative material on the micromechanically roughned surface.
- The monomer the composit resin wet the etched surface, flowed into the micropits, and generated retentive resin tags
- To produce a bond between enamel and resin-based restorative mateiials, sufficient etching of enamel is required to provides selective dissolution and associated rnicroporosity

Surface of etcthed enamel in which thc center of enamel rods have been preferentially dissolved by thc phosphoric acid.

Dentin bonding for composite restorative material

1. **First Generation adhesive (1960)**

- Developmental of surface active comonomer NPG-GMA
- Theorythically, this comonomer could chelate with calcium on tooth surface to generate to water-resistant chemical bond of resin to dentinal calcium
- Bond strength 2-3 Mpa

2. **Second generation adhesive**

- Phosphate bonding ester agent were introduced containing phenyl P and HEMA in etanol
- Its mechanism of action was based on the polar interaction between negatively changed phosphat in resin and positively changed Ca^{2+} in smear layer
- Bond strength 5-6 Mpa.

3. Third generation adhesive

- Designed not to remove entire smear layer but raher to modify it and allow penetration of acidic monomer
- These introduced acid-ething to hevily alter or to remove smear layer and dimineralizing dentin and a separate primer designed to penetrate dentin by its monomer
- Adhesive is an unfilled or partially resin that may contain some component of primer and attempt to promote bond strength
- Bond strength 3-8 Mpa

4. Fourth generation adhesive (1990)

- When primer and bonding resin are applied to etched dentin. They penetrate to intertubular dentin forming a resin dentin interdiffusion zone or hybrid layer
- They have the ability to bond as strongly to dentin as to enamel (total etch).
- Ability to bond moist dentin (wet dentin)
- Bond strength 13-30 MPa

5 . Fifth generation adhesive

- These are essentially distinguished by being one step or one bottel system. This is a bit mosnomer because this product are applied two steps (etchant + primer and adhesive) in one bottle
- Current dentin bonding agents rely on a complex combination of micromechanical retention by

  (1) penetration into partially opened dentinal tubules,

  (2) formation of a hybrid layer in which hydrophilic monomers penetrate and polymerize to form an interpenetrating network with a demineralized collagen fibril network,and

  (3) chemical interactions involving first-and second-order bonds.
- Bond strength 3-35 MPa.

6. Sixth generation adhesive (2002)

- They dissolve the smear layer when applied and do not require rinsing
- Minimize post operative sensitivity as they do not expose dentin tubular
- Bond strength to enamel and superficial dentin are greater than dentin

7. Seventh generation adhesive (2005)

- Self etching adhesive
- Require no mixing
- Single bottle containing acidic adhesive
- Bond strength to be equal to sixth generation adhesive

8. Eighth generation adhesive

Dual cure self etch resin adhesive for direct restoration

Description adhesive generation

Generation	Steps	Description
1st	3	Etch enamel, apply adhesive
2nd	3	Etch enamel, apply adhesive
3rd	3	Etch enamel, apply primer
4th	2	Total etch, apply primer
5th	2	Total etch, apply adhesive
6th	1 or 2	Apply self etch adheive
7th	1	Apply self etch adheive
8th	1	Apply self etch adheive

Composite resin characteristic

- Colour can be changed by liquid or water. Composite resin has hidroksil groups that can absorb liquid
- Strength

  Tensile and compressive strength << amalgam
- Radiopacity: the use of heavy metal (Ba, Sr)
- Polymerization shrinkage→ marginal leakege, caries secondary, post operative sensitive. The most commonly used monomer is bis-GMA which helps to reduce the polymerization shrinkage (7,5 vol.%)

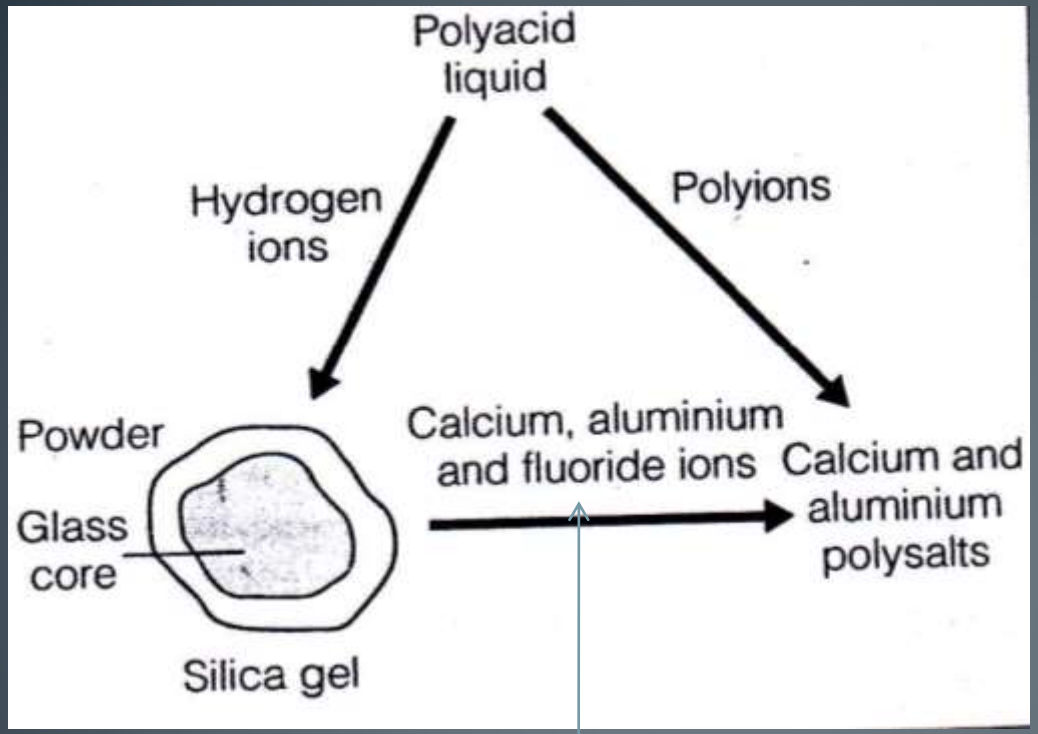
Biocompatibility

- Tolerated by pulp
  - with good seal
- Rare allergic reactions
  - HEMA
- Cytotoxicity
  - short lived
    - not a chronic source
- Degree of cure important
  - decrease free monomer

Phillip's Science of Dental Materials 2003

3. Glass Ionomer Cement (GIC)

- It is combined between Zinc polycarboxylate cement (powder, adhesive qualities) and silicate cement (liquid, F release)
- The two main features GIC have ability to bond to enamel and ability to release F
- It is were used mainly for restoration of abrasion/ erosion lesions and as a luting agent for C&B reconstruction



Dissolution

Gelation

Hardening

Classification glass ionomer cement

- Traditional glass ionomer cement

1. Type I: luting cement
2. Type II: restorative cement
3. Type III: liners and bases

- Resin modified glass ionomer: composite resin in which fillers subtituted with glass ionomer particles

Physical properties GIC

- Low solubility
- Coeficient thermal expansion similar to dentin
- Flouride release
- Compressive strength << compsite resin
- Bond to tooth structure
- Brittle
- Rough surface texture.

Clinical use GIC

- Indication for use of type II glass ionomer cement

  a. Class III and clas V restoration in adult

  b. Class I and II restoration in primary dentition

4. Resin-modified GIC

- To improve the handling properties of GIC by incorporating a resin which will polymerise under the action of blue light curing unit
- The acid-base setting reaction is essentially the same as for the GIC , that material differs from GIC in this reaction is much slower (giving a longer working time)
- The rapid set is provided by light activation mechanism causing polymerization of HEMA and copolymer-containing materials, additional cross-linking through the pendant methacrylate groups .

- Properties:

  - improved many the properties (prolonged working time, rapid set, resistance to desiccation)
- One potential drawback with incorporation of HEMA has been to be toxicity when it contact with dental pulp tissue and osteoblast.
- When used in conjunction with composites is no need to etch the surface .

DENTIN CONDITIONER

POLYACRYLIC ACID CAVITY CONDITIONER

For use only by a dental professional in the recommended indications.

RECOMMENDED INDICATIONS

DENTIN CONDITIONER is a mild polyacrylic acid solution designed to remove the dentinal smear layer and to condition dentine, thus enhancing the bond between glass ionomer cement and the dentine.

CONTRAINDICATIONS

In rare cases the product may cause sensitivity in some people. If any such reactions are experienced, discontinue the use of the product and refer to a physician.

DIRECTIONS FOR USE

1. After tooth preparation, apply DENTIN CONDITIONER to the bonding surfaces for 20 seconds using a cotton pellet or sponge.
2. Rinse thoroughly with water. Dry by blotting with a cotton pellet or gently blowing with an air syringe. DO NOT DESICCATE. Best results are obtained when prepared surfaces appear moist (glistening).
3. Apply GC Fuji BOND LC, GC Fuji II LC or other glass ionomer as a bonding agent, base/liner or restorative material.
4. Close the bottle immediately after use.