Sri Aurobindo College of Dentistry

Indore, Madhya Pradesh

INDIA

Module plan

- Topic : Glass Ionomer Cement
- Subject: Endodontics
- Target Group: Undergraduate Dentistry
- Mode: Powerpoint-Webinar
- Platform:Po Institutional LMS
- Presenter: Dr.Swadhin Raghuwansi

CONTENTS

DEFINITION

- A cement is a substance that hardens to act as a base , liner , filling material or adhesive to bind devices or prosthesis to the tooth structure or to each other. –**(Philips science of dental materials-12th edition)**

- Definition of Glass Ionomer Cement: A cement that consists of a basic glass & an acidic polymer which sets by an acid-base reaction between these components. **(Mclean & Wilson 1994)**

Phillips' Science of DENTAL MATERIALS 12th edition

- **KENETH J ANUSAVICE**
- Glass ionomer is the generic name of a group of materials that use silicate glass powder and aqueous solution of polyacrylic acid”.

- **CRAIG**
- A non metallic material used for luting, filling permanent or temporary restorative purposes, made by mixing components into a plastic mass that sets or as an adherent sealer in attaching various dental restorations in or on the tooth

INTRODUCTION

Glass ionomer cement was developed by Wilson and Kent in England in the year 1972

It was introduced in U.S. as ASPA (Alumino Silicate Poly Acrylate) in 1977

The glass ionomer was introduced as a potential replacement for silicate cement because of extensive use of this cement as a Dentin replacement material.

The greatest advantage of this new cement was its adhesion to enamel and dentin and the fluoride release for anti-cariogenic effect.

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ADA specification number : **96**

- It was named glass ionomer because, the powder is a type of glass and the setting reaction and adhesive bonding to tooth structure is due to ionic bond.

- Glass ionomer cement is often known as a biomimetic material, because of its similar mechanical properties to dentin.

- For this reason it is one of the most popular cements in dentistry.

B.E KENT coined the term “ GLASS IONOMER "

SYNONYMS OF GIC

- Man made Dentin
- Dentin Substitute
- Polyalkeonate cement
- Anhydrous cement
- ASPA

  Alumino Silicate Poly Acrylate

HISTORY AND EVOLUTION

- "Necessity is the mother of inventions", it was in late 1950's that history had already witnessed a host of restorative materials including dental amalgam, composites, but all had fallen short of that certain perfection that the dental researchers & clinicians aimed for.

- The material was to be tooth coloured, esthetic, adhesive, biocompatible, anticariogenic & most of all relatively economical.

- 1960's – First GIC produced by **ALAN WILSON**, the aluminium to silica ratio in powder was increased compared to silicate cement gives raise to increase in reactivity of glass hence it reacts faster with polyacrylic acid because this acid is weaker than phosphoric acid in silicate cement.

➢1968 – Smith produced the first zinc polyalkenoate cement. He replaced eugenol in zinc oxide eugenol cement with polyalkenoic acid, he discovered that resultant cement bonded to tooth structure however its physical properties were less than ideal.

➢Initially ASPA was a calcium-aluminosilicate glass system, introduced by **WILSON & KENT** which had calcium oxide along with the fluoride, alumina and silica. The liquid was an aqueous solution of 50% polyacrylic acid which converted into gel form only after a few months.

➢The first ASPA had inappropriate setting & esthetic demands it became evident in 1972 that incorporation of the positive isomer of tartaric acid can improve setting time & manipulation properties. This was named by WILSON as ASPA II [aluminosilicate polyacrylic acid].

- In 1974 McLean & Wilson proposed clinical use of GIC
- In 1974 they discovered ASPA 3 which had methyl alcohol added to polyacrylic acid but it had disadvantage of staining.
- In 1975 they discovered ASPA 4 which contained copolymers of acrylic acid & tartaric acid.
- FORSTEIN studied the pattern of fluoride release from GIC.
- CRISP ABEL & SIMMONS in 1979 discovered ASPA-X which had excellent translucency.
- PROSSER et al in 1984 developed ASPA 5 which contained polyacrylic acid in dry powder blended with glass powder mixed with water/ tartaric acid.

CLASSIFICATION

According to Skinners and Phillips

Type I - Luting

Type II - Restorative

Type III - Liner and Base

According To Mc Lean, Nicholson and Wilson (1994)

1. Glass ionomer cement
   a. Glass polyalkeonates
   b. Glass polyphosphonates

2. Resin modified GIC

3. Polyacid modified GIC

Text Book Of Vimal Sikri 4th edition

According to application

- Type I - Luting cements
- Type II - Restorative cements
- Type III - Lining cements
- Type IV - Fissure sealants
- Type V - Orthodontic cements
- Type VI - Core build up cements
- Type VII - Cermet Cement (gold , silver)
- Type VIII - ART
- Type IX - Pediatric

Text Book Of Vimal Sikri 4th edition

According to Graham Mount

- Type 1 - Luting GIC
- Type 2 - Restorative GIC
- Type 3 - Liner Or Base

Fig. 24.2: Type I luting GIC

Fig. 24.3: Type II restorative GIC

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NEWER CLASSIFICATION (By Sturdevant)

1) Traditional Glass Ionomer

Type I Luting cement

Type II Restorative cement

Type III Liners and Bases

2) Metal Modified GIC

Miracle mix

Cermet cement

3) Light Cure GIC

HEMA added to liquid

4) Hybrid GIC/ Resin Modified GIC

a. Composite resin in which fillers substituted with glass ionomer particle

b. Pre cured glasses blended into composites

Text Book Of Vimal Sikri 4th edition

ACCORDING TO DAVIDSON AND MJOR

1.Conventional/ Traditional
- Glass ionomer for direct restorations
    - Metal reinforced GIC
- High viscosity GIC
- Low viscosity GIC
- Base/ Liner
- Luting

2. Resin Modified GIC
- Restorative
- Base / Liner
- Pit & fissure sealant
- Luting
- Orthodontic cementation material

3. Polyacid modified resin Composites/ Compomers

Representative commercial products

Aquacem, Fuji I — Luting

Ketac bond — Bases and liners

Chem Fil, Fuji II — Restorations

Vitra bond — Light cure GIC

-Textbook Of Manappalli 4th Edition

COMPOSITION

- Basically powder is an acid soluble calcium flouroaluminosilicate glass.
- Formed by fusing silica[Sio2], alumina [Al2O3], calcium fluoride / fluorite(CaF2), at 1100°C to 1500 °C temperature.
- The glass is crushed, milled and then ground to a fine powder {20u – 50u)
- Fluoride portion act as ceramic flux.
- Strontium, Barium or zinc oxide provide radio opacity.

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Powder Contains :

Ingredient	Weight (%)
Silica $(SiO)_2$	41.9
Alumina (Al_2O_3)	28.6
Aluminum fluoride(AlF_3)	1.6
Calcium fluoride (CaF_2)	15.7
Sodium fluoride (NaF)	9.3
Aluminum phosphate $(AlPO_4)$	3.8

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ROLE OF COMPONENTS IN POWDER

1. Alumina (Al_2O_3) - Increase opacity

2. Silica (SiO_2) - Increase Translucency

3. Fluoride:
- Decrease fusion temperature
- Anti cariogenecity

4. Calcium fluoride (Ca F2)
- Increase opacity - Acts as flux

5. Aluminium flouride
- Acts as flux

6. Sodium flouride
- Acts as flux

7. Aluminium phosphates
- Decrease temperature
- Increase translucency

LIQUID

- POLYACRYLIC ACID – 40% TO 50%
- ITACONIC ACID-5%
- MALEIC ACID-5%
- TRICARBOXILIC ACID-5%
- TARTARIC ACID- Traces
- WATER – 50%

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Liquid Contains :

Originally the liquid was a 50% aqueous solution of polyacrylic acid. It was very viscous and had a tendency to gel.

Modern glass ionomer liquids are in the form of copolymers with itaconic acid, maleic acid and tricarboxylic acid.

This poly electrolytic liquid of GIC is, thus, also called as poly alkenoic acids.

- **Poly Acrylic Acid Copolymerizing with itaconic and maleic acid :**

To increase reactivity of liquid, decrease viscosity and reduce tendency of gelation.

- **Tartaric Acid:**

To control the setting reaction. improves handling characteristics.

- **Water**

Anhydrous Cement or water settable GIC

Consist of freeze-dried polyacrylic acid and glass powder in one bottle and water with tartaric acid in another bottle as liquid. Thus Cement has longer working time and shorter setting time


FIGURE 8.14 Water settable glass ionomer luting cement

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SETTING REACTION

It occurs in four steps:

- ***Dissolution***
- ***Gelation***
- ***Hardening***
- ***Maturation***

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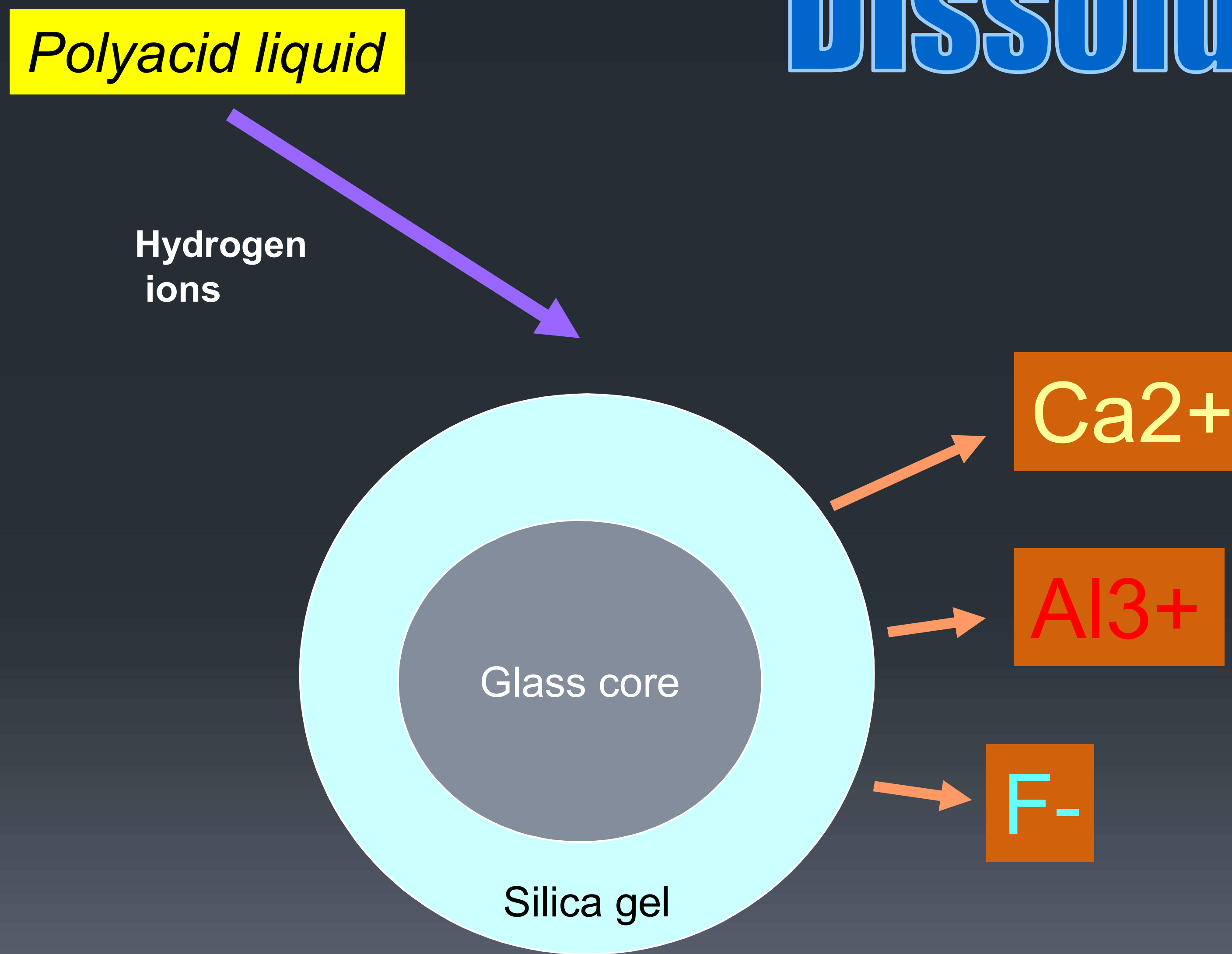
Dissolution



Gelation

Polyacid liquid

Ca2+

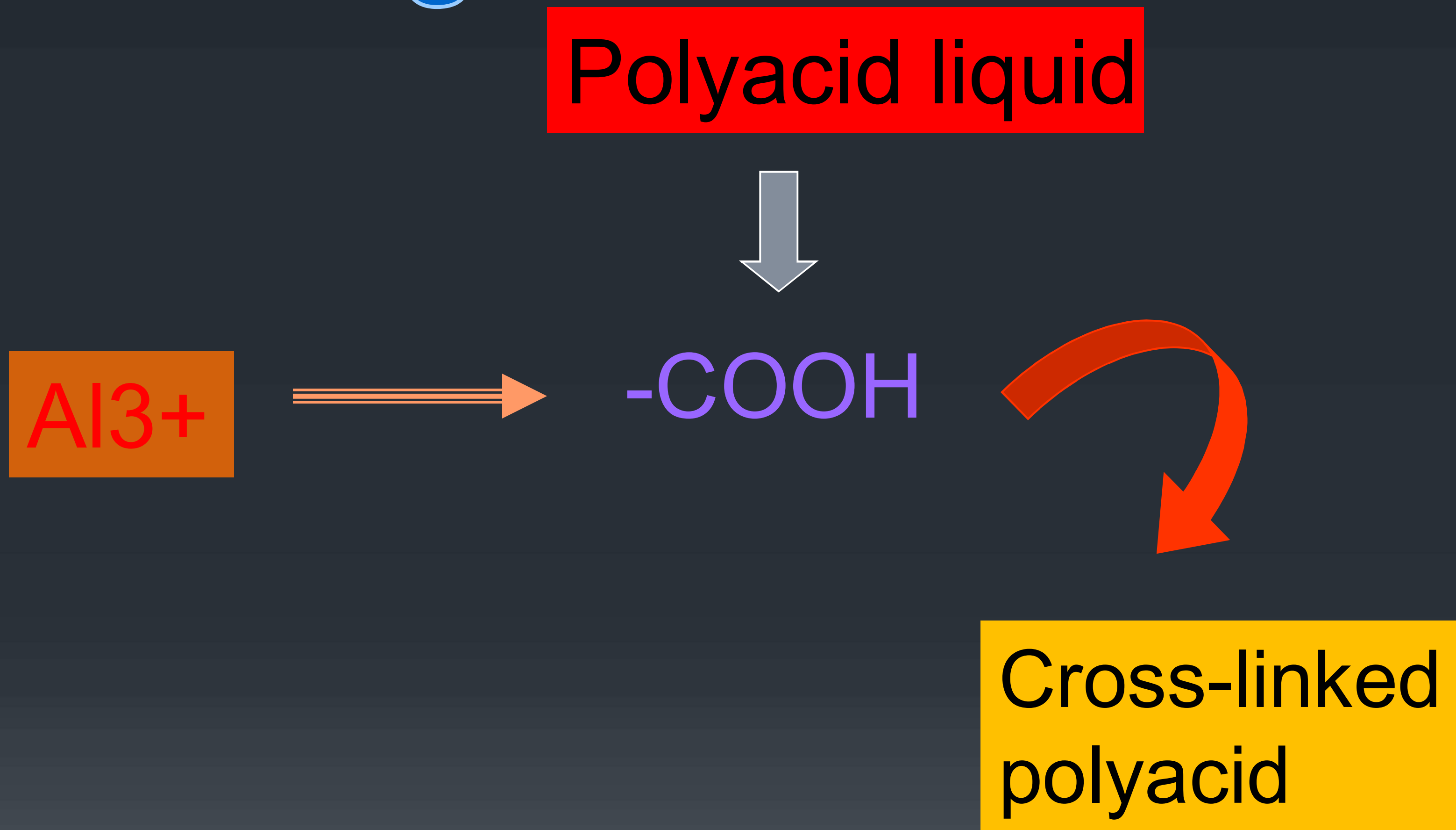
Al3+

F-

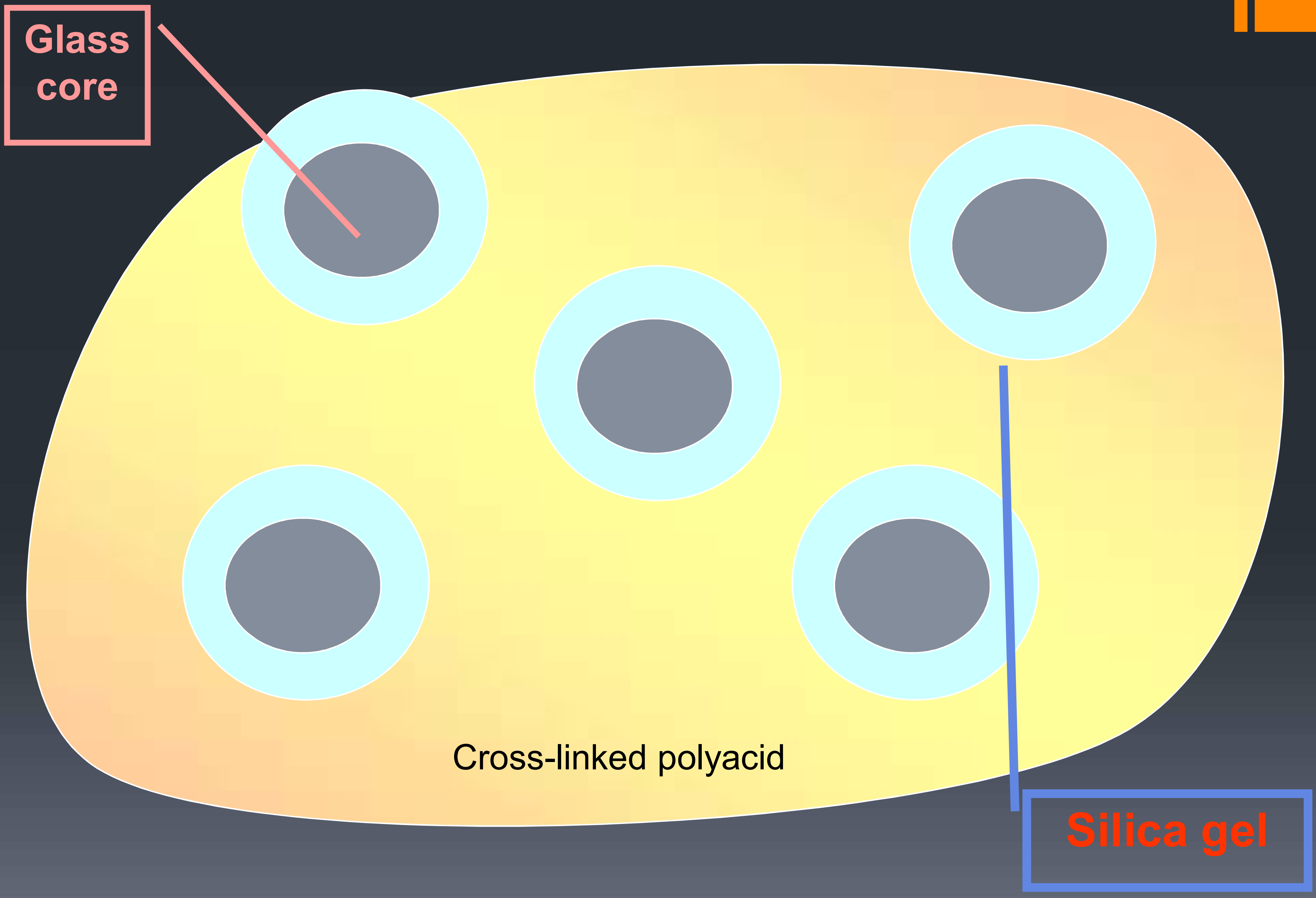
-COOH

Cross-linked polyacid

Hardening



MATURATION



Powder + Liquid

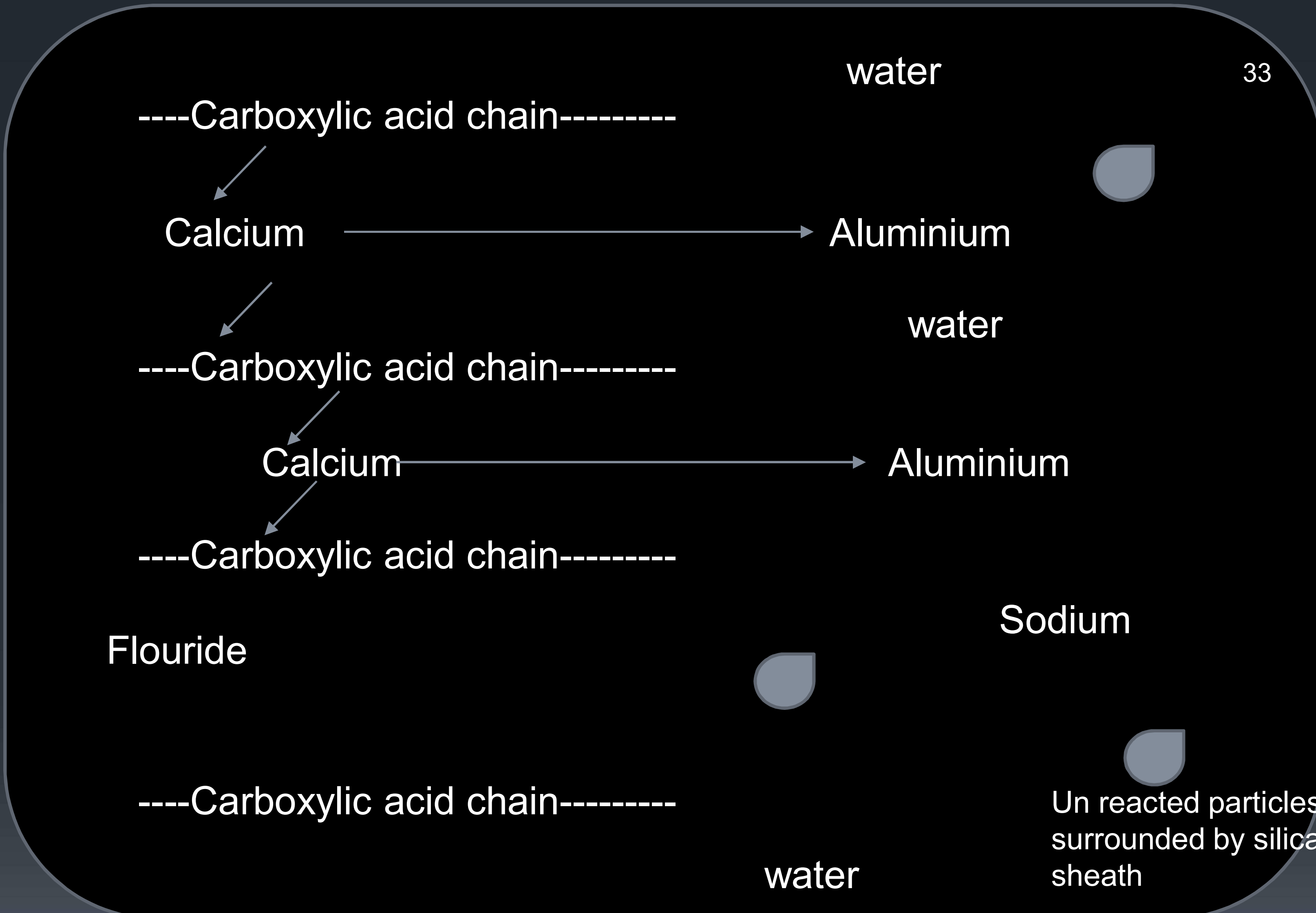
(Calcium aluminoflourosilicate) acid soluble

Polyacrylic acid, tartaric acid , water

Mixing powder and liquid

1. **Acid Attack Phase**
2. **Dissolution Phase**
3. **Cross Linking Phase** (initial with calcium ions and after 24 hours replace by aluminium ions.) helps in initial strength and integrity
4. **Maturation** matrix hydrated over time by water

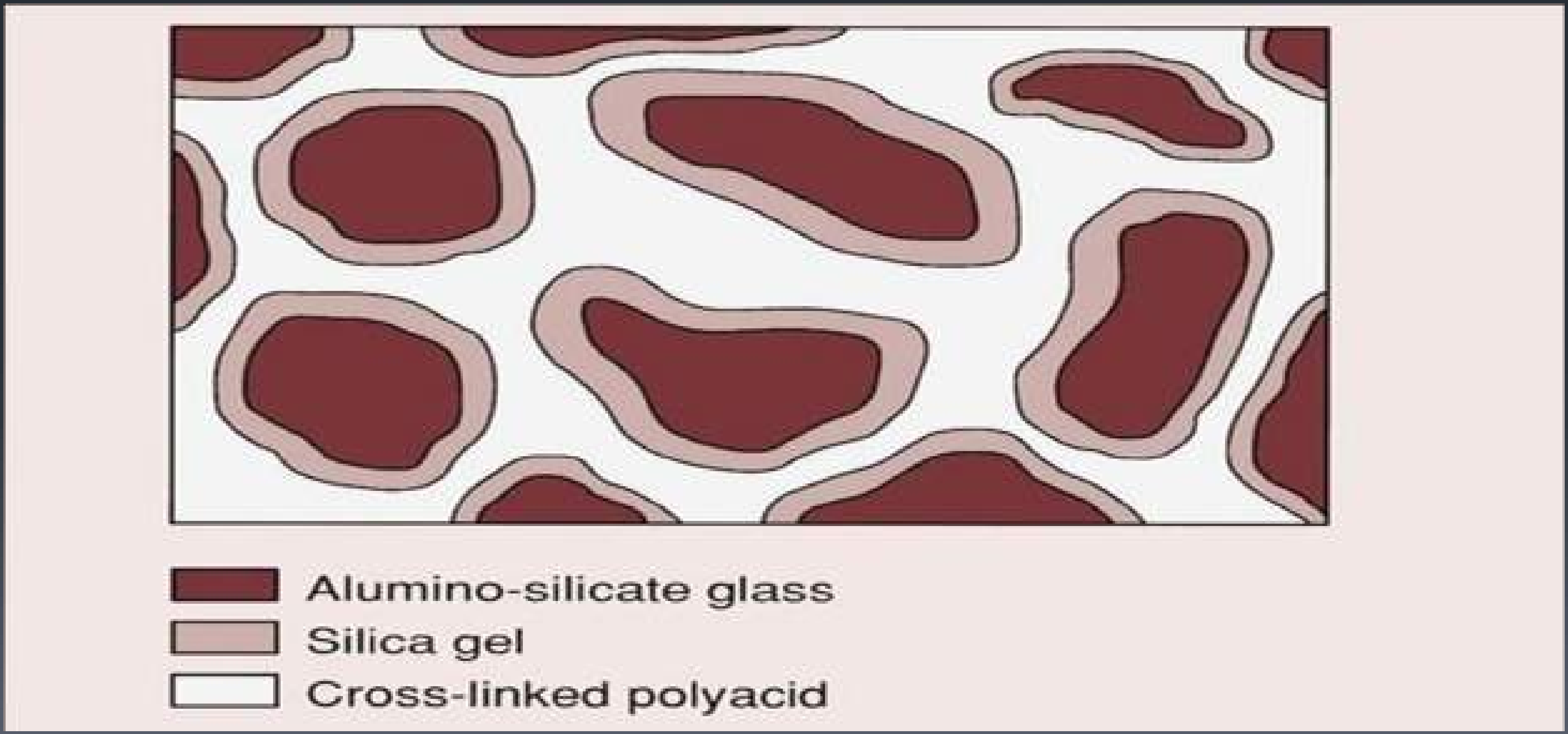
Chain of reaction happen within matrix



Reaction Medium Formed By
Water helps setting to occur

Structure of set cement

The set cement consists of unreacted powder particles surrounded by a silica gel sheath and embedded in an matrix of hydrated calcium and aluminum cross-linked poly salts.



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- Some Sodium ions Participates In cross linking by replacing hydrogen in carboxylic group

- Rest sodium and fluoride ions uniformly distributed in matrix.

- Role Of Water :

1. Reaction Medium where entire reaction occur.

2. Helps in maturation which enables the gel structure to remain stable and stronger

Sensitivity to air and moisture

Exposure of the cement to water before the hardening reaction is complete, leads to loss of cations and anions which form the matrix as they can be dissolved. Thus it is very important to protect the cement surface (by applying varnish, etc.) after it is placed in the mouth.

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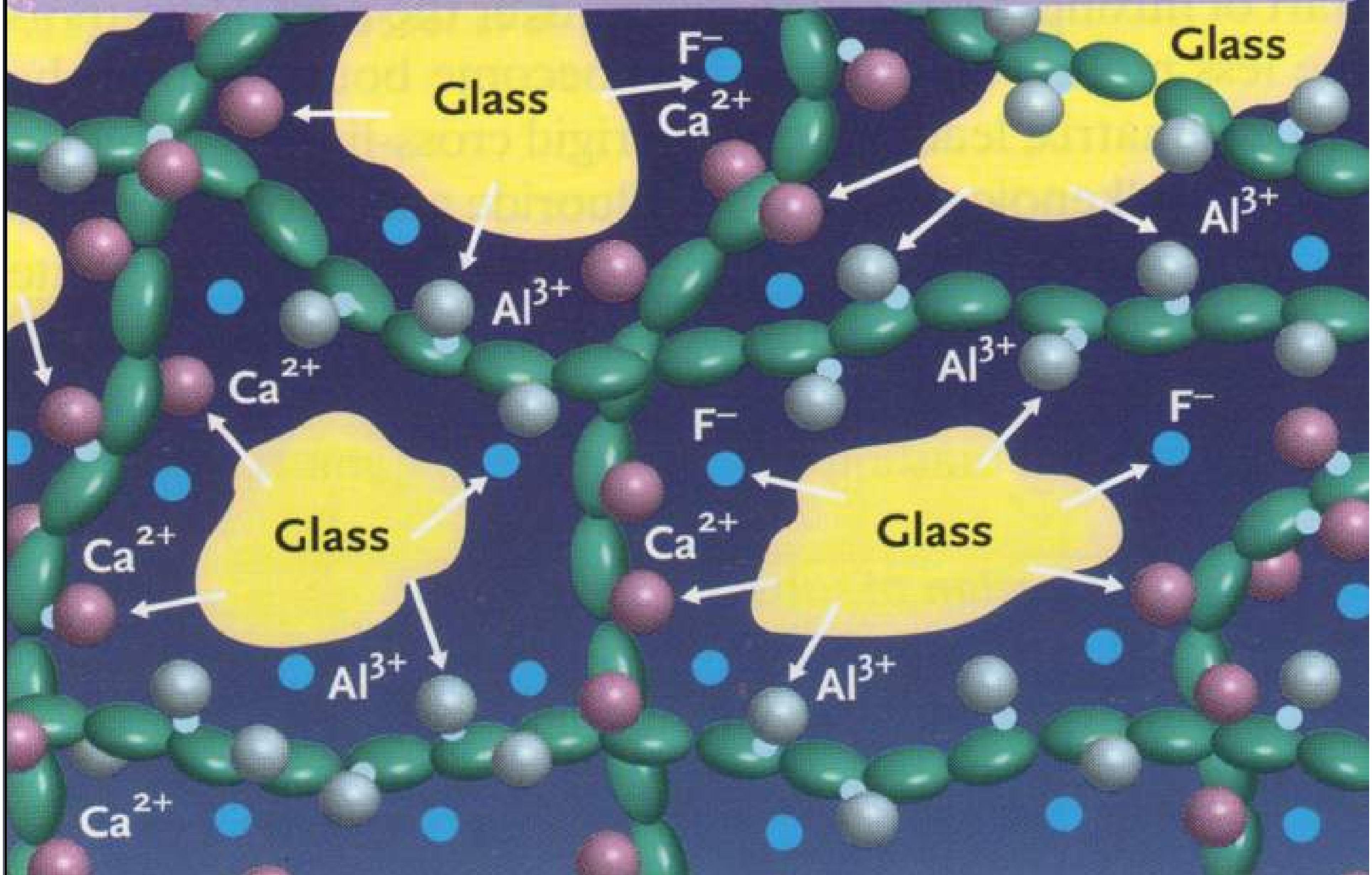
The setting reaction of glass–ionomer



The setting reaction also depends on several factors

- **GLASS COMPOSITION** –higher the Al/Si ratio – faster is the set, decrease working time.
- **PARTICLE SIZE** – finer the particle - faster is the set
- **ADDITION OF TARTARIC ACID** – sharpens the setting time without shortening the working time.
- **CONSTITUENT OF CEMENT** – greater the proportion of glass and lower water faster set and decrease working time
- **TEMPERATURE** – higher temperature – faster set and decrease working time.

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PROPERTIES

Physical properties

1. Sets rapidly in mouth

2. Initial compressive strength is low(150-200Mpa) but increases with time(after a year it can reach to 400Mpa)

3. Low solubility(0.7%)
4. Low flexural strength
5. Low shear strength
6. Co-efficient of thermal expansion close to that of tooth

Craig's Restorative Dental Materials(13th edition)

- **ABRASION RESISTANCE**

  GIC are less resistant to abrasion than composite resins but their resistance improves considerably as they mature.

- **FRACTURE TOUGHNESS**

  Glass Ionomer cements are much inferior to composites in this aspect.

- **HARDNESS:**

  It is less than composites. The value is 48 KHN.

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TABLE 14-9 Fracture Toughness of Glass Ionomer Materials and Selected Other Materials

Type of Material	Fracture Toughness ($MPa \cdot m^{1/2}$)
Amalgam[1]	0.97–1.60
Hybrid composite[2]	1.75–1.92
Conventional GIC (luting)[3]	0.27–0.37
Conventional GIC (restoration)[4]	0.72
Metal-reinforced GIC (cermet)[5]	0.51
Metal-reinforced GIC (admixture)[5]	0.30
High-viscosity GIC[6]	0.45–0.72
Hybrid GIC (luting)[3]	0.79–1.08
Hybrid GIC (restoration)[5]	1.37
Compomer (restoration)[2]	0.97–1.23
Resin cement[3]	1.30

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Mixing Time : 45 to 60 seconds

WORKING TIME of traditional cement is 2-3 minutes.

SETTING TIME:

Type I: 4-5 minutes
Type II: 7 minutes

POLYMERIZATION SHRINKAGE:
Not seen with GIC

GIC sets slowly and develops less interfacial stress.

Adhesion

- It bonds chemically to tooth structure by chelation
- Bonding is due to reaction between carboxyl group of poly acid and calcium hydroxyapatite
- Bonding with enamel is higher compared to dentin due to greater inorganic content
- Principal barrier to adhesion is water

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Esthetics

- GIC is tooth coloured material and available in different shades
- Inferior to composites
- They lack translucency and rough surface texture
- Potential for discolouration and staining

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Biocompatibility

- Glass ionomer cements are considered as biocompatible dental materials because of following reasons:

I. Polyacrylic acid present in the liquid is a weak acid

II. Dissociated hydrogen ions present in GIC are further bound to the polymer chains electrostatically.

III. The long polymer chains tangle on one another, this prevents their penetration into the dentin tubules.

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- The postoperative sensitivity after GIC placement is usually seen with “water-mixed” forms of the GICs.
- This is because of low viscosity and low initial pH of these cements.
- Type I glass ionomer cement show more sensitivity than type II cements because of following factors:

I. Seating of the restoration results in pressure which further increases sensitivity.
II. Use of a low powder-to-liquid ratio mix.
III. Luting GICs are placed over a large surface area of cut dentin.
IV. Microleakage because of early moisture contamination can result in sensitivity.

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Anti-cariogenic properties

Type II glass ionomer releases fluoride in amounts comparable to silicate cements initially and continue to do so over an extended period of time.

In addition, due to its adhesive effect they have the potential for reducing infiltration of oral fluids at the cement-tooth interface, thereby preventing secondary caries.

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COMPARATIVE PROPERTIES OF GLASS IONOMER CEMENT

Property	TYPE- I	TYPE- II	TYPE- III
P:L ratio	1.5:1	3:1	3:1
Working time	3.5 min	2.0 min	2.0 min
Setting time	7.0 min	5.0 min	4.0 min
Compressive strength(Mpa)	120	150-200	120
Tensile sterngth(Mpa)	9-12	15-20	6-10
Flexural strength	12-15	18-20	13-16
Surface hardness	160	200	120
Film thickness	20	-	-
Coeff.thermal expansion	-	$13x10^{-6}$	$8x10^{-6}$
Solubility	0.1	0.1	0.1

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Advantages of GIC

- Inherent Chemical adhesion to tooth structure
- Biocompatible because large sized polyacrylic acid molecules prevent the acid from producing pulpal response.
- Little shrinkage and good marginal seal.
- Anticariogenic because of fluoride release.
- Aesthetic.
- Minimal tooth preparation required hence easy to use on children.
- Less soluble than other cements
- Less technique sensitive than composite resins.

Disadvantages of GIC

- Brittle and low fracture resistance
- Low wear resistance
- Water sensitivity during setting phase affects physical properties and aesthetics.
- Some newer products release less fluoride than conventional GIC.
- Opaque which makes glass ionomer cement less aesthetic than composites.
- Not inherently radiopaque.
- Require moisture control during manipulation and placement

Indications

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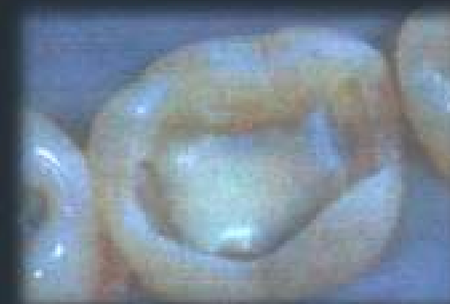
1. Restoration of permanent teeth
    - Class V and Class III cavities
    - Abrasion and erosion lesions
    - Root caries

2. Restoration of deciduous teeth
    - Class I- IV cavities
    - Rampant caries, nursing bottle caries

3. Luting or cementing
    - Metal restorations (inlays, onlays & crowns)
    - Veneers
    - Pins and Posts
    - Orthodontic bands and brackets

4. Preventive restorations
    - Tunnel preparation
    - Pit and fissure sealant

5. Protective liner under composite and amalgam



6. Dentin substitute

7. Core build up

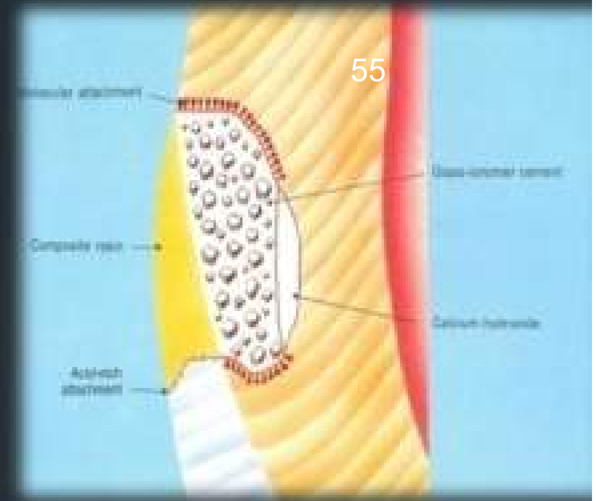
8. Splinting of periodontally weakened teeth

9.. Other restorative techniques

a) Sandwich technique

b) Atraumatic restorative treatment

(Fuji VIII and Fuji IX)



10. In Endodontics

- Repair of external root resorption
- Repair of perforation
- Retrograde filling

Contraindications

1) **Class IV carious lesions (or) fractured incisors**
2) **Lesions involving large areas of labial enamel where esthetics is of major importance.**
3) **Class II carious lesion where conventional cavities are prepared, for replacement of existing amalgam restorations.**
4) **Lost cusp areas.**

FLOURIDE RELEASE

Glass ionomer have a cariostatic effect.

Fluoride ions released from the restorative materials become incorporated in hydroxyapatite crystals of adjacent tooth structure to form structure such as fluorapatite that is more resistant to acid mediated decalcification

The fluoride originates from that used in preparing the alumino silicate glass, which contain upto 23% fluoride.

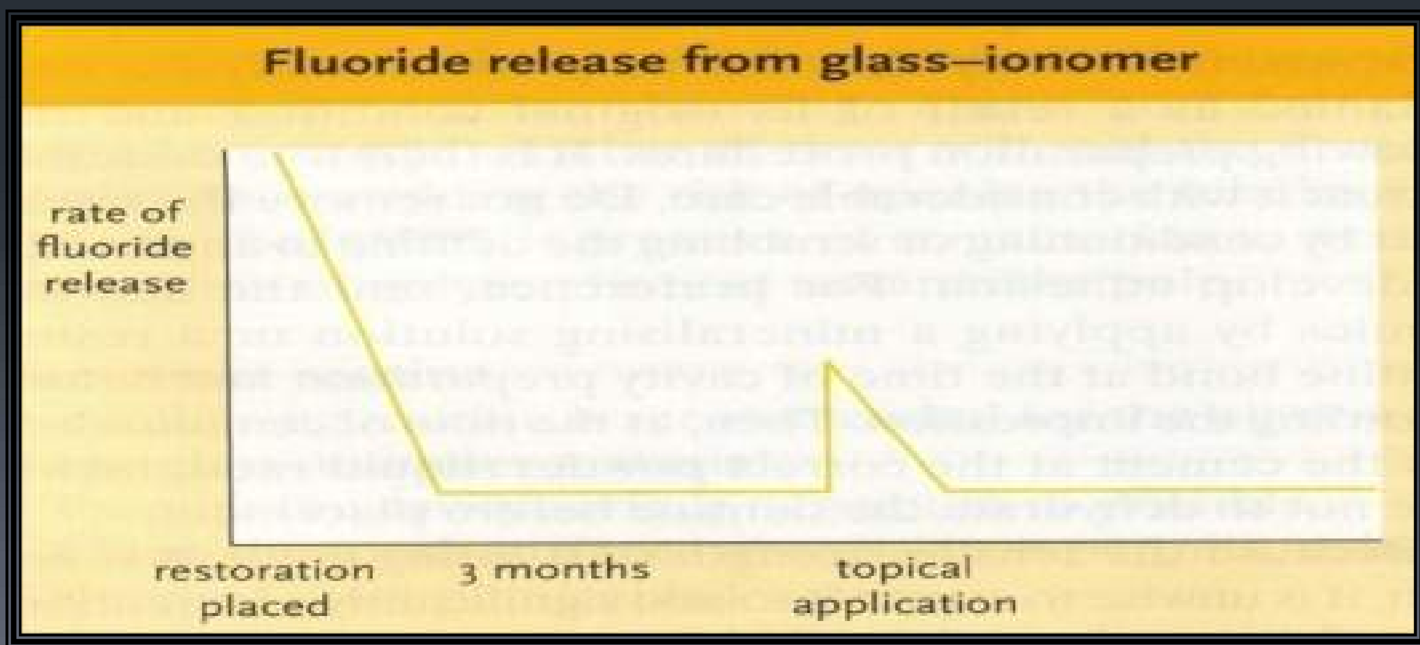
Thickly mixed cements used for restorations release more fluoride than thinly mixed ones used for luting because they contain proportionately more glasses and hence more fluoride.

Fundamentals of Operative Dentistry 3rd edition, Summit

DURATION OF FLOURIDE RELEASE

❖Initial release is high. But declines after 3 months. After this, fluoride release is continuous for a long period.

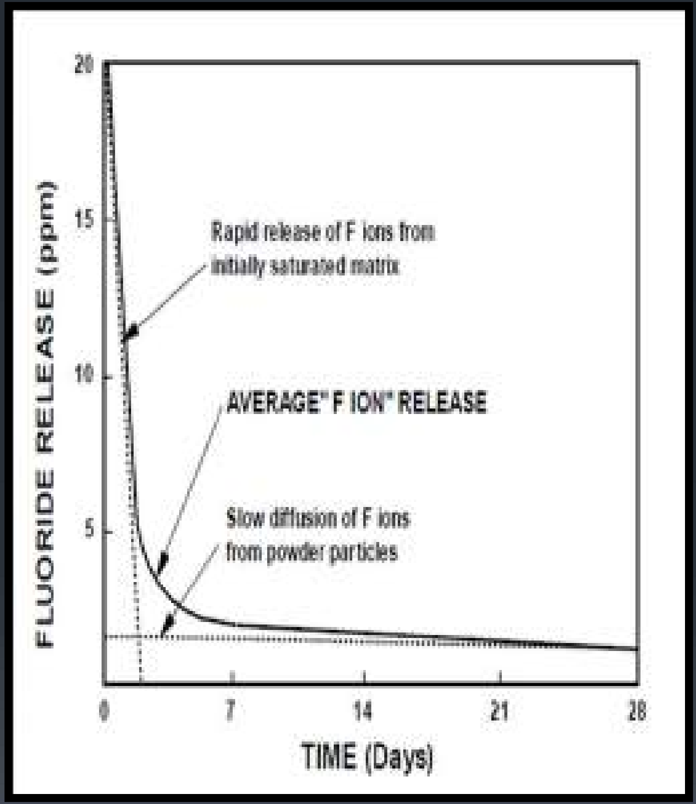
❖Fluoride can also be taken up into the cement during topical fluoride treatment and released again ,thus GIC act as fluoride reservoir.



FLUORIDE RE-CHARGING OF GLASS IONOMERS

- Fluoride release exponentially declines to low levels (0.5-2.0 ppm typically)
- **Re-charging Fluoride** absorption from other sources into GIC materials for re-release later
- Re-charging -- occurs when F can readily diffuse from high-to-low concentrations
- Re-charging strategies:

1. Use daily fluoride rinses to provide F source for re-charging
2. Use F toothpastes for re-charging
3. Use topical fluorides for re-charging



FLUORIDE RELEASE FROM VARIOUS PRODUCTS

CEMENT TYPE	14 DAYS	30 DAYS
CERMET	200 µg	300 µg
SILVER ALLOY ADMIX	3350 µg	4040 µg
TYPE I GIC	470 µg	700 µg
TYPE II GIC	440 µg	650 µg
GIC LINER [conventional]	1000 µg	1300 µg
GIC LINER [Light cure]	1200 µg	1600 µg

MANIPULATION

DISPENSING AND MIXING

POWDER AND LIQUID

CLICKER DISPENSERS

ENCAPSULATED DISPENSERS

NOZZLE TYPE

1.PREPARATION OF TOOTH SURFACE

- The enamel & dentin are first cleaned with pumice slurry followed by swabbing with polyacrylic acid for 5 sec. After conditioning & rinsing ,tooth surface should isolate & dry.

2.PROPORTIONING & MIXING

- Powder & liquid ratio is 3:1 by wt. Powder & liquid is dispensed just prior to mixing.
- Mixing is done by plastic spatula because metal spatula may react with glass particles of gic.
- First increment is incorporated rapidly to produce a homogenous milky consistency.
- Mixing done in folding method to preserves gel structure.
- Finished mix should have a glossy surface.

3. PROTECTION OF CEMENT DURING SETTING

- Glass ionomer cement is extremely sensitive to air & water during setting.
- Immediately after placement into cavity, preshaped matrix is applied to it.

4. FINISHING

- Excess material should be trimmed from margins.
- Hand instruments are preferred to rotary tools to avoid ditching.
- Further finishing is done after 24hrs.

5.PROTECTION OF CEMENT AFTER SETTING

- Before dismissing the patient ,restoration is again coated with the protective agent to protect trimmed area.
- Failure to protect for first 24hrs results in weaken cement.

DIFFERENT TYPES OF SURFACE CONDITIONERS USED ARE

1. POLYACRYLIC ACID

- 10% polyacrylic acid for 10 seconds.
- It removes surface debris and smoothens out irregularities.
- It tends to open up dentinal tubules.
- It is the conditioner of choice as it is a part of the cement forming system.

-Textbook Of Manappalli 4th Edition

2. CITRIC ACID

50% citric acid for 5 seconds was the earliest conditioner used

3. TANNIC ACID

25% for 30 seconds.

4. FERRIC CHLORIDE

2% solution provides metal linkage between collagen and GIC without opening up dentinal tubules.

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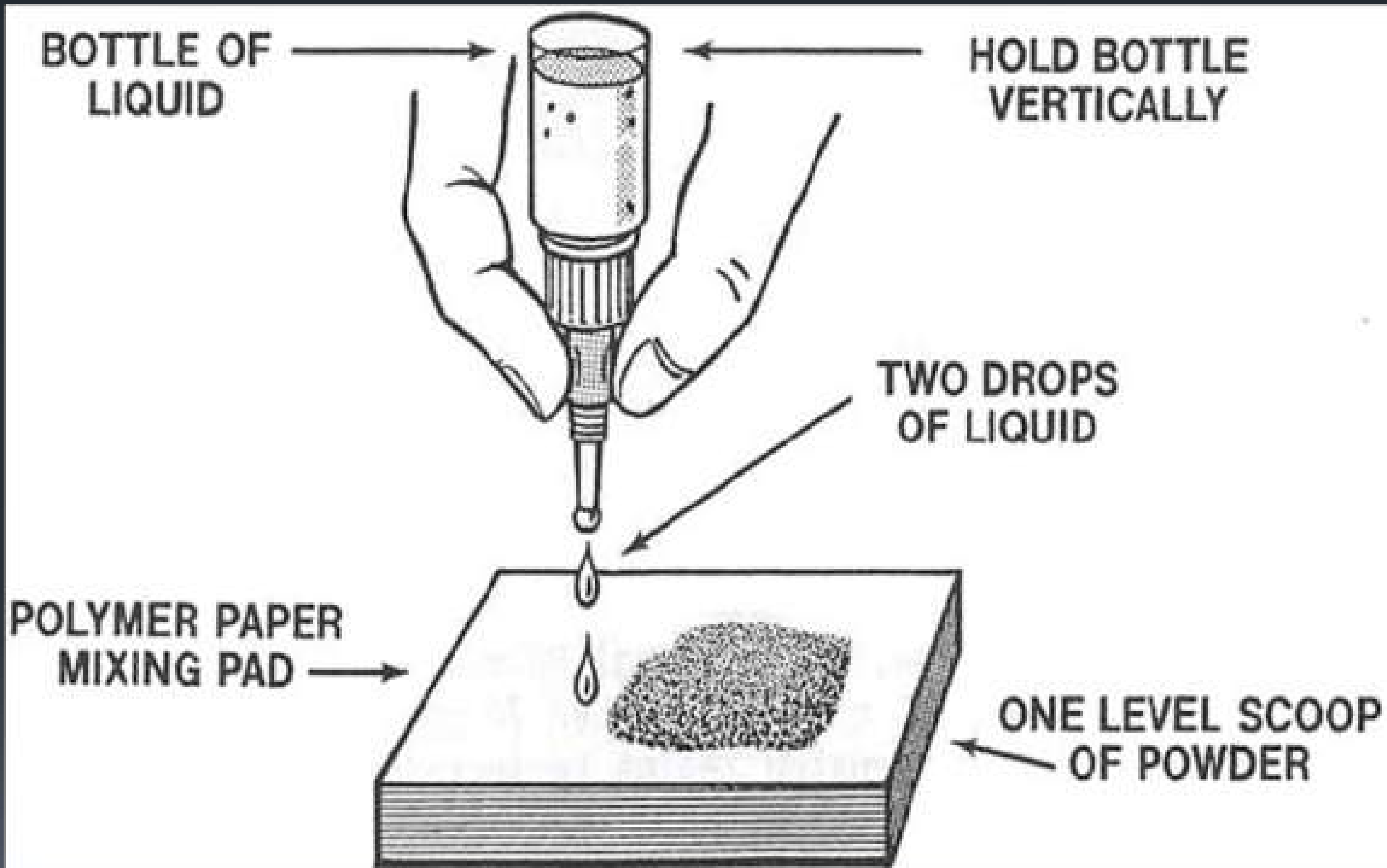
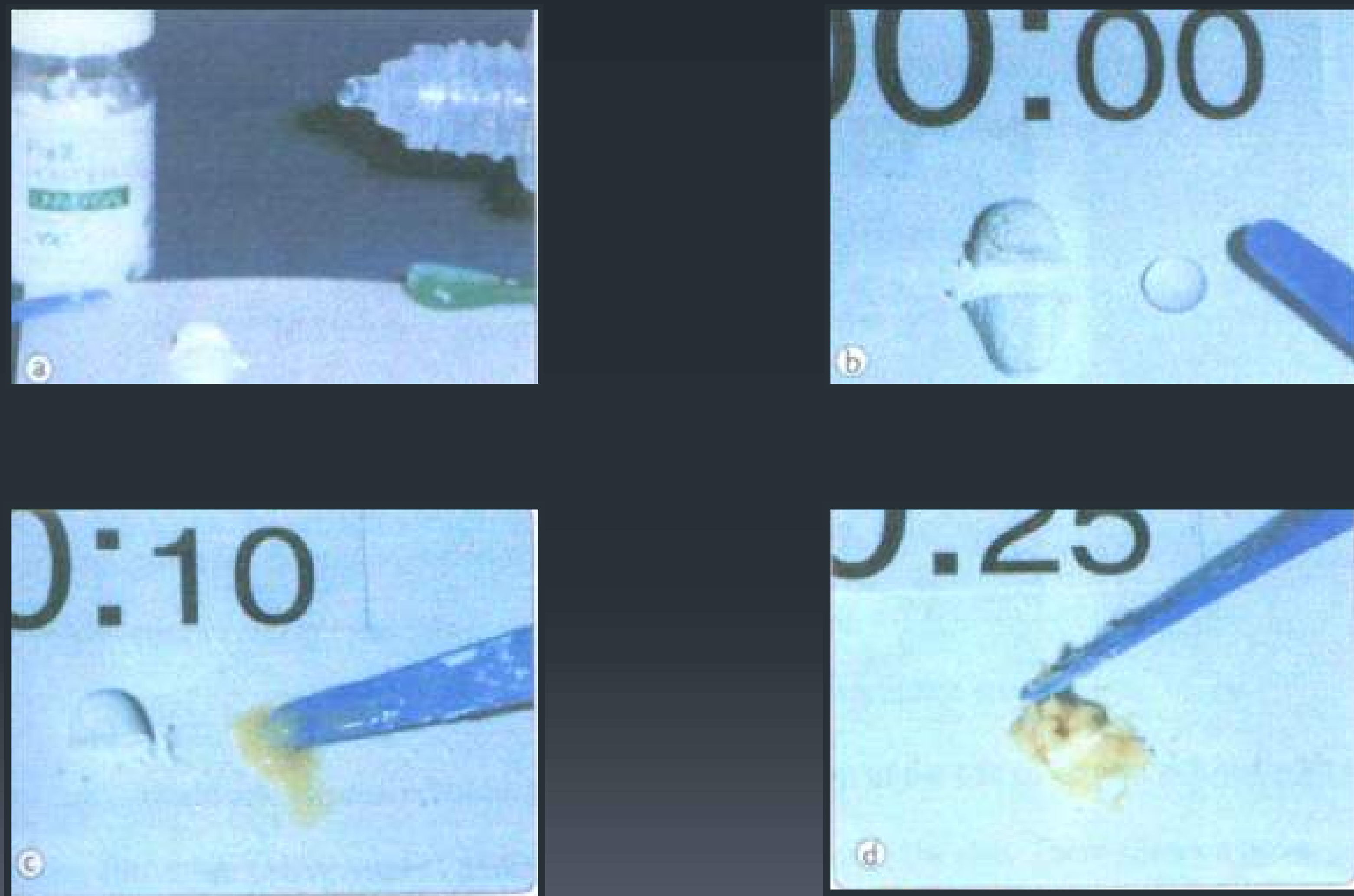

BOTTLE OF
LIQUID
HOLD BOTTLE
VERTICALLY
TWO DROPS
OF LIQUID
POLYMER PAPER
MIXING PAD
ONE LEVEL SCOOP
OF POWDER

MANIPULATION OF GIC



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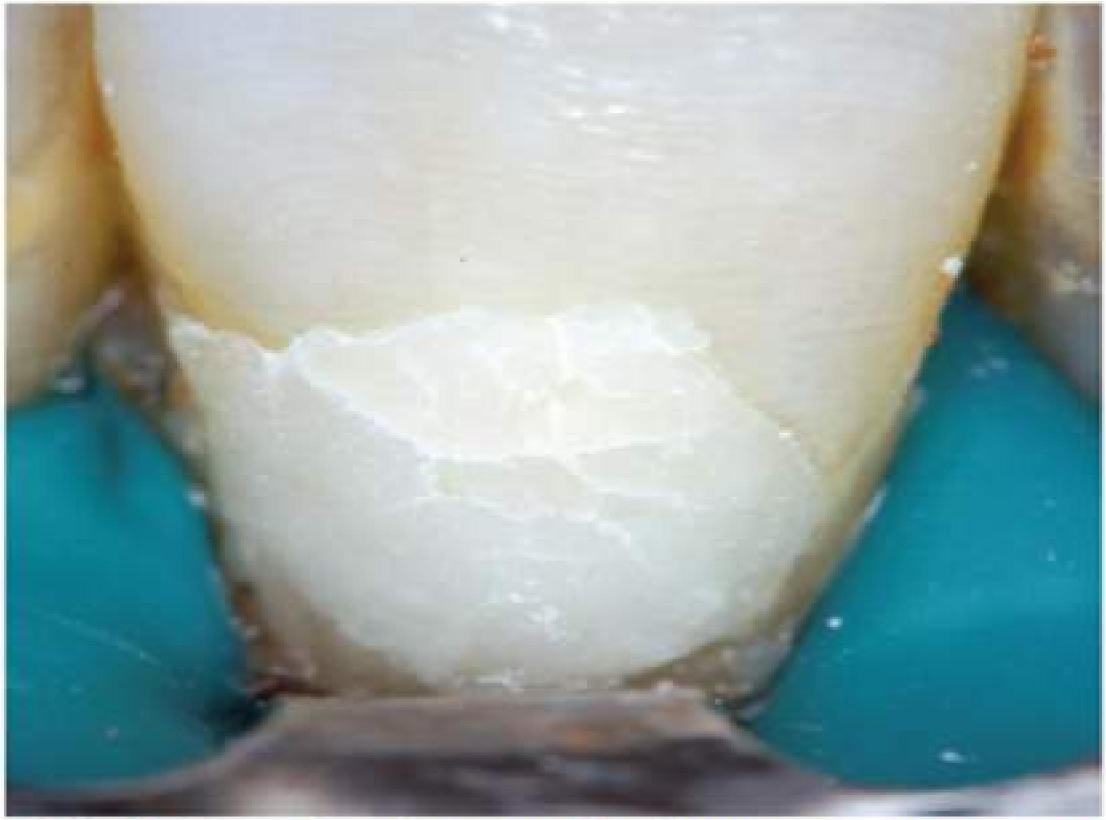

FIGURE 14-18 Crazed surface on glass ionomer restorations resulted from inadequate protection of the material during maturation. (Courtesy of Dr. S. Geradeli.)

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SANDWICH TECHNIQUE

- Devolped by Mclean
- To combine the beneficial properties of GIC & composite
- Also known as layering or stratification

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CLINICAL STEPS:-

- After cavity preparation, condition the cavity to develop good adhesion with GIC.
- Place Type III GIC into prepared cavity and after setting, etch the enamel & GIC with Ortho phosphoric acid for 15 seconds.
- This will improve micromechanical bond to composite resin.
- Apply a thin layer of low viscosity enamel bonding agent & finally place the composite resin over GIC & light cure it.


Sandwich Technique

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ADVANTAGES

- Polymerisation shrinkage is less,due to reduced bulk of composite.
- Favorable pulpal response.
- Chemical bond to the tooth.
- Anticariogenic property.
- Better strength,finishing,esthetics of overlying composite resin.

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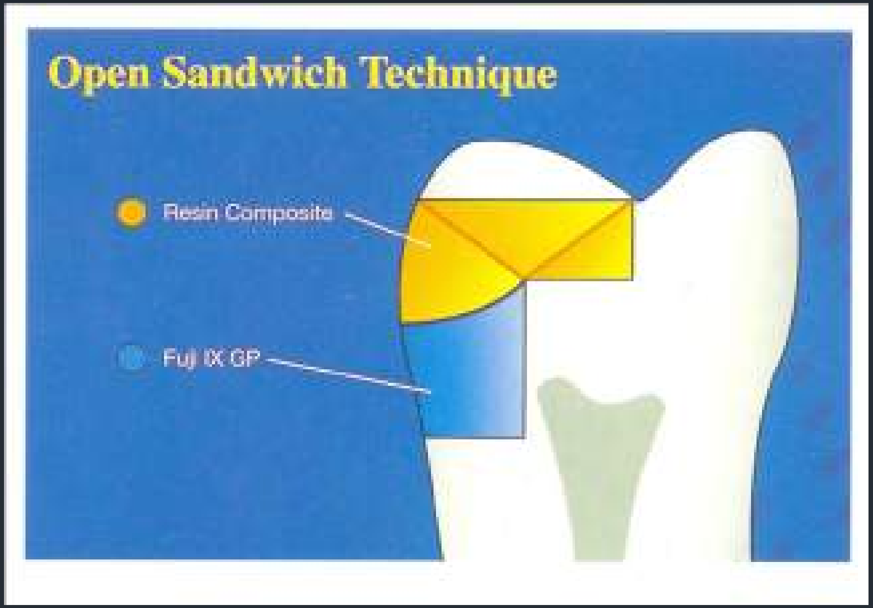
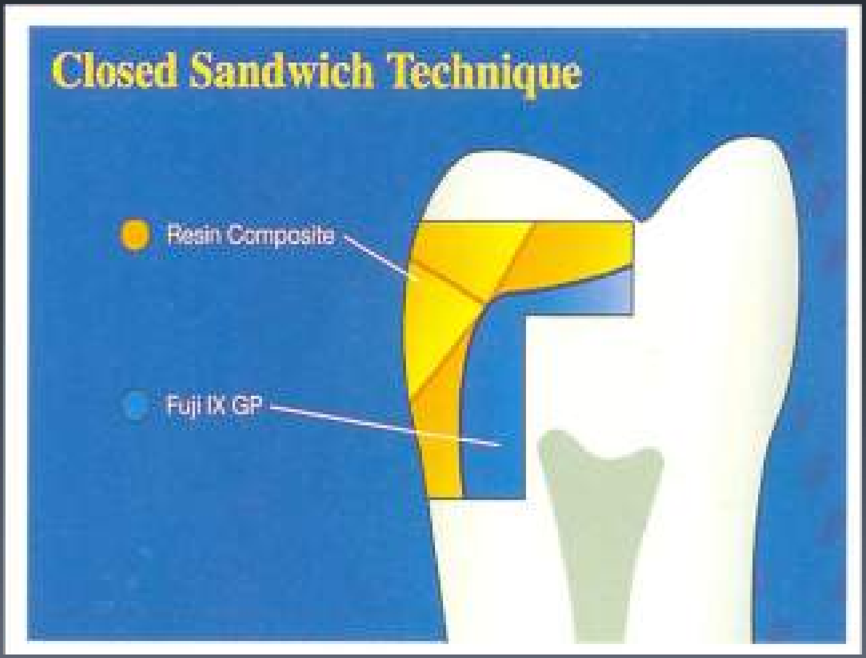
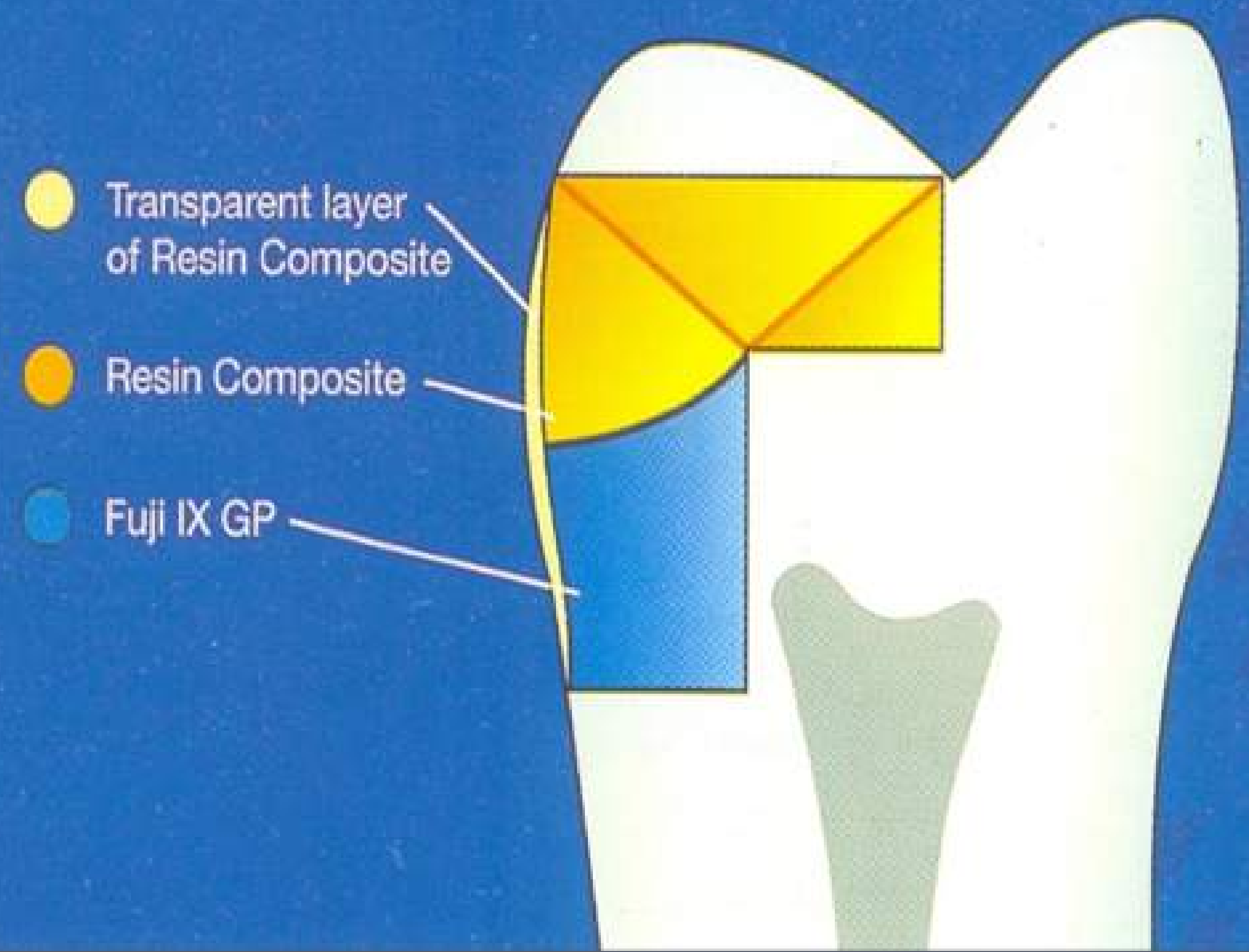


In the open technique, the GIC is used to replace the dentin and also fill the cervical part of the box, which results in a part of the GIC being exposed to the oral environment. Use the "open sandwich" technique when there is no remaining enamel at the gingival margin

In the closed technique, the dentin is covered by the GIC, which is in turn completely covered by the overlaying composite. Use the "closed sandwich" technique when there is remaining enamel at the gingival margin



Centripetal Build Up Technique



MODIFIED GLASS IONOMERS

Over the years glass ionomer has been modified by manufacturers in order to compensate for some of their deficiencies. This has resulted in new products.

The modified glass ionomers are:

1. Metal modified GIC
2. Resin modified GIC

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1. METAL MODIFIED GLASS IONOMER CEMENT

They have improved the strength, fracture toughness and resistance to wear and yet maintained the potential for adhesion and anticariogenic property.

Two methods are employed

1. Silver alloy admixed Spherical amalgam alloy powder is mixed with restorative type GIC powder (Miracle Mix).

2. Cermet Silver particles are bonded to glass particles. This is done by sintering a mixture of the two powders at a high temperature (Ketac-Silver).

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2. Resin Modified Glass-Ionomer Cements

A dimethyl methacrylate monomer, hydroxyethyl methacrylate (HEMA) is grafted in the polyacrylic acid.

The presence of unsaturated carbon-carbon bonds enables the covalent cross-linking of the matrix.

With the exposure of light, polymerization is initiated along the methacrylate groups. After that the polyacrylic acid reacts with glass particles though acid base reaction.

Fuji II LC is one commercial preparation of resin modified glassionomer

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These materials were developed to overcome some of the drawbacks of conventional GIC like

1. Moisture sensitivity
2. Low initial strength
3. Fixed working times.

TYPES

1. Resin-modified glass ionomer cement (RMGI), e.g. Fuji II LC, Vitremer, Photac Fil

2. Compomers or polyacid-modified composites (PMC), e.g. Dyract Variglass VLC

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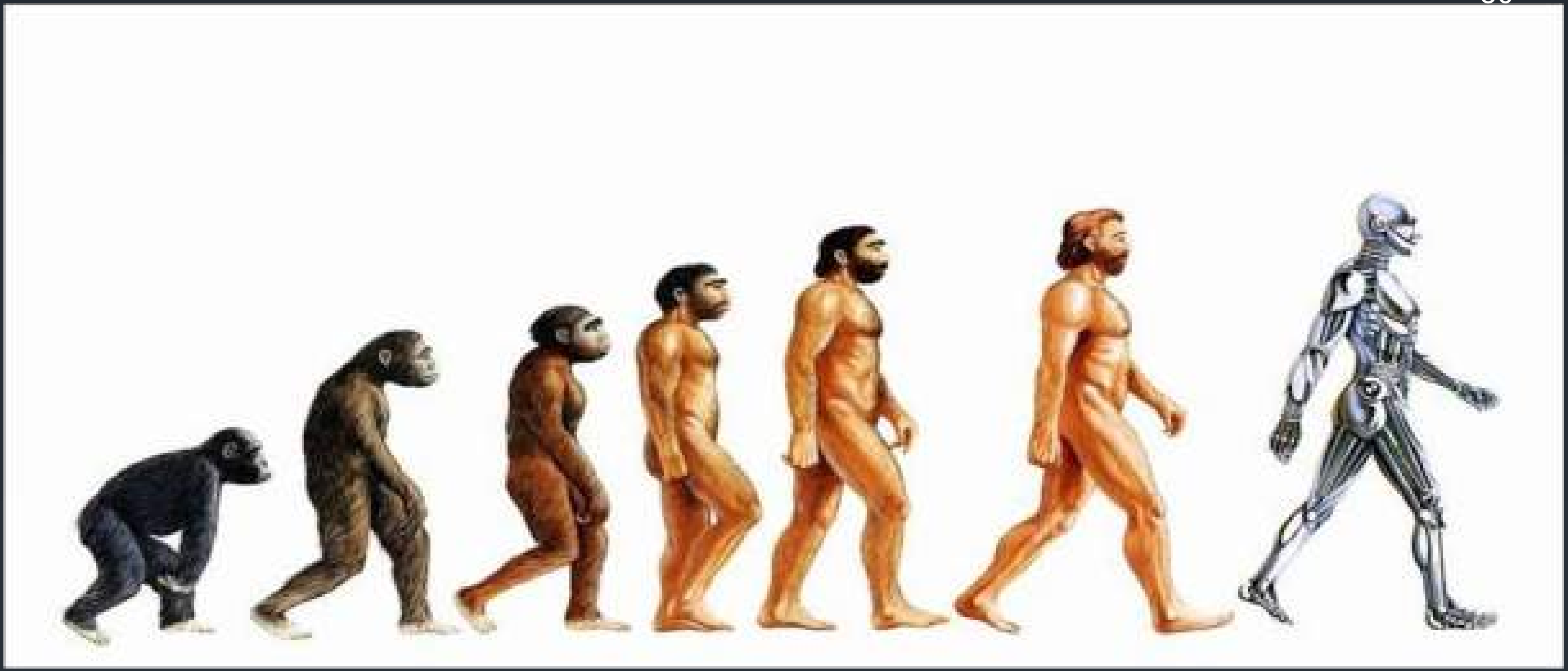

RECENT ADVANCES IN GLASS IONOMER CEMENT

- Compomers
- Condensable / Self-hardening GIC
- Flowable GIC
- The Bioactive glass
- Fibre reinforced GIC
- Giomers
- Hainomers

- Chlorhexidine impregnated GIC
- Proline containing GIC
- Zirconia containing GIC
- Nano bioceramic modified GIC
- Calcium aluminate GIC

COMPOMERS

- Compomer can be defined as a material that contains both the essential components of GIC but at levels insufficient to promote the acid –base curing reaction in the dark
- Compomer is a combination of the word ‘comp’ for composite “omer” for ionomer.
- Though introduced as a type of GIC, it became apparent in terms of clinical use and performance and it is best considered as a composite

Properties:

- **ADHESION**: to tooth requires acid –etching as acid base reaction for ion exchange which requires water and does not occur for some time after placement. Bond strengths achieved usually approach the typical resin bonding systems. It is = 18-24Mpa

- **FLUORIDE RELEASE**: is limited. It is significantly less than Type II or RMGIC. F release usually starts after about 2-3 months; it peaks initially and then falls rapidly

- **PHYSICAL PROPERTIES**: Fracture toughness, Flexural strength and Wear resistance are better than GIC but less than composite.

INDICATIONS

- P& F sealant
- Restoration of primary teeth, class III and V lesions along with cervical abrasions and erosions and intermediate restorations
- Bases for composites, liners
- Small core build ups
- Filling undercuts in old crown preparations
- Root surface sealing

CONTRAINDICATIONS

- Class IV lesions
- Conventional class II cavities
- Lost cusp areas
- Restorations involving large labial surface

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

- *Fluoride Release and Rechargability*

GICs>RMGICs>PAMCRs

- *Wear Resistance*

PAMCRs>GICs>RMGICs

- *Strength*

PAMCRs>RMGICs>GICs

- *Ease of Handling*

PAMCRs>RMGICs>GICs

- *Polishability and Esthetics*

PAMCRs>RMGICs>GICs

SELF-HARDENING RESIN GLASS IONOMER CEMENTS

- This is another recent development in resin – modified glass ionomer Luting cements. These contain certain monomers with initiators to allow self polymerization similar to those used in cold-cure acrylics It mainly contains benzoyl peroxide and amine added to the glass Ionomer.

IMPROVED TRADITIONAL GLASS IONOMERS

HIGHLY VISCOUS GLASS IONOMER

- Due to the possibility of reduced secondary caries by fluoride release and to the comparative ease of use of conventional glass ionomers, further developments have been made for posterior restorations in primary and permanent dentition.

- This material was developed largely as a response to the need for filling materials in the Atraumatic Restorative Therapy or “ART”.

The Low Viscosity/Flowable GIC –

As lining, pit and fissure sealing , endodontic sealers , sealing of hypersensitive cervical areas and has increase flow.eg: Fuji lining LC, Fuji III and IV

Hainomers:

These are newer bioactive materials developed by incorporating hydroxyapatite within glass ionomer powder. These are mainly being used as bone cements in oral maxillofacial surgery and may a future role as retrograde filling material. They have a role in bonding directly to bone and affect its growth and development

BIOACTIVE GLASS IONOMER CEMENT

- This idea was developed by Hench and co in 1973.
- It takes into account the fact that on acid dissolution of glass, there is formation of a layer rich in Ca and PO4 around the glass, such a glass can form intimate bioactive bonds with bone cells and get fully integrated with the bone.
- It is being used experimentally as Bone cement, Retrograde filling material, For perforation repair, Augmentation of alveolar ridges in edentulous ridges , implant cementation, Infra- bony pocket correction

Fibre reinforced Glass ionomer cement

- The incorporation of alumina fibres and other fibres such as glass fibre, silica fibre, carbon fibre etc to the existing glass fibre at suitable filler/glass ratio was tried mainly to improve the flexural strength of cement

- Unfortunately these composite materials are difficult to mix if sufficient quantity of fibre is used to produce a significant increase in strength

- In addition resistance to abrasion decreases due to lack of bonding between fibres and matrix

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GIOMERS

True hybridization of GIC and composite . But here pre-reacted GIC powder is dispersed phase within compomer. Combine fluoride release and fluoride recharge of GIC esthetic & easy polishable

INDICATIONS

- Class I, II, III, IV, and Class V cavities
- Restoration of cervical erosion and Root caries
- Laminates and core build up
- Restoration of primary teeth.
- Repair of fracture of porcelain and composites

Chlorhexidine impregnated GIC

It is developed to increase the anticariogenic action of GIC. Still under experimental stage. Experiments conducted on cariogenic organisms

Proline Containing Glass Ionomer Cement

- Amino acid-containing GIC
- Had better surface hardness properties than commercial Fuji IX GIC.
- This formulation of fast-set glass ionomer showed increased water sorption without adversely affecting the amount of fluoride release. Considering its biocompatibility, this material shows promise not only as a dental restorative material but also as a bone cement with low cytotoxicity

Zirconia containing GIC

A potential substitute for miracle mix. The diametral tensile strength of zirconia containing GIC significantly Greater than that of Miracle mix due to better interfacial bonding Between the particles and matrix.

Calcium Aluminate GIC

- A hybrid product with a composition between that of calcium aluminate and GIC
- It is designed for luting fixed prosthesis.

- component is made by sintering a mixture of high-purity Al_2O_3 and CaO (approximately 1 : 1 molar ratio) to create monocalciumaluminate.

- The main ingredients are calcium aluminate, polyacrylic acid, tartaric acid, strontium-fluoro-alumino-glass, and strontium fluoride.

-The liquid component contains 99.6% water and 0.4% additivesfor controlling setting. The calcium aluminate contributes to a basic pH during curing, reduction in microleakage, excellent biocompatibility, and long-term stability andstrength.

FUJI VII COMMAND SET

- Appear Pink on setting
- Pink shade absorbs light energy and accelerates setting
- Advantages -
- 6 times is the fluoride release
- Antibacterial properties
- Setting time– 4 min

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NANOIONOMER

The latest advancement in resin-modified glass ionomers is the nanoionomer available commercially since 2007

it is a resin-modified glass ionomer in which some nanoparticles such as nanomers and nano clusters are added to the glass

Like all RMGIs, it has an aqueous component with a polycarboxylic acid and water-miscible methacrylate monomers

The addition of nanoparticles improves the polishability and the optical characteristics of the cured ionomer

The fluoride release is not compromised

There is presence of significant acid-base reaction

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CONCLUSION

- Many years have passed by since the glass ionomer cement was first invented and it has been a popular material from the time it was introduced into the market.

- Even though the stronger and more esthetic materials were available, glass ionomer restorations still remained the choice of many practitioners because they satisfy many of the characteristics of ideal cement.

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