

GLASS IONOMER CEMENTS



- POLYALKENOATE CEMENT
- GIC
- ASPA (*ALUMINO SILICATE POLYACRYLIC ACID*)
- MAN MADE DENTIN (*DENTIN SUBSTITUTE*)

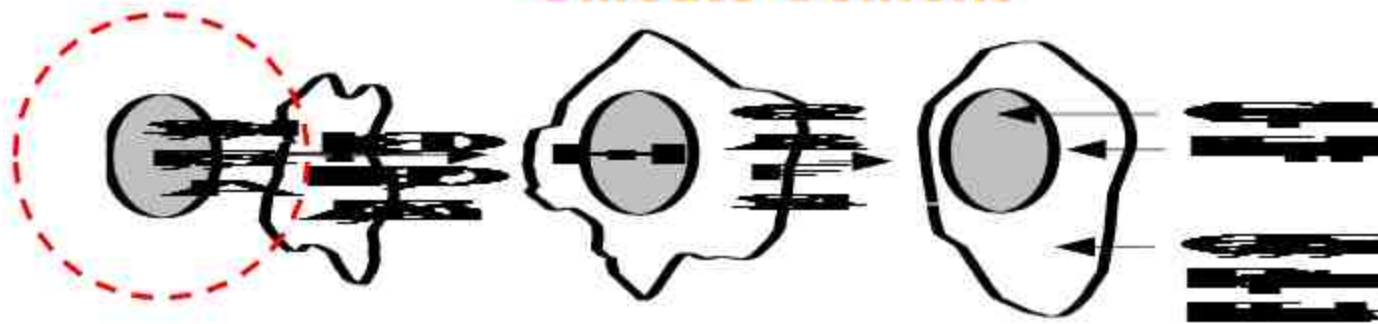
DEVELOPMENT

- Invented in late 1969
- First reported in England by Wilson & Kent in 1971
- The term Glass Ionomer Cement was coined by B.E.Kent

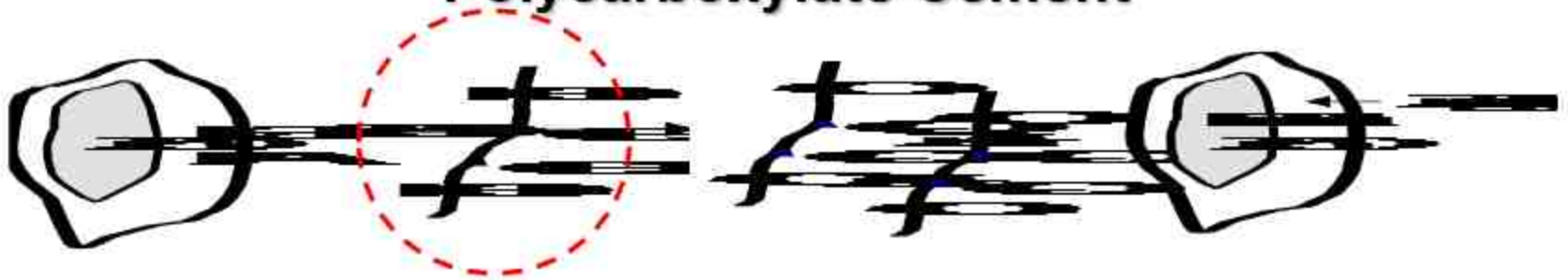
GLASS IONOMERS

HYBRID = SC [Powder] and PCC [Liquid] = A.S.P.A.

Silicate Cement



Polycarboxylate Cement



- **ASPA I (Wilson & Kent 1969) :**
first clinical trial
high in fluoride (G -200)
slow setting
minimal working time
almost opaque
- **ASPA II (Crisp & Wilson 1972) :**
Tartaric acid
improved manipulation
extending working time
sharpening setting time
liquid tended to gel



- **ASPA IV (Crisp & Wilson 1973)** : first marketable material (class I , fissure sealing)
copolymer of acrylic & itaconic acid
- **ASPA IV a (1977)** : luting version
fine grain
- **ASPA X (Crisp, Abul, Wilson 1979)** : approximal lesions, minimal cavity preparation (buccal approach; Mclean 1980)
improved translucency

- **ASPA V (1982) : water-activated/ water-settable cement**
- **ASPA V a : water hardening luting agent**
- **Metal reinforced glass ionomer (Sced, Wilson 1980; Simmons 1983) : improved the strength**
- **Cermet (Mclean, Gasser 1985) :**
improved wear resistance
radiopacity
burnishability & smoother surface

Wygant(1958) & Wilson (1978)

The glass ionomer cement is an unusual material with unusual properties. It is neither purely organic nor purely inorganic but a hybrid of both. It is neither a polymer nor a hydraulic cement but sets by chemical gelation as a result of a reaction between an acid and a base.

This class of cement sets, as the name implies, as a result of reaction between an acid and base; the product of the reaction, a hydrogel salt, acts as a binding matrix.

Anusavice

Glass ionomer is the generic name of a group of materials that use silicate glass powder & aqueous solution of polyacrylic acid. Also known as the Polyalkenoate cement

CLASSIFICATION

Wilson & McLean 1988

Type I Luting cements

Type II Restorative cements

a) Restorative aesthetic

b) Restorative Reinforced

Anusavice

Type I Luting cements

Type II Restorative cements

Type III Liners and bases

McLean et al 1994

- 1) Glass Ionomer cement
- 2) Resin modified Glass Ionomer cement
- 3) Polyacid Modified Composite Resins

Newer classification

1. Traditional glass ionomer

- a) Type I Luting cement
- b) Type II Restorative cement
- c) Type III Liners & Bases

2. Metal modified glass ionomer

- a) Miracle Mix
- b) Cermet

3. Light cure glass ionomer

4. Hybrid/resin modified glass ionomer

- a) Composite resin in which fillers substituted with glass ionomer particles
- b) Pre-cured blended into composites

ACCORDING TO APPLICATION

- Type1 - luting cements
- Type2 - restorative
- Type3 - lining and base cements
- Type4 - fissure sealant
- Type5 - orthodontic cement
- Type6 - core build up cements
- Type7 - temporary command set
- Type8 - aesthetic restorations
- Type9 - posterior restorative cements, ART

COMPOSITION

Glass component

Developed on the basis of silicate cement

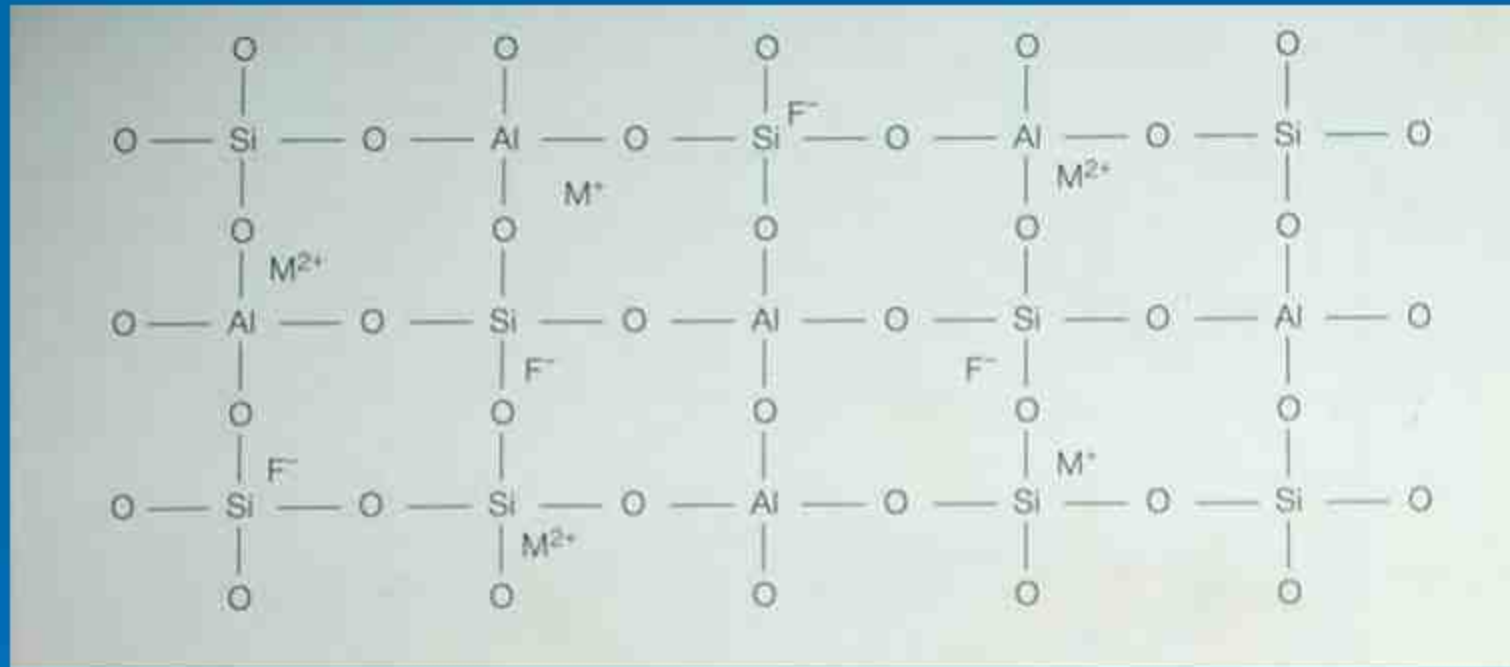
Calcium aluminosilicate glass containing fluoride (*ion leachable glass*)

POWDER

INGREDIENT	(%)	ACTION
➤ Silica	(35-50%)	main ingredient
➤ Alumina	(20-30%)	strength and flux
➤ Aluminum fluoride	(1.5-2.5%)	anti cariogenic
➤ CaFluoride	(15-20%)	anti cariogenic
➤ Naflouride	(3-6%)	anti cariogenic
➤ Al phosphate	(4-12%)	matrix formation

Other ions : La, Sr, Ba (radiopacity)

Skeletal structure of glass TETRAHEDON



➤ **Fluoride :**

total 10 -23 %

essential component

lowers the temperature of fusion

improves the working characteristics

increases the strength of the set cement

in moderate amounts enhances translucency

releases fluoride

- Glasses are prepared by fusing the components between 1100°C – 1500°C
- Ground, sieved, crushed

Particles between 4 - 50 microns

Glasses high in silica are more translucent

Al₂O₃ : SiO₂ ratio is crucial (1: 2)

Further increase in ratio renders glass more basic & reactive & so reduces the setting time

Increase in alumina content increases the compressive strength but decreases the translucency.

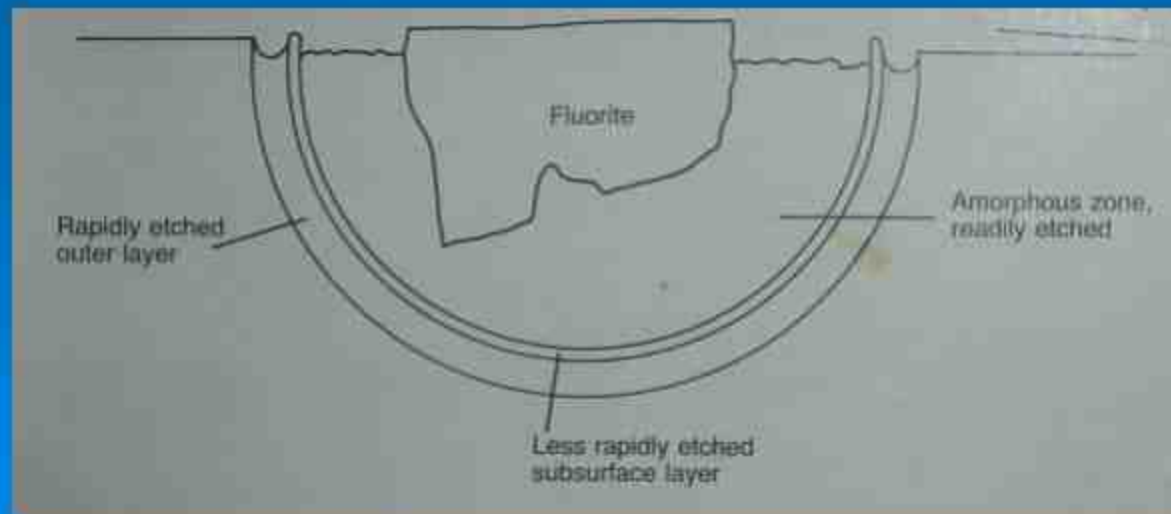
- Cryolite (Na_3AlF_6) : flux
improves translucency
- AlPO_4 : adds body to the cement
improves translucency

Glass Structure

➤ Barry et al 1979

Phase-separated glass droplets :

- calcium-rich
- crystalline core of calcium fluoride surrounded by amorphous phase rich in Ca but containing Al and Silicon.



➤ **Treatment of glasses :**

Washing glasses with mineral or organic acids has been advocated in order to reduce the concentration of calcium at the surface of phase-separated droplets in the glass.

This process reduces the amount of calcium extracted during the early stages of the reaction, and so prolongs the working time

Liquid component

The acid is a polyelectrolyte , which is a homopolymer or copolymer of unsaturated carboxylic acids known scientifically as alkenoic acids.

Poly acrylic acid is most commonly used

LIQUID

- Polyacrylic acid (40-55%)
- Itaconic acid/Maleic acid/
Tricarboxylic acid (5%)
- Tartaric acid traces
- Water (50%)

- Poly acid may be in form of concentrated aqueous solution (40% - 50%) or blended dry with the glass powder.

- Anhydrous cements: water or diluted tartaric acid
 - Higher mol.wt of acid can be incorporated
 - Fine film thickness can be obtained
 - Improved physical properties
 - Improved shelf-life

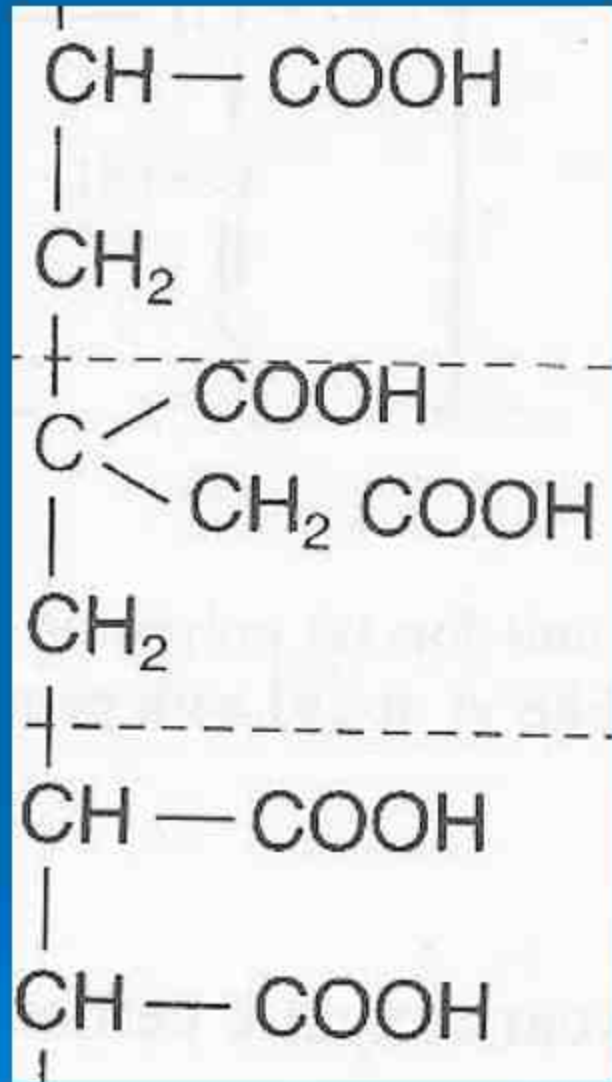
➤ Gelation

ASPA II : was not suitable

Slow increase in hydrogen bonding between poly (acrylic) acid chains.

Crisp (1974) : methyl alcohol (ASPA III)

Crisp, Wilson (1977) : copolymer of acrylic and itaconic acids



ACRYIC ACID

ITACONIC ACID

MALEIC ACID

➤ Itaconic acid :

- promotes reactivity between the glass and the liquid.
- prevents gelation of the liquid which can result from hydrogen bonding between two polyacrylic acid chains.

➤ Polymaleic acid :

- a stronger acid than polyacrylic acid
- causes the cement to harden and lose its moisture sensitivity faster.
- This occurs because polymaleic acid has more carboxyl (COOH) groups which lead to more rapid polycarboxylate crosslinking.

Tartaric acid: 1976 (Wilson & coworkers) :

- "fourth important component".
- The other three are the powder, polyacids, and water
- Renders workable cement pastes
- Improved rheologic property (decreased viscosity)
- Sharpens the set without shortening the working time (aids in the extraction of ions from aluminosilicate glass & facilitates their binding to the polyacid chain)
- In moderate amounts increases strength
- Enabled the fluoride content of the glass to be reduce(hence improved translucency)

Glass composition affects

- Working characteristics
- Setting time
- Resistance to erosion
- Strength
- Aesthetics

Effect of nature of poly (alkenoic acid) on cement properties

The higher the molecular weight of the poly acid , the higher will be the strength of the cement.

However, there is increase in viscosity of the mix.

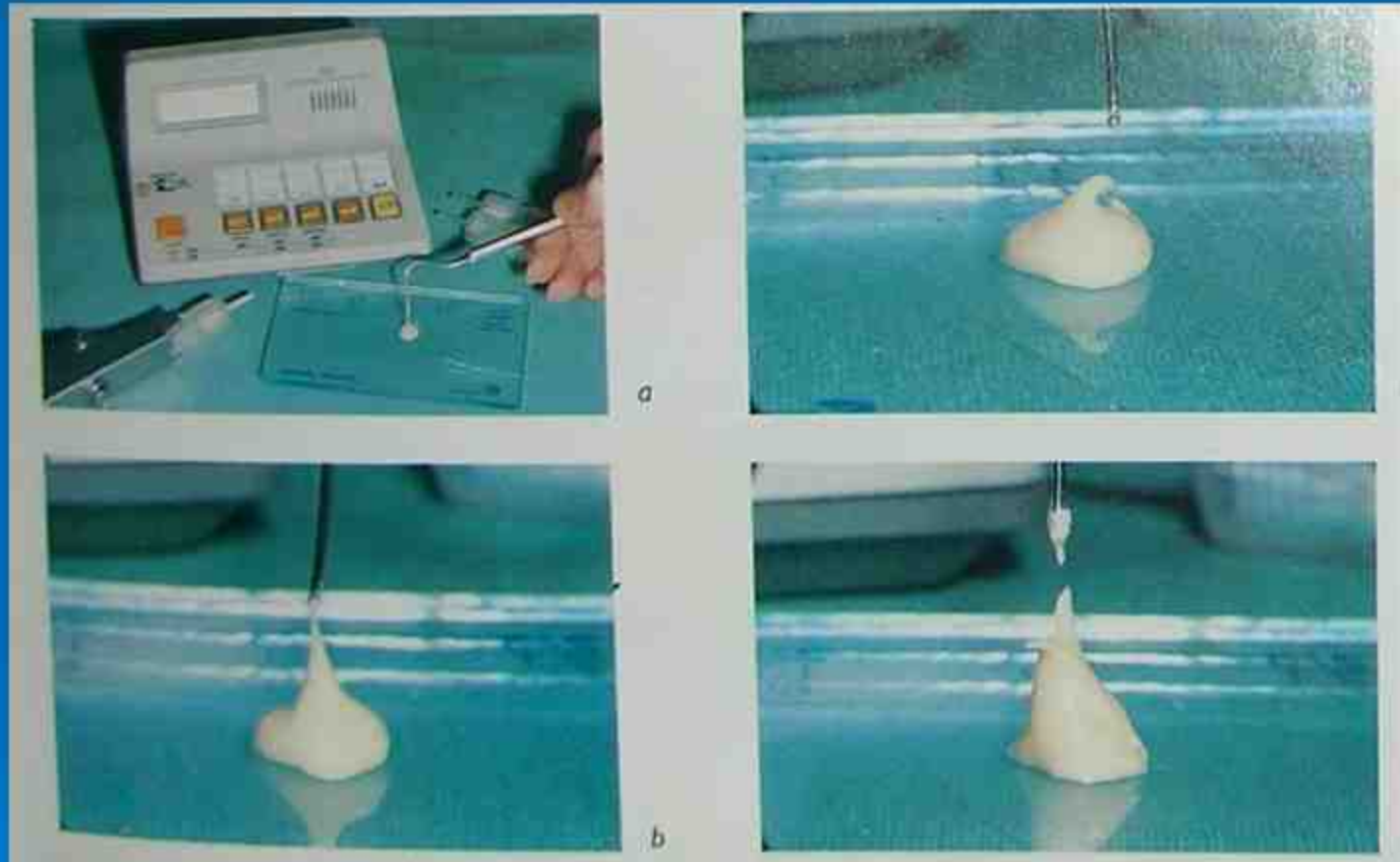
Packaging and Dispensing

- Two Component system : powder, liquid
- Capsulated form
- Powder and water (water – settable cements)
- Light cure system

Mechanical mixing

- Trituration of glass ionomer cement capsules is done for a recommended time (10 sec) in
 - ❑ High- speed amalgamators : 3000 cycles/min
 - ❑ Ultra high- speed amalgamators : 4000 cycles/min
- Consistent control over the P:L ratio
- Elimination of variation with hand spatulation
- Capsule will act as a syringe for placement of material into the cavity

Mechanical mixing



“Loss of gloss” or Slump test

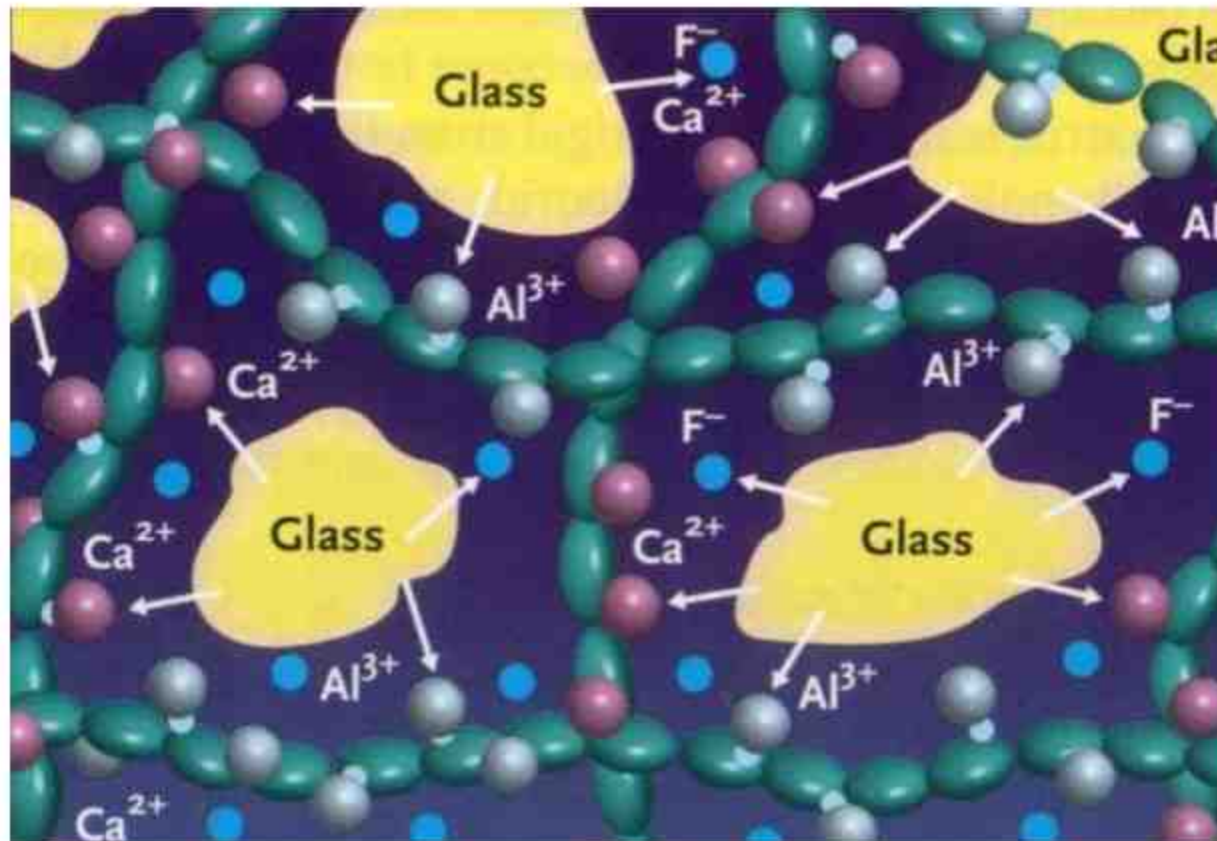
Hand Mixing

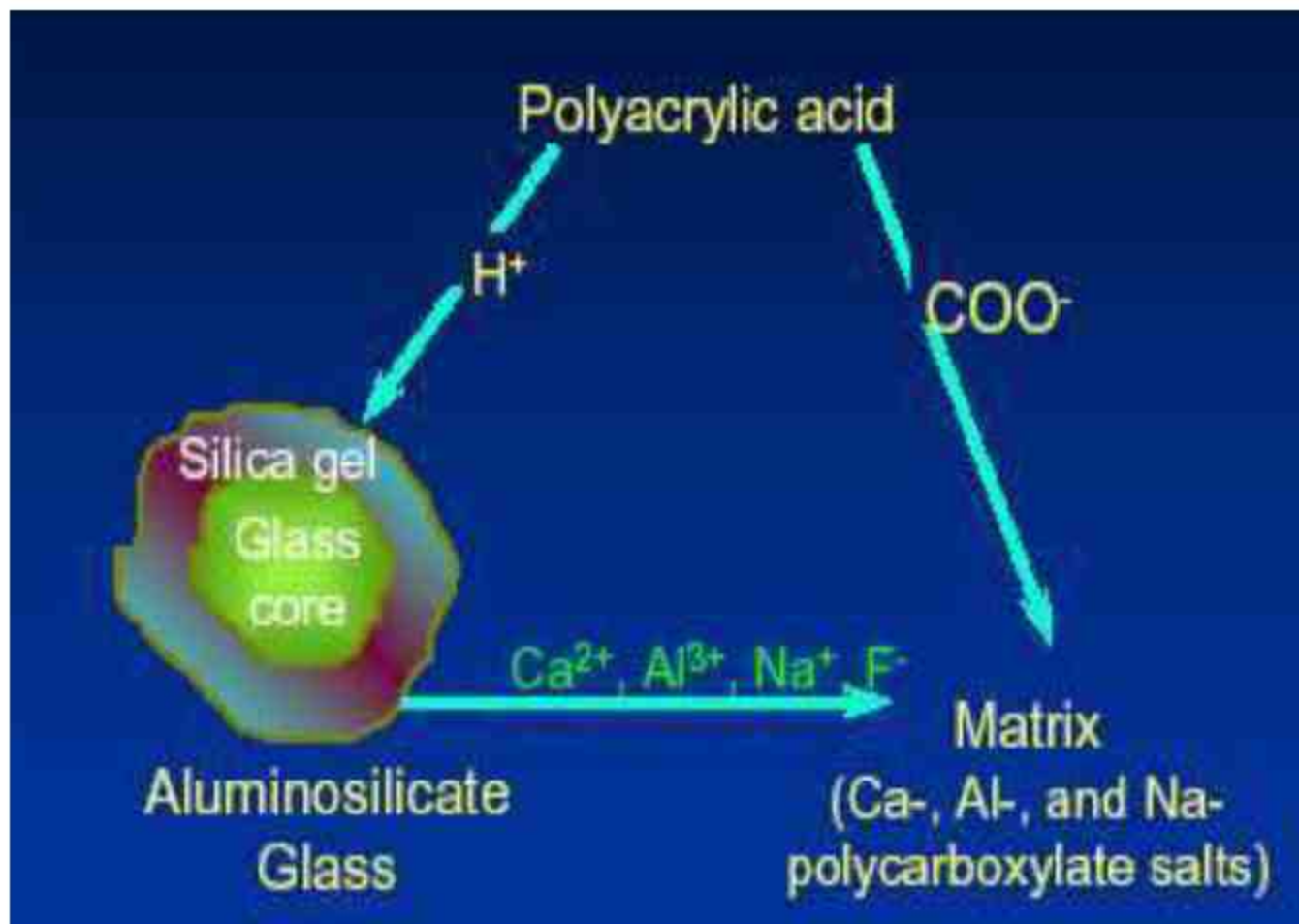
- A paper-pad or a cool dry glass slab can be used to extend the working time.
- Rapid incorporation of powder into the liquid by folding method using a stiff plastic spatula.
- 45- 60 sec
 - *Greater latitude in controlling the amount of cement needed.*
 - *Ensures a better shade matching ability by adjusting the amount of existing powder*

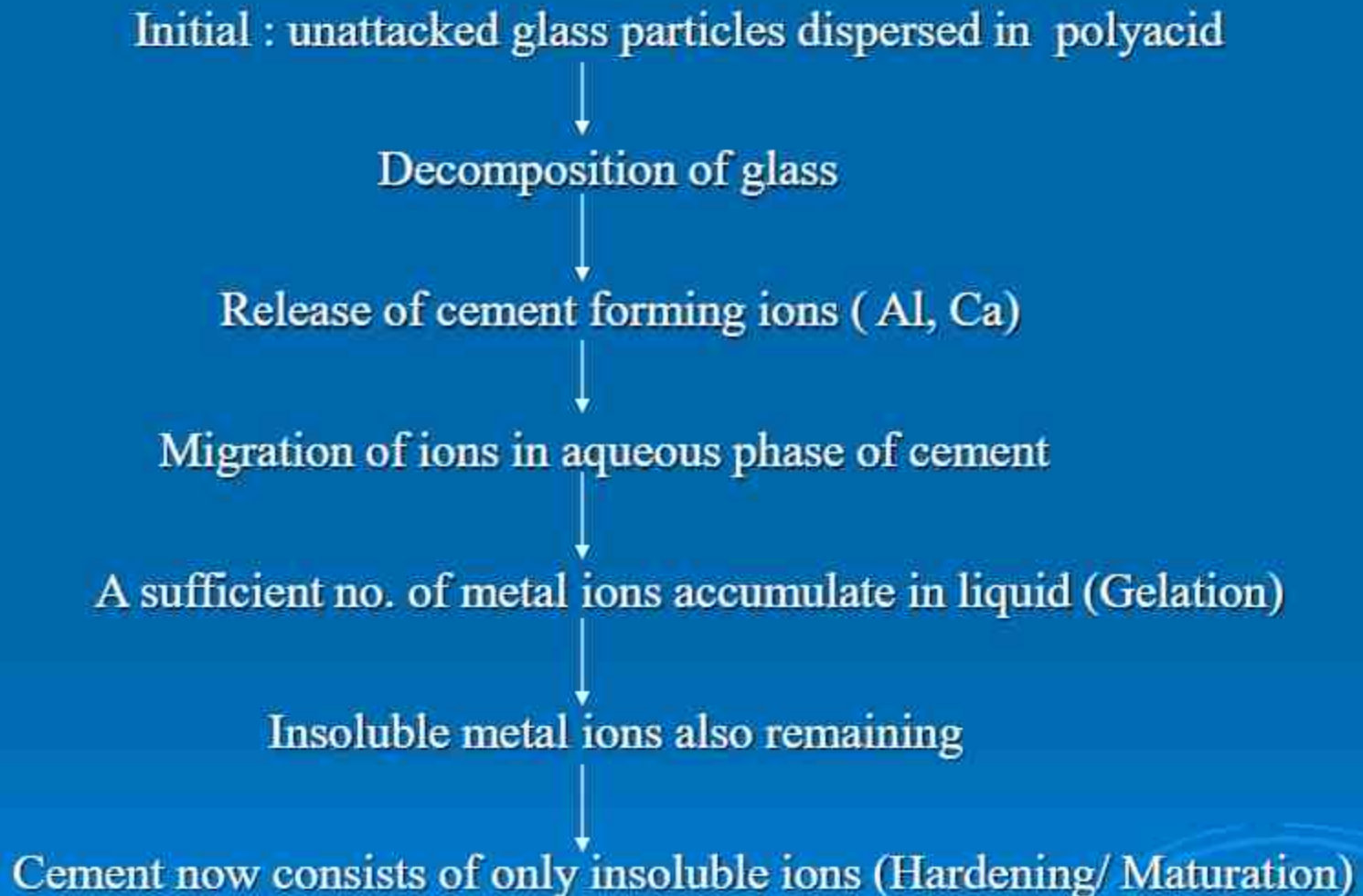


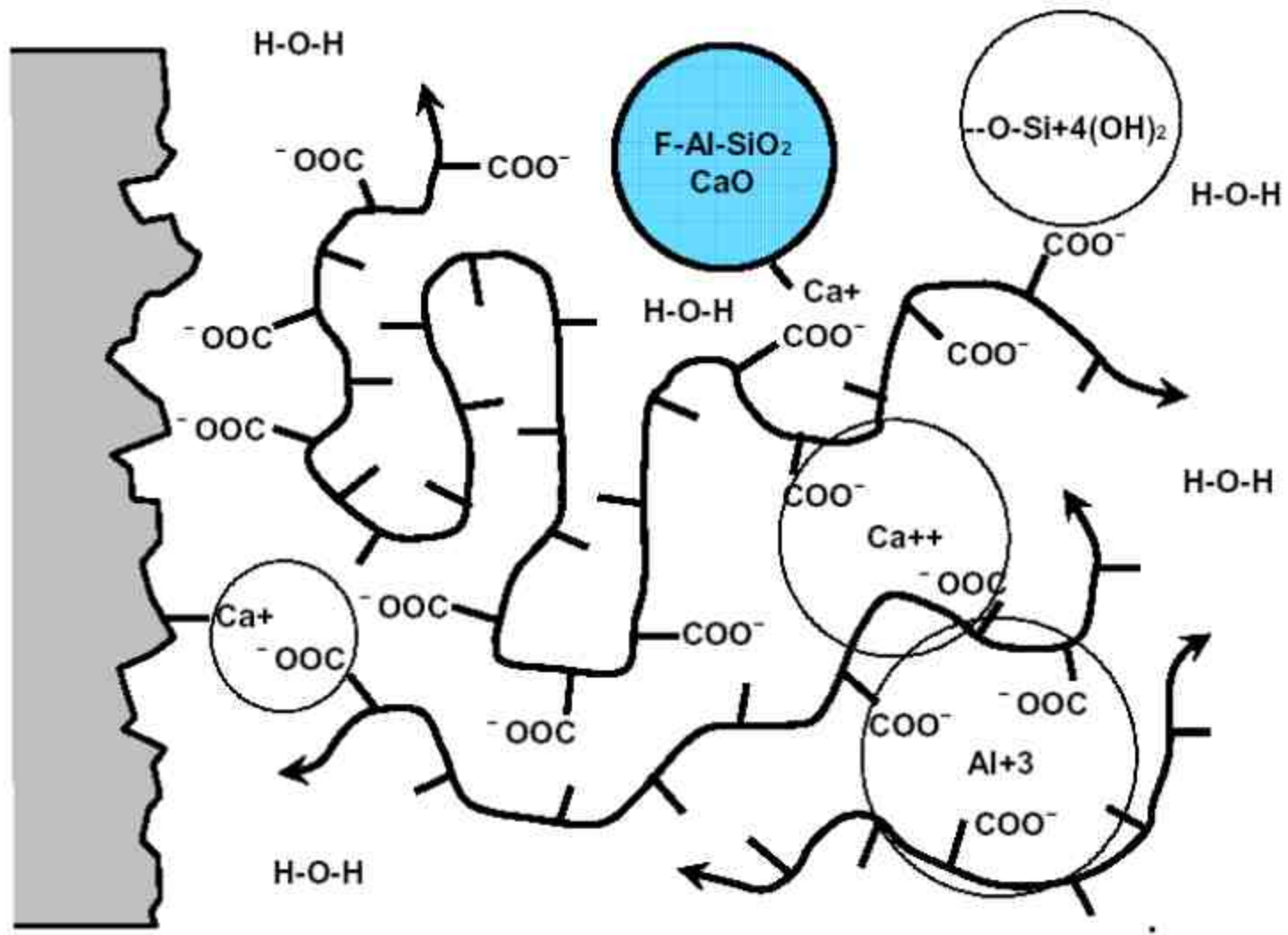
Chemistry of setting

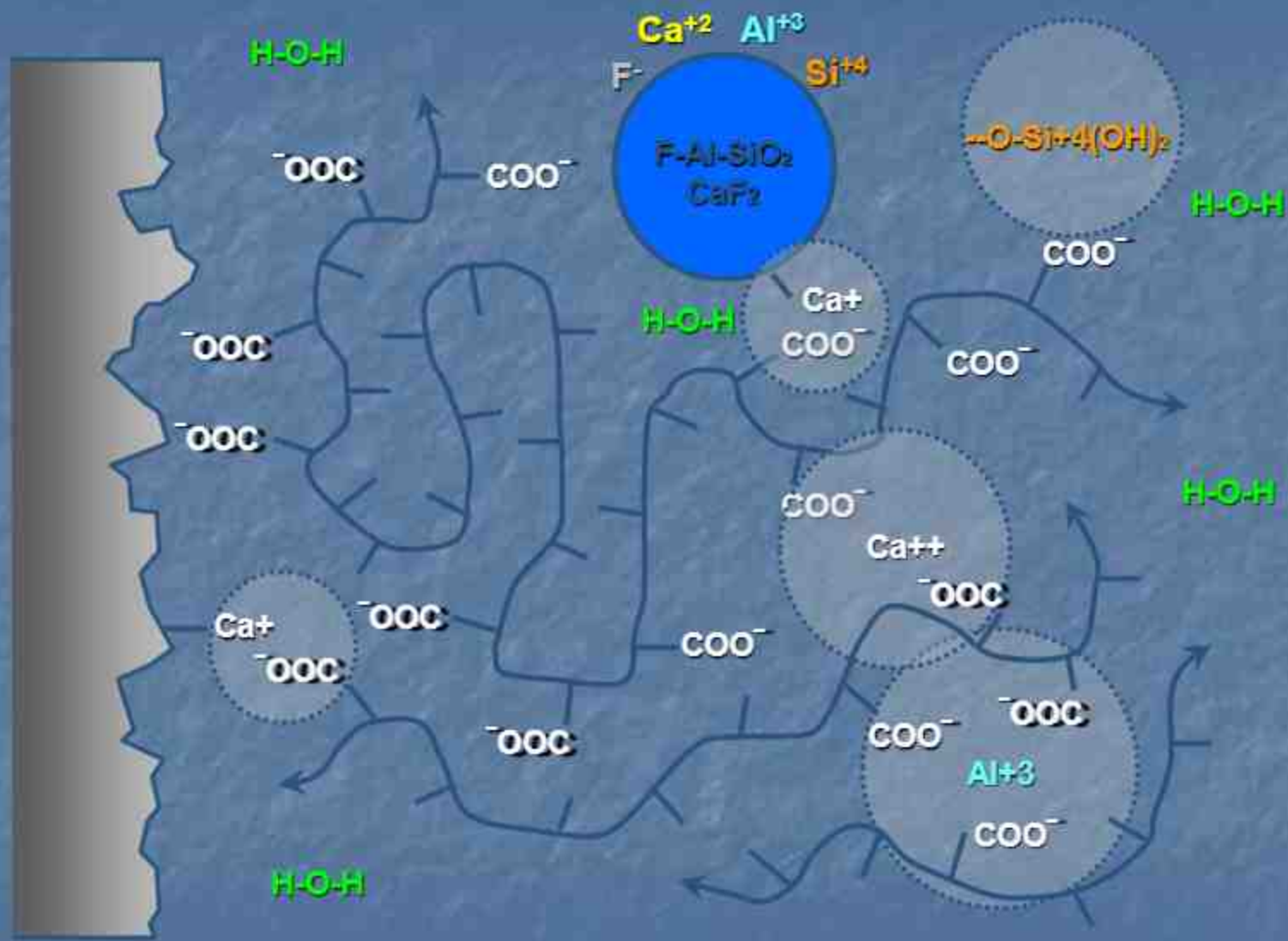
Fluoroaluminosilicate glass(base) + polyacid \longrightarrow polyacid matrix(salts)













The final set structure is a complex composite of the original glass particles ensheathed by a siliceous hydrogel and bonded together by a matrix phase of hydrated fluoridated calcium and aluminum polyacrylates.

➤ Water :

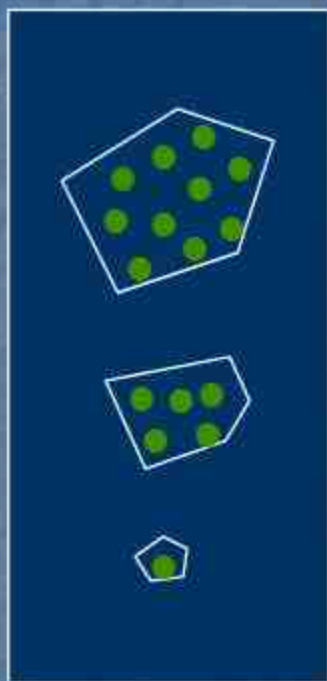
Essential part of cement structure

Reaction medium (Ca & Al ions that are leached are transported to react with the poly acid to form the polyacrylate matrix)

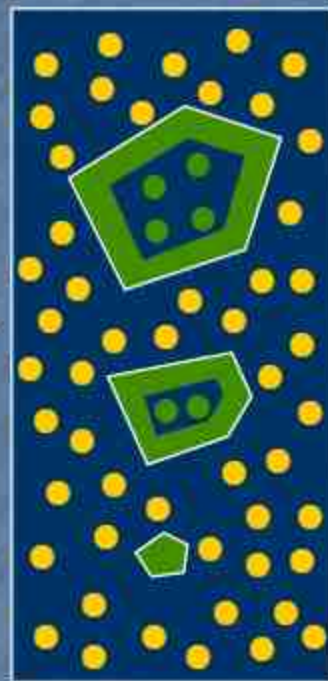
Hydrating reaction products (siliceous hydrogel & polyacrylate salts)

- “Loosely bound water” : readily removed by desiccation
- “Tightly bound water” : cannot be removed
associated with the hydration of
shell of cation – polyacrylate.

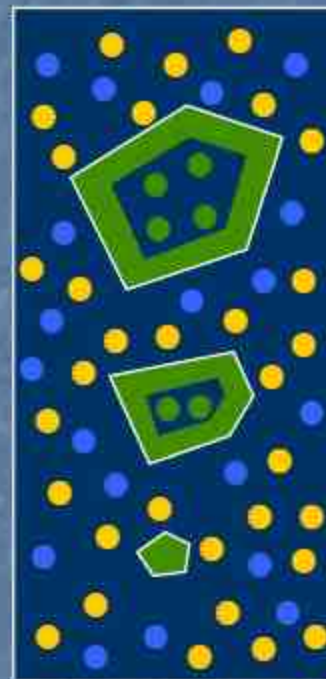
Initial



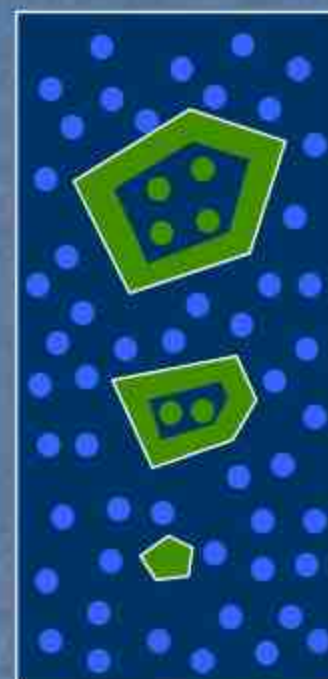
Dissolution



Gelation



Hardening



Silica gel



Soluble metal ions



Insoluble metal ions

- The loosely bound water is labile
- Loss of water will retard the setting reaction
- As the cement ages the degree of hydration; the tightly bound water increases
- Increase in strength & modulus & decrease in plasticity

- **Desiccation** — shrinkage (loss of water will retard cement formation)
crazing
weak cement
- Early contact with moisture is equally damaging.
- Cement is only stable in atmosphere of 80% relative humidity
- In higher humidity, cement absorbs water & consequent hygroscopic expansion.

- During the initial setting reaction (formation of Ca polyacrylate salts), the cement is highly soluble in water
- Chances of losing the loosely bound water
- Due to slow set
- Treatment of glass(removal of excess Ca ions) : fast setting

➤ **Cement protection :**

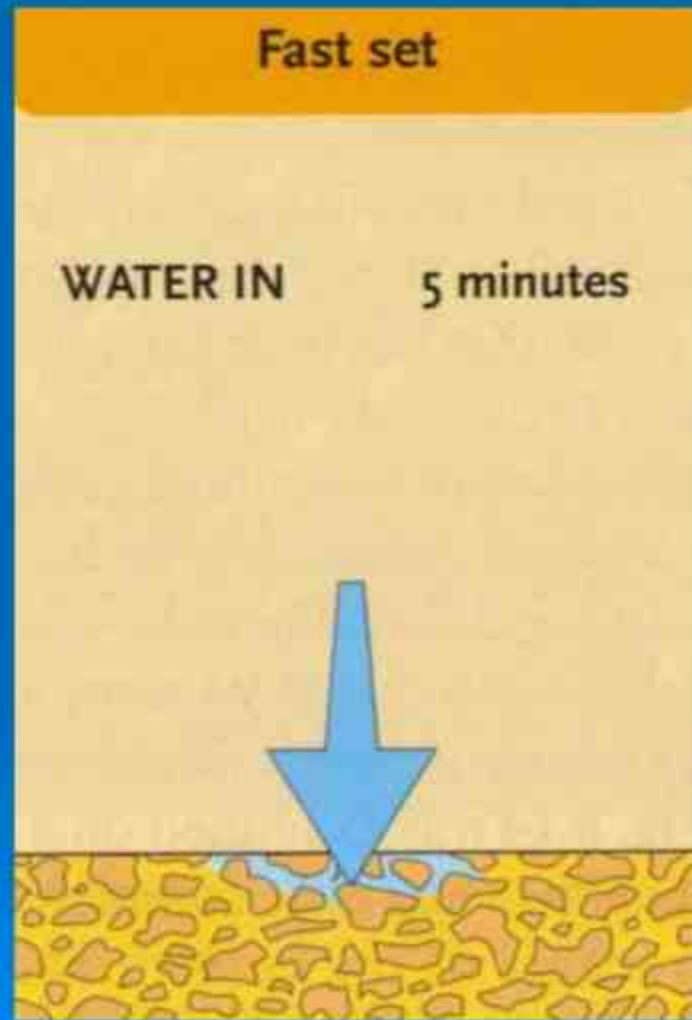
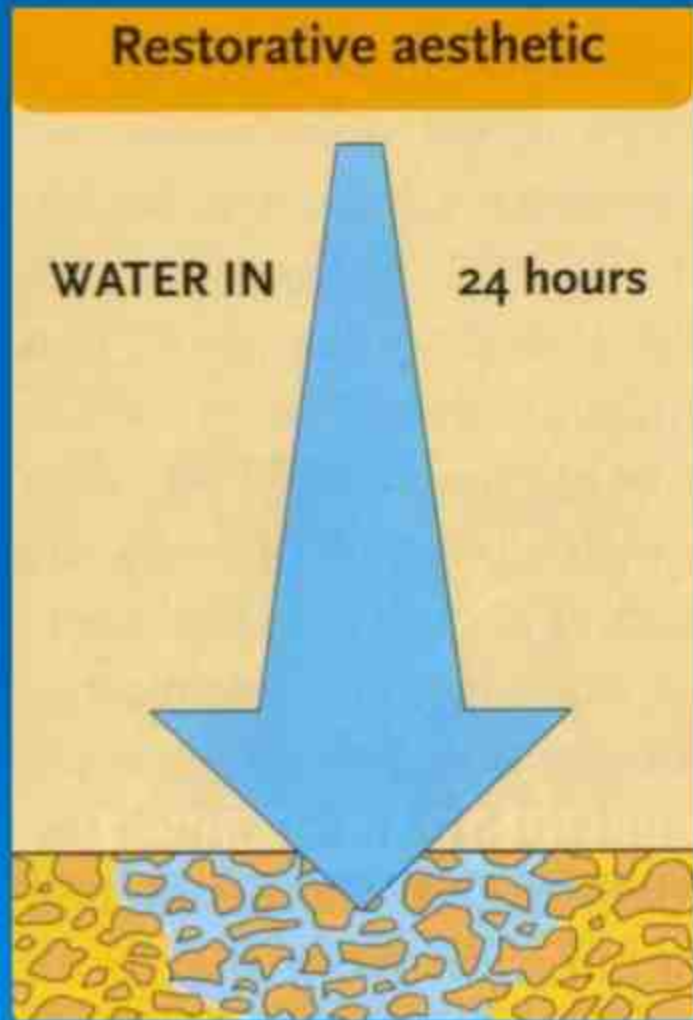
Varnish

Bonding agents

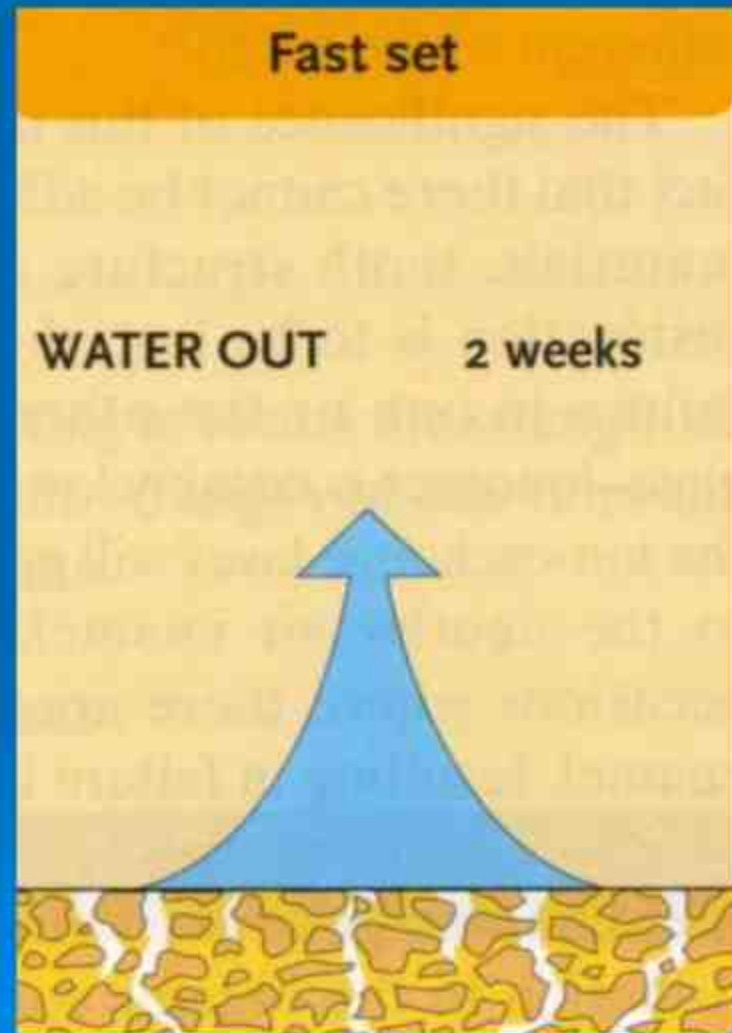
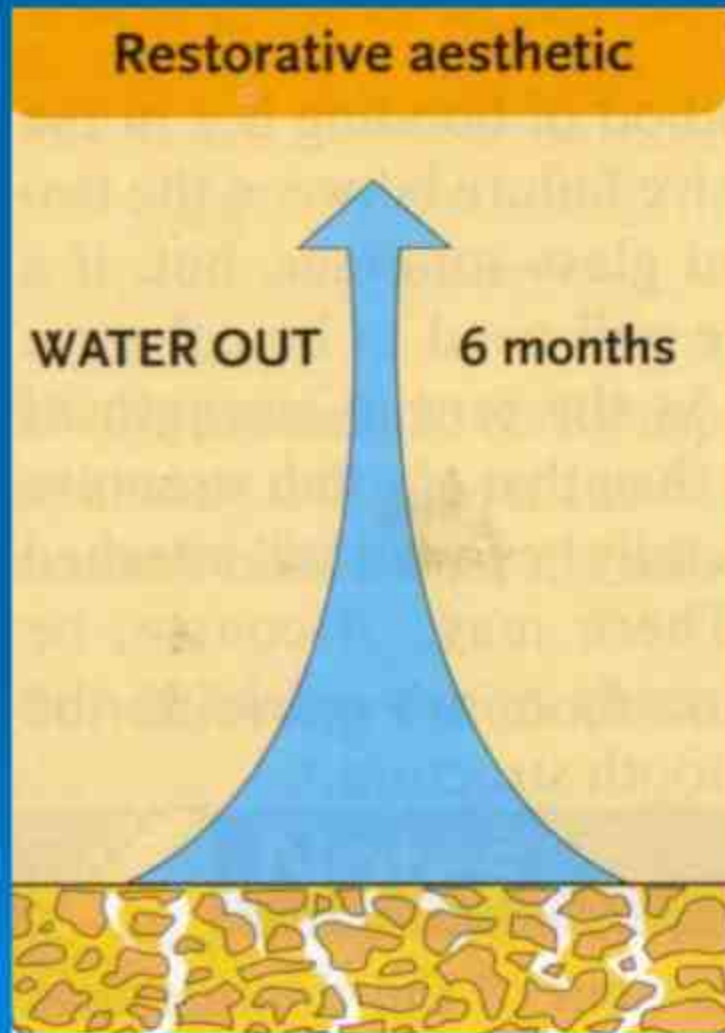
Petroleum jelly

Cocoa butter

Water uptake



Water loss



Factors affecting the rate of setting

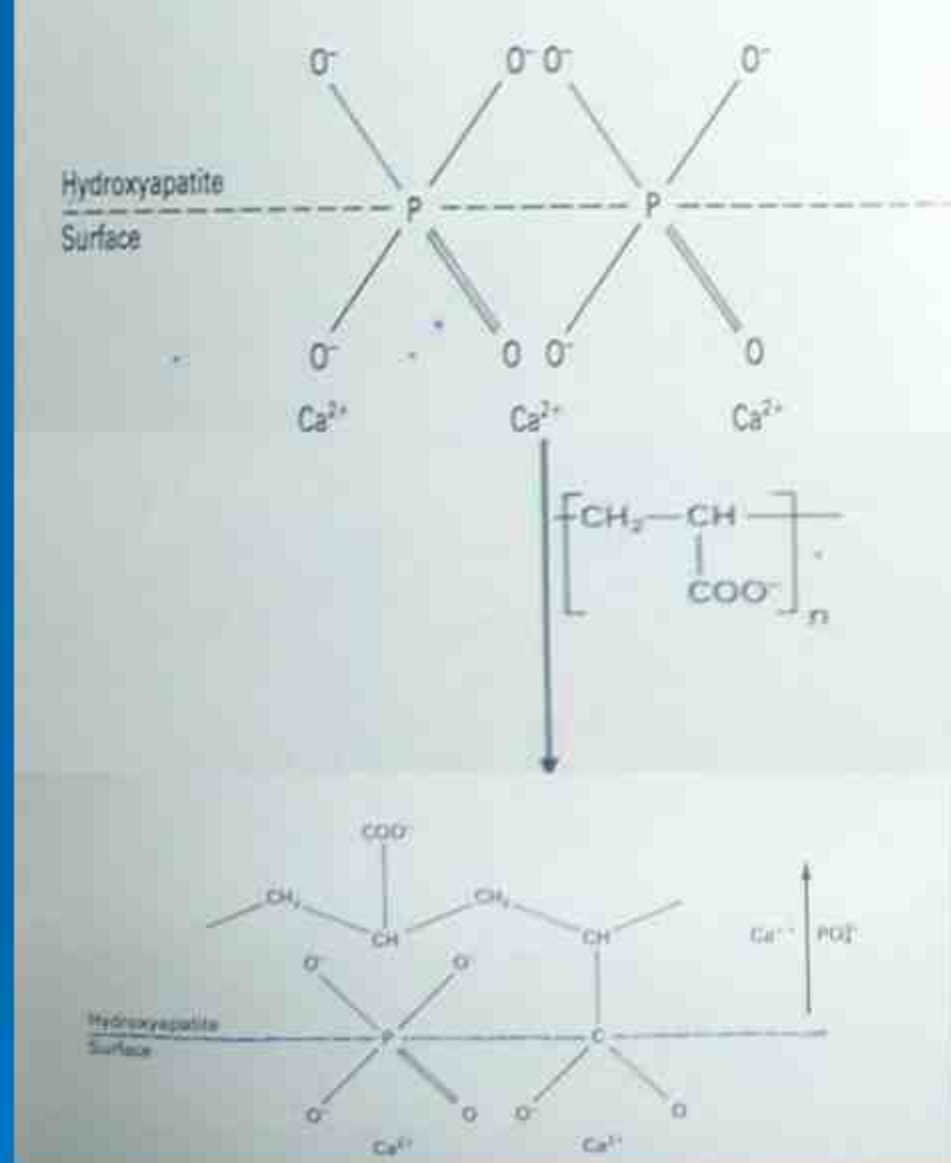
- Glass composition : Alumina/silica ratio
- Tartaric acid
- Particle size
- P:L ratio
- Temperature of the mix

Adhesion

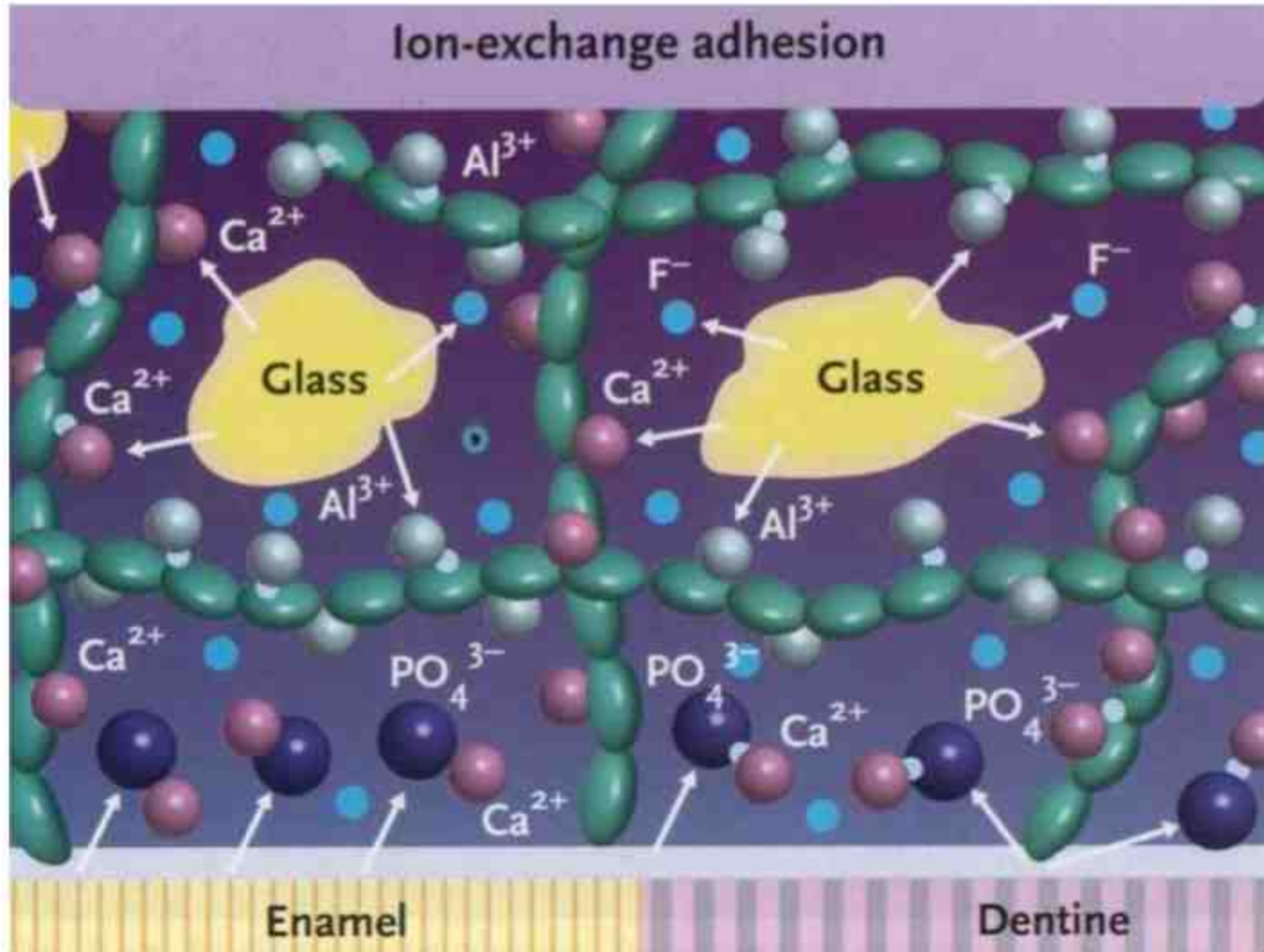
- Most important property
- Allows the conservative approach to restoration
- Advantage in restoring cervical lesions & in sealing pits & fissures
- Provide a perfect seal.

- Smith (1968) speculated chelation of calcium in apatite is involved in adhesion.
- Beech(1973) proposed ionic bond between Ca in apatite & polyacrylic acid.
- Wilson(1974) suggested that the initial adhesion is through the hydrogen bonding by the free carboxyl groups which is replaced by ionic bonds as the cement ages.

- **Wilson, Prosser & Powis (1983) :**
Ion exchange adhesion
- Poly alkenoic acid chains penetrate the apatite surface & displace phosphate ions.
- Each phosphate ion takes with it a calcium ion .

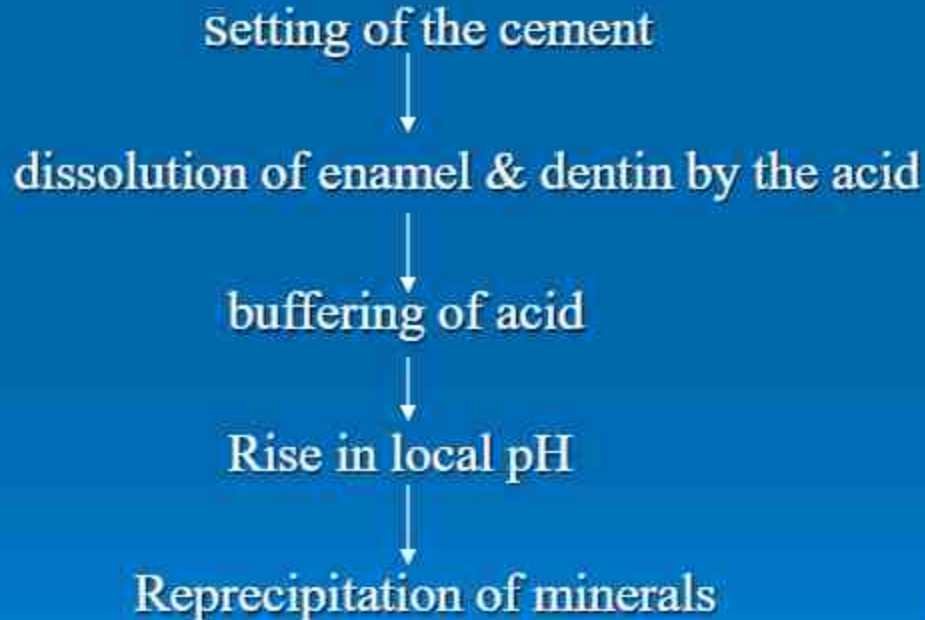


Ion-exchange adhesion



Diffusion-based adhesion

- Formation of **'ion-enriched' layer** : is an intermediate layer between the cement & apatite; consists of Ca, Al phosphates & polyacrylates.



- The bond of glass ionomer to enamel is better than that to dentin
- Bonding to apatite is principle mode of adhesion
- **Bonding to dentin (collagen) ?**
- Either hydrogen bonding or metallic ion bridging between carboxyl groups of polyacid & collagen of dentin

Surface conditioning

- Glass ionomers are appropriate for restoring abrasion/erosion cavities
- However, the tooth surface is coated with pellicle, other surface debris hence conditioning treatment is required.
- Adhesion is mediated through the mineral component
- Strong acids are not recommended

Mount 1984

- Isotonic to minimize osmotic effects
- pH ranging from 5.5- 8.0
- Nontoxic to dentin, pulp, gingival tissues
- Compatible with the chemistry of the setting reaction of cement
- Have water solubility & readily removed

- 50% Citric acid (Mclean, Wilson 1977)
- Surface active microbial solutions (Powis et al 1982):
 - 0.1% chlorhexidine gluconate
 - 0.08% dodecin
 - 3% NaF
- 25% Tannic acid
- 2% aqueous sol. Ferric chloride
- Mineralizing solutions (Causton, Johnson 1979): ITS solution
- EDTA
- Polyacrylic acid

- ❑ 10% polyacrylic acid
- ❑ Residue left behind does not interfere with the setting reaction.
- ❑ Enhances the wettability of the tooth surface & pre-activate the Ca & Phosphate ions rendering them available for bonding.

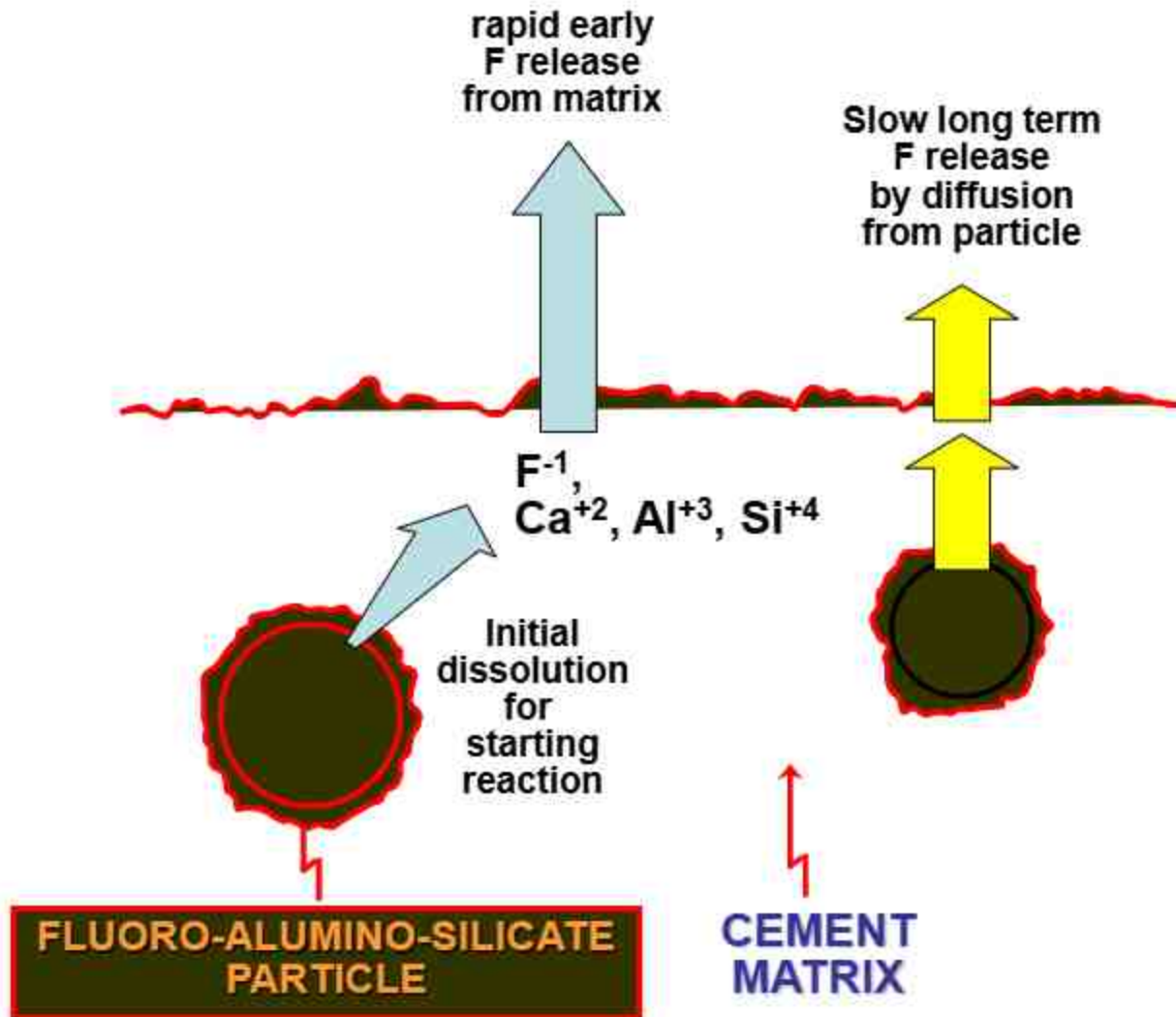
- Bond strength to tooth depends on the nature of the polyacid used
- Cements based on polyacrylic acid bond more strongly than those based on copolymers of polyacrylic acid (Abousch & Jenkins; 1986)

Fluoride release

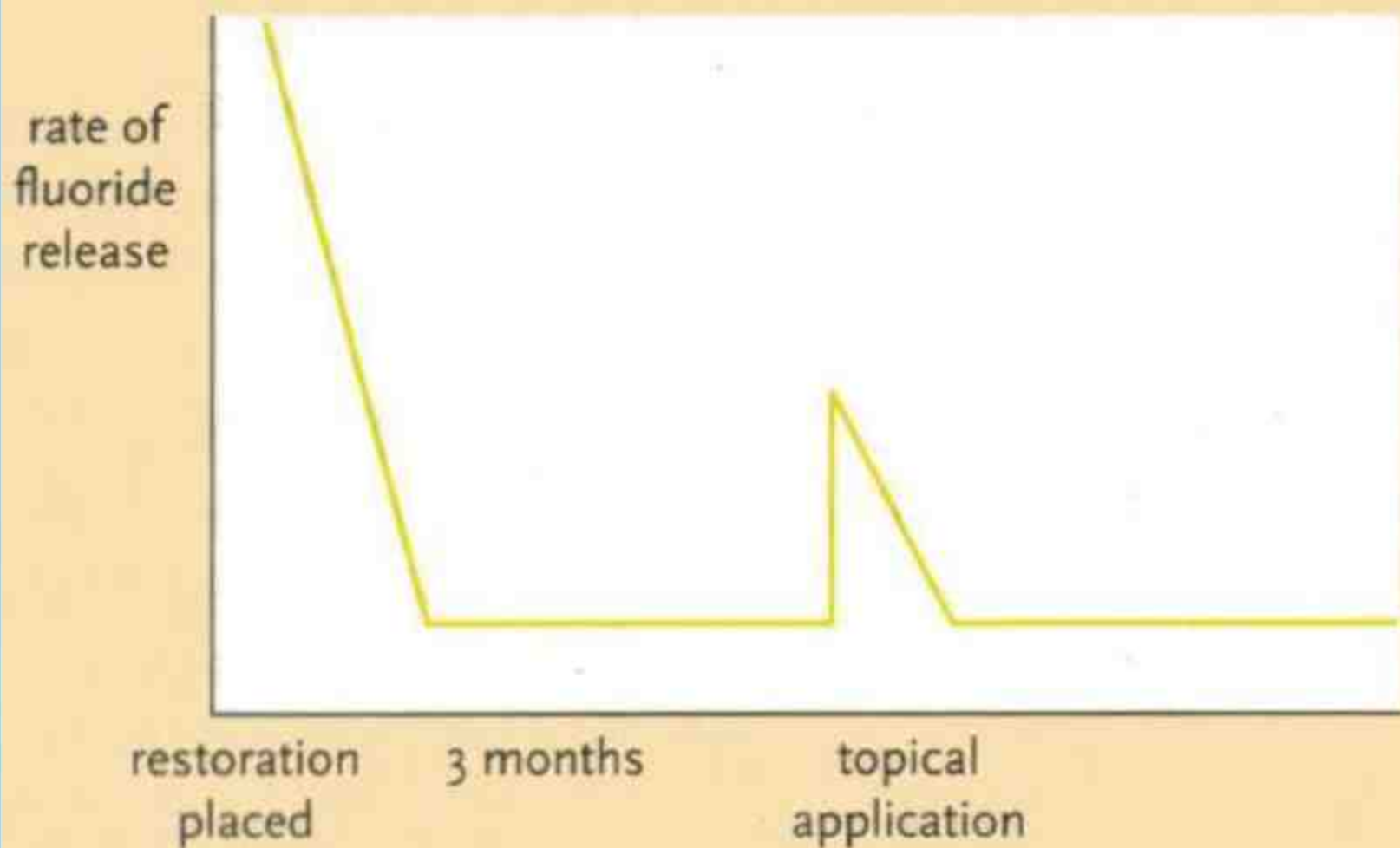
- Provides cariostatic effect
 - Source of F ions : Calcium fluoride, Strontium fluoride, Lanthanum fluoride, Cryolite, Aluminum trifluoride.
 - Mechanism of fluoride release is not completely understood.
- **Two reactions are involved**
- A short – term reaction of high fluoride release corresponding to initial elution due to the post setting maturation process
 - A long – term reaction of low release attributed to equilibrium diffusion processes.

FLUORIDE RELEASE

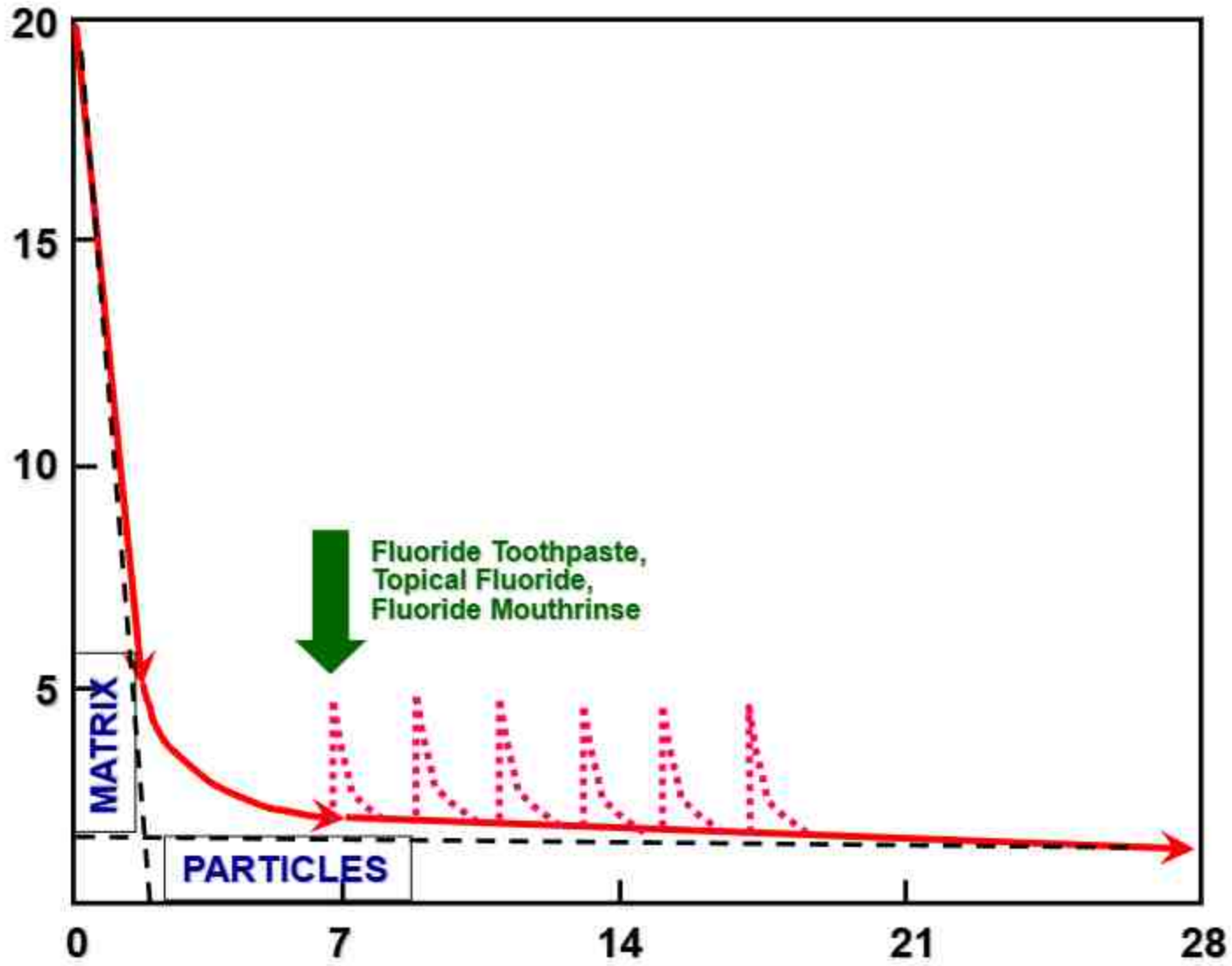
Fluoride comes from matrix and particles at different rates.



Fluoride release from glass-ionomer



FLUORIDE RELEASE (ppm)



TIME (Days)

Fluoride rechargability

- Ability of GIC to recharge fluoride
- Osmotic pressure
- Dynamic equilibrium is established with the oral environment
- Fluoride levels when increases in the proximity of the restoration, fluorine diffuses in & accumulated in the cement.
- When the levels of fluoride in oral environment decreases, the accumulated fluoride is released.

- Thick mixed cement used for restorations release more fluoride than thin mix as they contain proportionately more glasses, & hence more fluoride.
- Fluoride released has antimicrobial action against streptococcus mutans in plaque.

micron gm - F

14 days

30 days

Type II glass ionomer

440

650

- Cermet

200

300

- Silver alloy admix

3350

4040

Glass ionomer liners

470

700

- conventional

1000

1300

- light – cured

1200

1600

micron gm F/sq.cm/day

3days

7 days

14days

100days

GIC

15.5

7.5

4.5

1.8

RMGIC

4.0

2.6

2

0.9

Compomer

5.0

3.2

2.1

0.8

- The ionic radius of the fluoride ion (1.36) is similar to that of hydroxyl ion (1.40); fluoride can easily replace the hydroxyl ion in the apatite lattice.
- Increase the resistance to demineralization
- This is found in a zone of about 3mm thick around the restoration
- Anti- caries effect ,increases resistance to plaque acids (Brudevold et al 1967, Murray 1972,)
- Lowers the surface energy of apatite making difficult for plaque to adhere (Glantz 1969)
- Alters the carbohydrate metabolism of dental plaque

- Plaque over the glass ionomer restorations show reduce proportions of streptococcus mutans (Benelli 1993; Forrs 1995)

Biological properties

BIOCOMPATIBILITY WITH PULP ?

- Dhal & Tronstad(1976), Meryon & coworkers(1983) found that freshly mixed glass ionomer cement were cytotoxic
- Kawahara& coworkers (1979) reported that although the freshly mixed cement inhibited cellular proliferation, it was not cytotoxic
- Causes greater inflammatory response than Zinc-oxide eugenol cement but less than zinc polycarboxylate

McClean & Wilson (1974)

1. Poly acrylic acid is a weak acid
2. When partly neutralized, the tendency of the acid to dissociate into H ions & polyacrylate ions is reduced because of the increase in the negative charge on the chain
3. Has high molecular weight(larger molecular size of acid, thus does not penetrate the dentinal tubules)
4. Readily precipitated by Ca ions in the tubules

Physical properties

- Although high in compressive strength
- Lack fracture toughness
- Brittle
- Low wear resistance
- Co-efficient of thermal expansion is similar to that of tooth

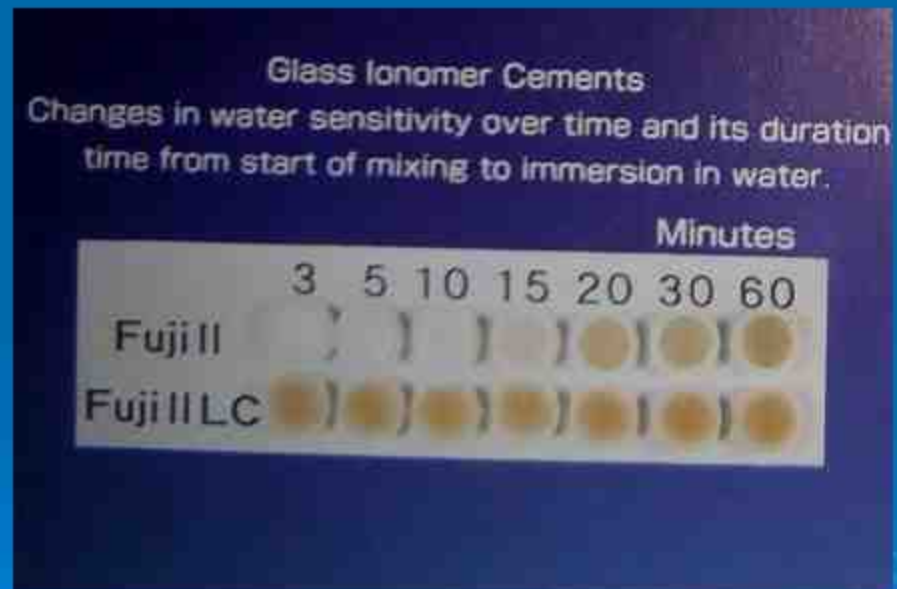
	silicate	GIC	Cermet	RMGIC
Compressive	180	150	150	105
Tensile	3.5	6.6	6.7	20
Hardness	70	48	39	40

Material loss during stimulated occlusal wear (cm sq.)

Amalgam	0.2
Conventional composite	0.4
Glass ionomer	6.0
Cermet	0.3

Translucency

- Filler is glass
- Slow hydration & post set hardening
- Complete translucency



CLINICAL APPLICATIONS

➤ *Restorative Materials*

- Restoration of erosion/abrasion lesions without cavity preparation
- Sealing and filling of occlusal pits and fissures
- Restoration of deciduous teeth
- Restoration of class III, V lesions
- Repair of defective margins in restorations
- Minimum cavity preparations(tunnel preparations)
- Core build up
- Provisional restorations where future veneer crowns are required
- sealing of root surfaces for overdentures

➤ *Fast setting cement lining and bases*

- Lining of all types of cavities where a biological seal and cariostatic action are required
- Replacement of carious dentin where attachment of composite resins using the acid-etch technique
- Sealing and filling of occlusal fissures showing early signs of caries

Contraindications for use

- Class IV carious lesions or fractured incisors
- Lesions involving large areas of labial enamel
- Class II carious lesions (replacement of existing amalgam restoration)
- Lost cusp areas

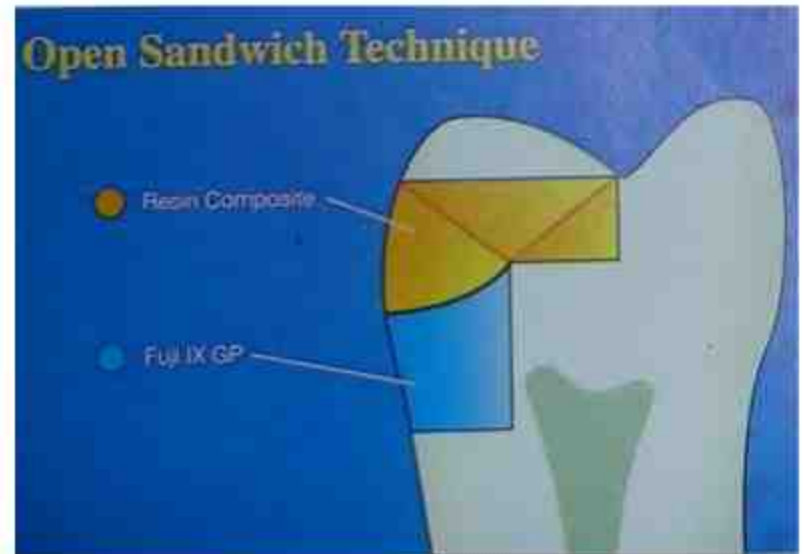
Disadvantages

- Low tensile strength, fracture toughness
- Poor edge strength
- Esthetically less pleasing than composite
- Technique sensitive
- P:L ratio alteration can cause
- Post operative sensitivity
- Reduced physical & mechanical properties

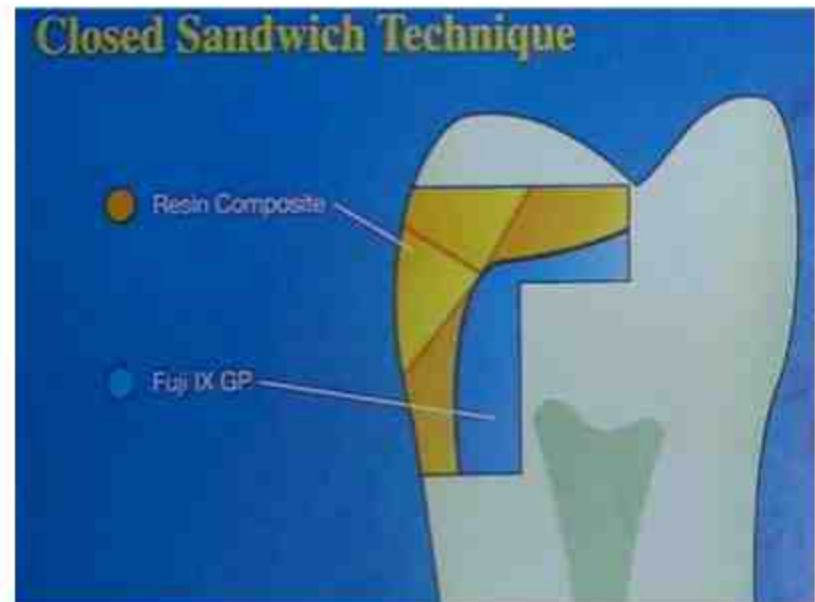
Sandwich technique

- Involves replacing the lost dentin with glass ionomer & enamel with resin composite
 - Glass ionomer base can be light –cured or chemical set cement
 - Class I, II, III, V lesions
-
- “Delayed or closed”
 - “Open”

- **Glass ionomer forms the part of external surface of the restoration**



- **Glass ionomer is completely covered by the overlying composite**

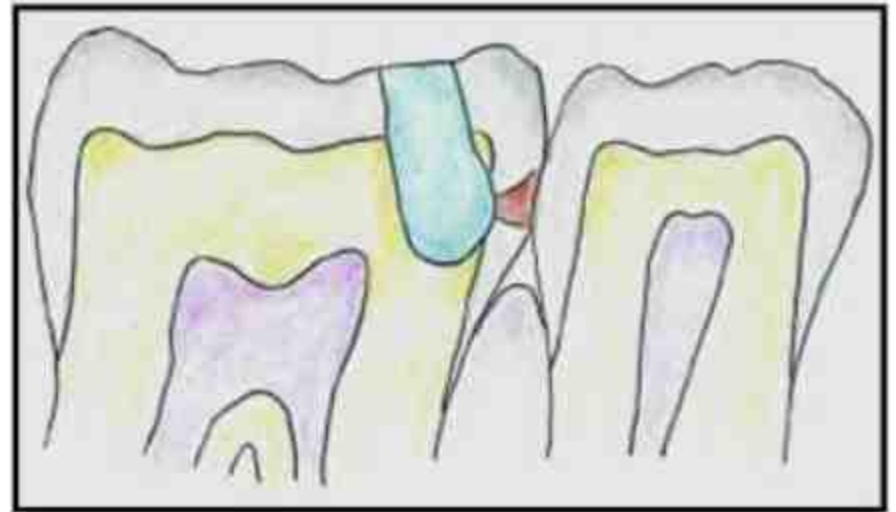


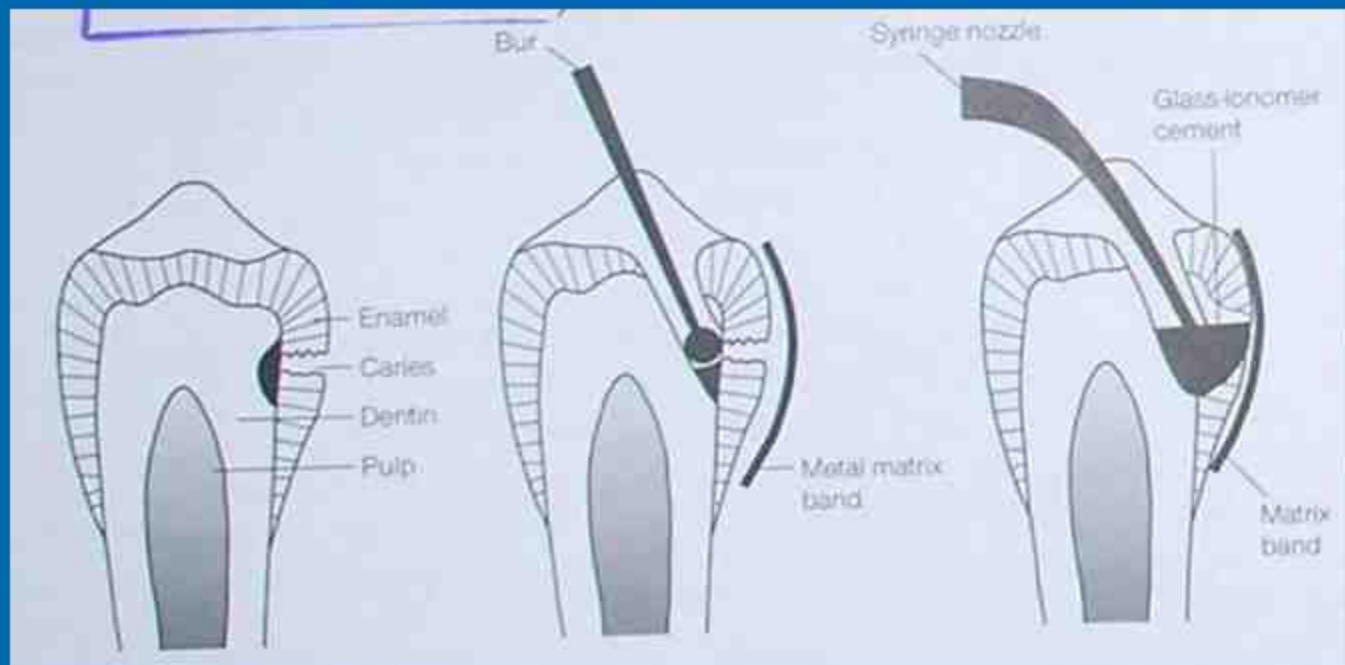
Tunnel restorations

- First described by Jinks 1963
- As a conservative alternative to the conventional procedure in class II cavity preparation in primary molars
- With the introduction of GIC, McLean, Knight, Hunt suggested its use in tunnel restorations in deciduous & permanent teeth



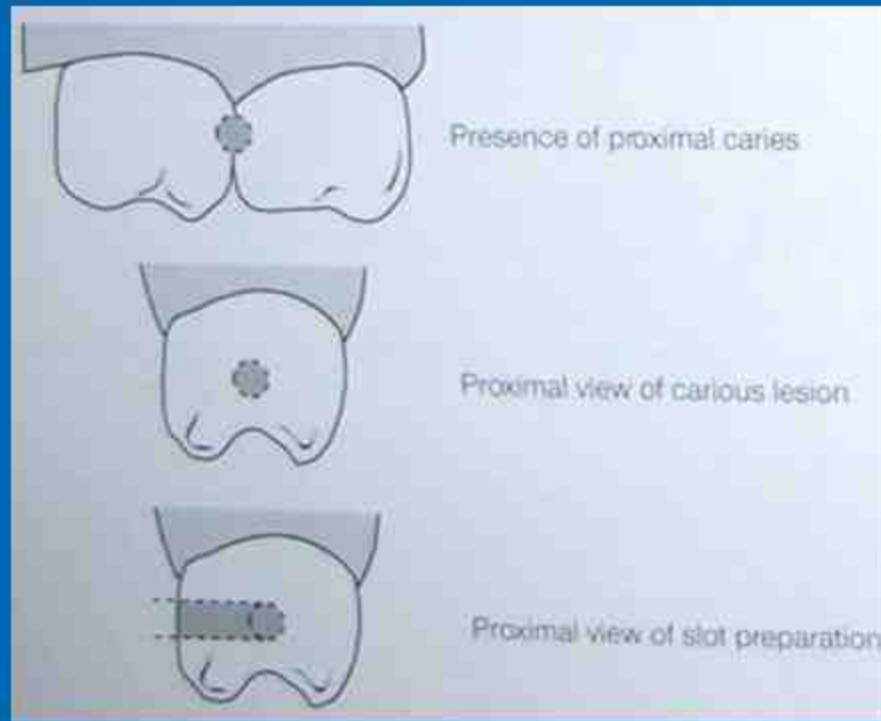
- In 1990 PR Hunt proposed a variation, whereby the preparation did not extend through the interproximal wall, but rather left carious enamel intact in the assumption that remineralization could occur with the release of fluoride from a GIC restoration





Tay & Lynch , 1990

Glass ionomer is syringed into the proximal lesion prior to the restoration of the occlusal access cavity



- An alternative approach for small proximal lesions
- Morand & Jonas 1994
- Lateral tunnel or slot preparation
- The proximal lesion is accessed through the buccal or lingual surface with the preservation of tooth structure (marginal ridge)

➤ **Advantages**

- Preservation of marginal ridge, hence maintaining the strength of tooth
- Retention of interproximal contacts

➤ **Disadvantages**

- Complete excavation of caries is not feasible
- Difficulty in insertion & finishing of the restorative material

A.R.T. RESTORATIONS

ART = Atraumatic Restorative Technique



Developed as temporary restorations for 3rd world countries.

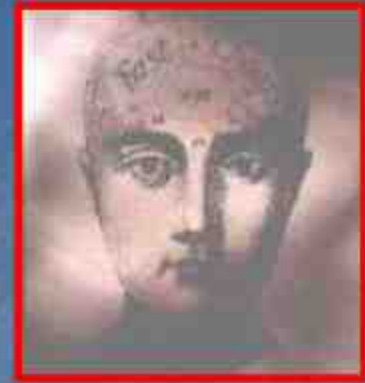
First tested in African countries.

Now used widely in Asian countries.

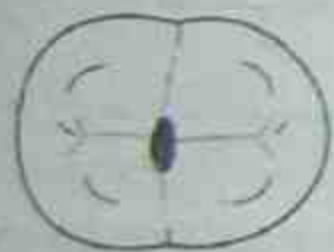
Original technique = scoop, finger mix, finger insertion.

Current technique = P/L or precapsulated mixture.





- **First started in Tanzania in mid- 1980**
- **Unavailability of adequate dental personnel, restorative instruments & poor dental set up**
- **Appropriate intervention in underdeveloped countries, refugees**
- **As a treatment option for physically or mentally handicapped persons**



(a)



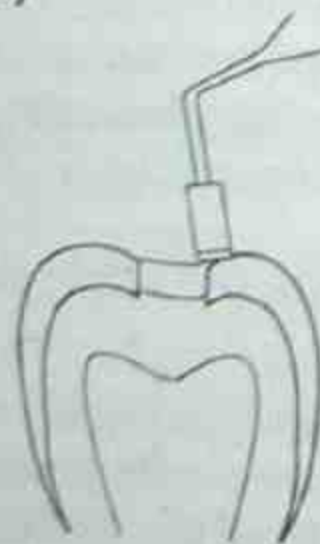
(b)



(c)



(d)



(e)



Class I Class II

Class V Lining Base Core-build up



**Packable Glass Ionomer Restorative
Cement in a normal and a fast setting
version**



Easy to pack & contour



Strong chemical adhesion



Excellent marginal seal



Biocompatible



Fluoride release



Improved mechanical properties



Sets only in 3 min.

Advantages

- No sophisticated dental instruments are required
- Treatment not dependent on electricity
- Minimal discomfort to patient
- The operator requires minimal training
- Fluoride release from GIC
- Low cost
- Less time consuming

Luting cement

- For cementation of crowns, bridges, inlays & orthodontic appliances.
- P:L 1.5 : 1
- Fast set with early resistance to water
- Film thickness 25 microns
- Eg. Ketac – cem
Fuji I



The ideal properties of luting cements (McClean, Wilson et al) :

- Low viscosity & film thickness
- Long working time with rapid set at mouth temperature
- Resistance to dissolution
- High compression & tensile strength
- Adhesion to tooth & restoration
- Cariostatic
- Pulp compatibility
- Translucency
- Radiopaque

	Compressive strength (68.7)	Tensile strength	Modulus of Elasticity	pH
➤ ZnPO ₄	105	5.5	13.5	2.1 – 5.5
➤ Zn Poly carboxylate	55	6.2	5.1	3.4 – 5.9
➤ GIC	86	6.2	7.3	2.3 – 5.9

➤ Zinc polycarboxylate cement:

- Though offered adhesion to tooth structure, its low tensile strength decreased the longevity of the restoration.

➤ Zinc phosphate cement:

- Higher viscosity, so necessary to maintain positive pressure so that the appliance do not lift off after its placement

- The tensile strength of both cements are similar
- The thixotropic flow property of glass ionomer allows for easier placement of the prosthesis without the need to retain pressure during seating
- Therefore, easy to achieve thinner film thickness
- Potential of ongoing fluoride release

Post operative sensitivity

It was linked with early glass ionomers which had a larger particle size

- Young tooth with large pulp horns & permeable dentin
- Iatrogenic tooth dessication
- Cement mixed too thin
- Improper P:L ratio
- Pre existing pulpal pathology



Applications in endodontics

- Root canal sealing :
 - Concept first introduced by Pittford
 - Root canal , being free of salivary or blood contamination is an ideal environment for placement of GIC
 - But, difficult to retreat
 - Partial removal during preparation of post space is slower
 - Not useful as a retrograde root filling due to difficulty in maintaining dry surgical field
 - Eg. Ketac- endo



- Good sealing efficacy
- Antimicrobial
- Persistence of the cement in the periapical tissues when it extrudes, show no side effects; it has low tissue solubility & biocompatible
- Friedman 1995 has stated 78% success & only 6% failure rate
- Fuss & Torpe, 1996 had reported cases of successful perforation repair with GIC
- As a coronal sealing after RCT



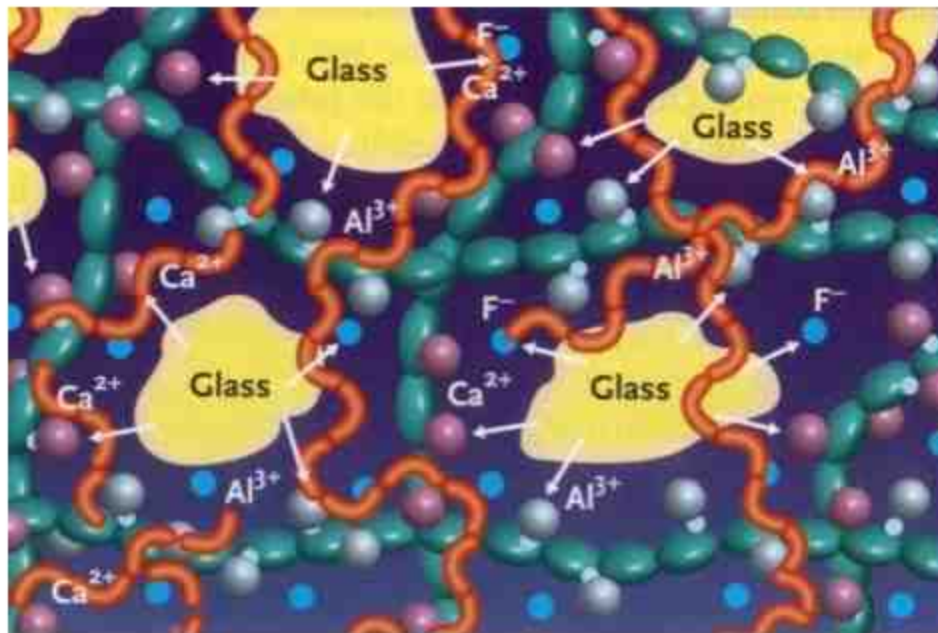
- Smaller particles offering excellent aesthetics and polishability
- As a restorative material for use in Class III, V and deciduous teeth
- Multipurpose material, with secondary indications such as liner, base and core build-up.

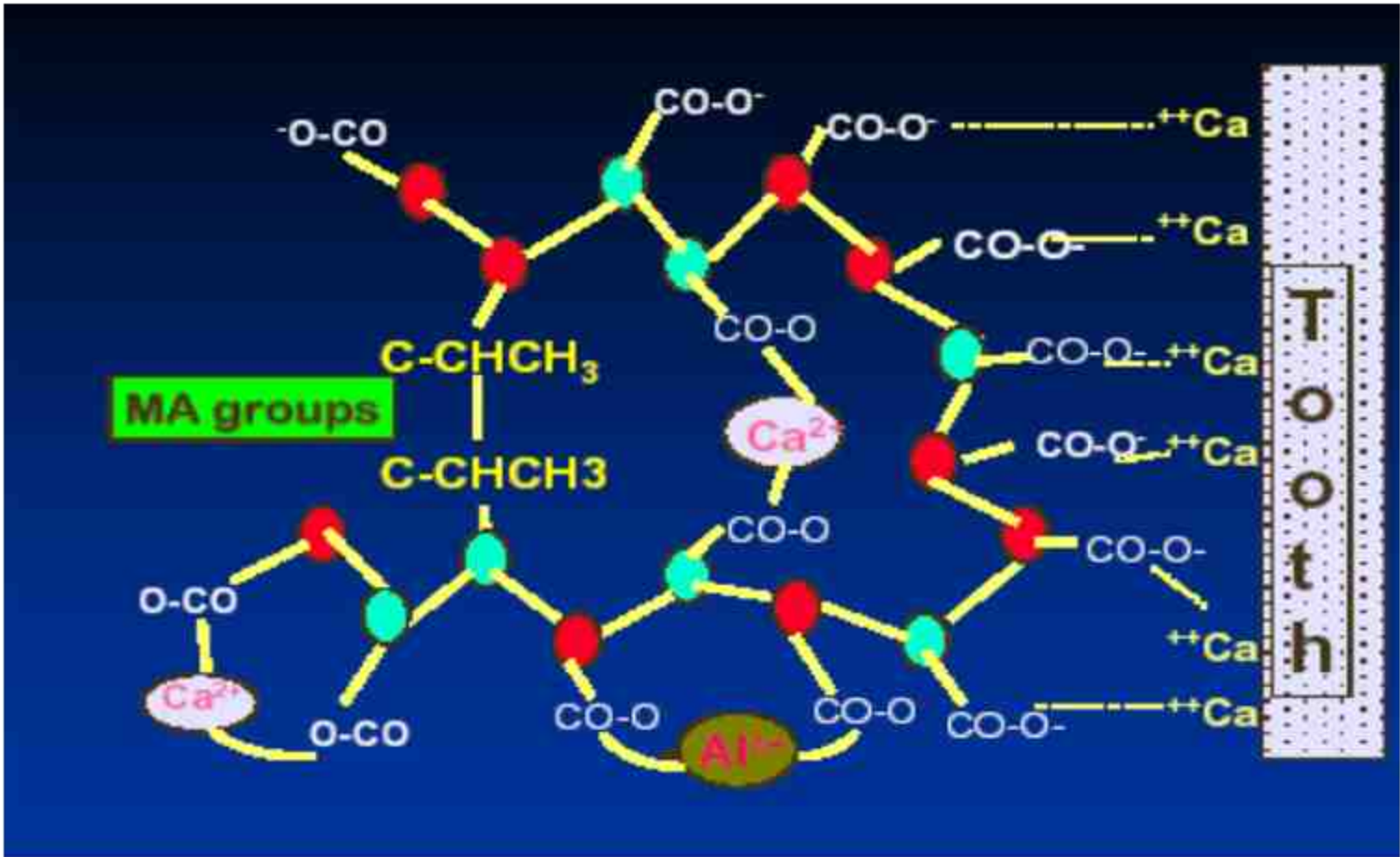
Eg. Photac- fil, Relyx Luting plus



Resin-modified GIC

- Developed chiefly to overcome the problems of moisture sensitivity and low early mechanical strength
- Water- soluble resin monomer (HEMA) into aqueous solution of polyacrylic acid
- The system undergoes light polymerization of the resin providing an umbrella effect & protect the ongoing acid-base reaction within the cement.





- Water- contamination is eliminated.
- The poly acrylate chains will continue to grow under the protective umbrella of set resins.
- Finally remaining unset resins will auto-cure by oxidation- reduction reactions & acid-base reaction.
- Similar to conventional glass ionomers they are biocompatible to pulp.
- GC Fuji LC, GC Fuji Lining, Photac-Fil, Photac Bond, Vitremere, Vitrebond

- Bond strength of the resin-modified cement to dentine is significantly higher than that of conventional glass ionomer cement and the bond is a stable one.
- It may be because of the slowness of the acid-base reaction in the modified cement that the polyacid is available for a longer period, resulting in the formation of a stronger adhesive bond.

	Type II GIC	RMGIC
Compressive strength	150 MPa	105 MPa
Tensile strength	6.6 MPa	20 MPa
KHN	48	40

Increased tensile strength as water sensitivity is eliminated by addition of resins

- Risk of polymerization shrinkage
- Limited depth of cure
- Incremental placement is advised
- Amount of fluoride release is reduced

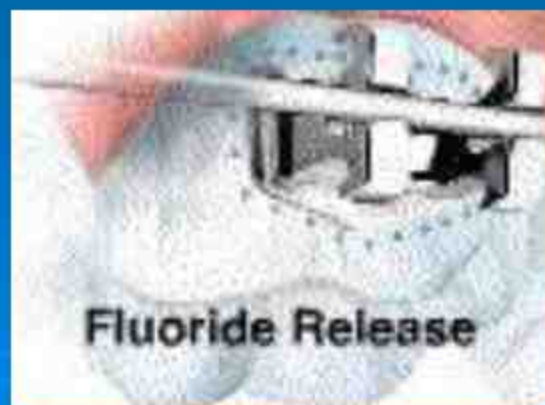
GC Fuji ORTHO LC

Light-Cured Resin
Reinforced Glass Ionomer
Orthodontic Cement



- Smith 1988, 9 month study, bands cemented with Zn Phosphate & glass ionomer cement were compared
- The no. of recementations was reduced by more than 50% with the glass ionomer
- Demineralization was seen in about 24% cases in the Zinc Phosphate group while none was observed in glass ionomer group

- Orthodontic treatment increases levels of streptococcus mutans in plaque
- Risk of enamel demineralization
- Various studies (Fricker1987; Arrends1991;Thilander 1997) have reported less enamel demineralization under orthodontic brackets & bands retained with glass ionomer





- GC Fuji III is a chemical cured glass ionomer cement developed as a pit and fissure protection material for primary caries.
- GC Fuji III features excellent flow necessary for placement
- magnificent sealing of areas and fluoride release which helps to prevent caries in and around the sealed areas for a long time.
- GC Fuji III also offers excellent biocompatibility as a glass ionomer cement.
- Unlike resin materials, there is no need to acid etch the tooth surface, facilitating operation.

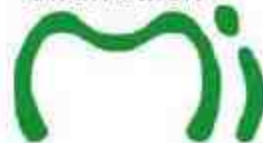


- GC Fuji TRIAGE - a glass ionomer sealant and surface protection material.
- Temporary filling of endodontic access
- As an intermediate restorative and for treatment of non-cavitated lesions, such as toothbrush abrasion and root surface sensitivity.

- **Fuji VII is a free-flowing, high fluoride releasing glass ionomer cement.**
- **Clearly identified by its Pink shade GC Fuji VII is now available in White which can also be used for minimally prepared micro-cavities where good flow, high fluoride release and strong chemical adhesion are desired.**
- **Fuji 7 has a pink hue for easy identification while helping it blend into the oral environment.**



MINIMUM
INTERVENTION



- **Setting time**
- **Light curing 20 – 40 seconds**
- **Auto cure 4 min.**

Advantages

- **Can be applied when saliva control is not possible.**

To treat newly erupted molars (partially) covered by tissue

- **Surface protection in erupting molars**



- **Acute caries stabilisation material**



- **Temporary & intermediate restorations**



- **Temporary endodontic sealing material**



- **Root surface protection**



- **Self curing conventional GIC**
 - No addition of resins
 - Chemical adhesion to tooth structure
 - No etching, no bonding
- **Optional Command set with VLC unit**
 - For early protection against de-hydration
- **Translucent pink shade**
 - Visible control during recalls
- **Low viscosity**
 - Easy to apply
- **Better marginal seal**
 - Has a tooth- like thermal co-efficient of expansion
- **Very high level of fluoride release**
 - 3 times more than Fuji I & 6 times more than Fuji IX



- Fuji VIII is a glass ionomer cement with physical and aesthetic properties
- Used for Class III, V and root surface restorations
- Developed to provide the best translucency and a perfect match with Vita shades.
- The product has good aesthetics, translucency without light curing
- Reliable bond strength to enamel and dentine
- Excellent physical properties, reaching 90% of its mechanical properties in ten minutes and is economical



Smart materials/ Fluoride charged materials

Consists of two parts : restoration
charge

When the therapeutic potential of the restoration is spent with the release of fluoride ; these materials can be charged with fluoride again by topical application

Hence, these materials are smart in a way that they need not be replaced

COMPOMERS



Glass Ionomers

RMGI

Compomers

Composites



- ▶ First introduced in European market in 1993
- ▶ As a combination of properties of both glass ionomer & resin composite
- ▶ Mc lean et al suggested the term Polyacid Modified Resin composite in 1994



What is a compomer?

- ▶ Water- free, single component, light – cured composite consisting of poly acid modified dimethacrylate monomers reinforced with strontium or bariumaluminosilicate glass particles as fillers which functions to release fluoride including a light-curable monomer like urethane dimethacrylate (UDMA) or Bis-GMA.

- ▶ The dominant setting reaction is the resinous photopolymerization and no acid-base reaction can occur until later when the material absorbs water.

- ▶ Light induced free radical polymerization of the monomer
- ▶ Acid – base reaction of the ion leachable glass filler particles with the dehydrated polyalkenoic acid when water sorption takes place from the oral cavity
- ▶ Leads to further ionic cross-linking of the polymer & fluoride release

Dyract

- ▶ The urethane dimethacrylate (UDMA) monomer
- ▶ innovative character of Dyract is TCB resin.
- ▶ It consists of a new monomer of dual functionality, made up of a butane tetracarboxylic acid backbone with a polymerizable (HEMA) side chain.
- ▶ The resultant new monomer contains two methacrylate groups as well as two carboxyl groups.
- ▶ The former can cross-link with other methacrylate terminated resins when initiated through radical polymerization while the later groups can undergo acid-base reaction to form a salt with metal ions and water.

F2000

Dimethacrylate functional oligomer (CDMA oligomer allows greater cross-linking of the resin matrix

Comprised of 3 monomers –

Citric acid derived CDMA Oligomer

Glyceryl dimethacrylate (GDMA) – has greater ratio of methacrylate group to carboxyl group – allows greater cross linking of resin matrix.

High molecular mass hydrophilic polymer takes up a controlled amount of fluid & facilitates the transport of fluorides .

Ist generation compomer

Dyract

Contains solely glass ionomer fillers

Mean particle size of 2.5 μm

13 % of fluoride.

IInd generation

Compoglass

Fillers - methacrylate monomers & conventional glass ionomer fillers

Mean particle size of 1.5 μm

In F2000

Fluoro-aluminosilicate glass filler

Average particle size - 3 μm

A small amount of colloidal silica is added - 84 % by mass.

Hytac Aplitip

Ground Ca-Al-Znfluoroglass.

Mean particle size - 5 μm & 66 % of the composition by mass.

Dyract AP

Strontiumfluoro-silicate glass filler

Mean particle size reduced to 0.8 μm

Self-adhesive property of the restorative itself. TCB monomer consists of hydrophilic carboxyl (-COOH) groups

Such polyelectrolytes can bond to enamel & dentine without acid etching.

Adhesion to the tooth surface through the primer/adhesive system

Advantages

- Ease of placement
- No mixing
- Easy to polish
- Good esthetics
- Less susceptible to dehydration
- Radiopaque
- Excellent handling

Disadvantages

- ▶ Require a bonding agent
- ▶ More marginal staining and chipping
- ▶ Wears more than composite
- ▶ Weaker physical properties than composites
- ▶ Clinical significance of fluoride release undermined



The Giomer Concept

- ❑ Hybrid aesthetic restorative materials
- ❑ Combine glass ionomers & resin composites - **PRG composites**.
- ❑ **pre-reacted glass ionomer (PRG) technology**.

The fluoroaluminosilicate glass in these materials is reacted with polyalkenoic acid in water prior to inclusion into silica-filled urethane resin

- ❑ Pre-reaction can only surface (S-PRG) or almost entire particle (F-PRG).
- ❑ Does not have a acid-base reaction .
- ❑ Require bonding agents for adhesion to tooth structure.

Eg REACTMER (Shofu Inc, Kyoto, Japan), FL-BOND, BEAUTIFIL



Multi functional glass
Properties



Microscopic technology
[Particle size control]

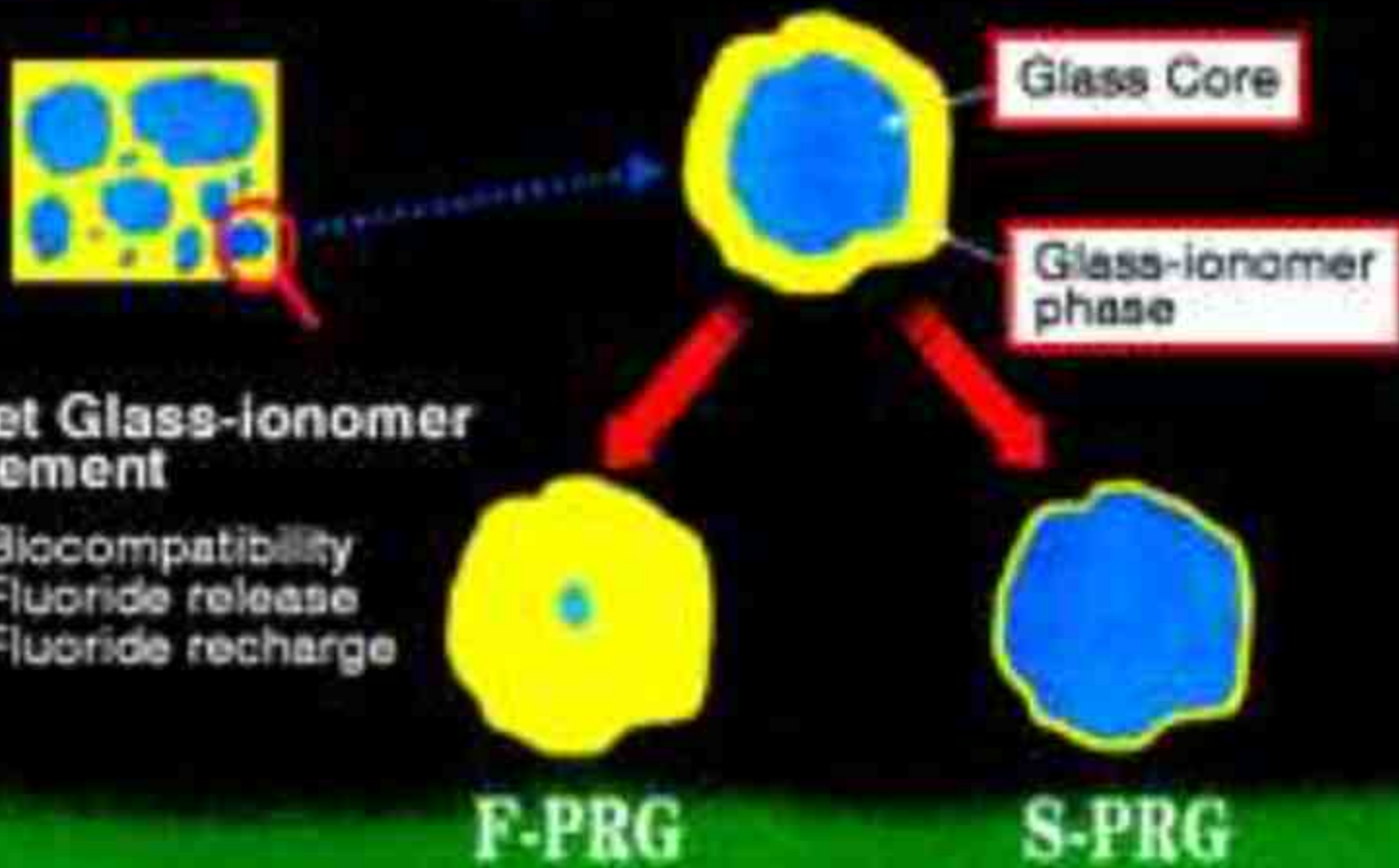


Acid-Reactive Fluoride Containing Glass



Poly Acid Liquid

Schematic image of F-PRG and S-PRG



S-PRG TECHNOLOGY

Glass-Ionomer reaction on the surface only



Glass particle

Phase of glass-ionomer

S-PRG Filler



S-PRG Filler

+

Resin

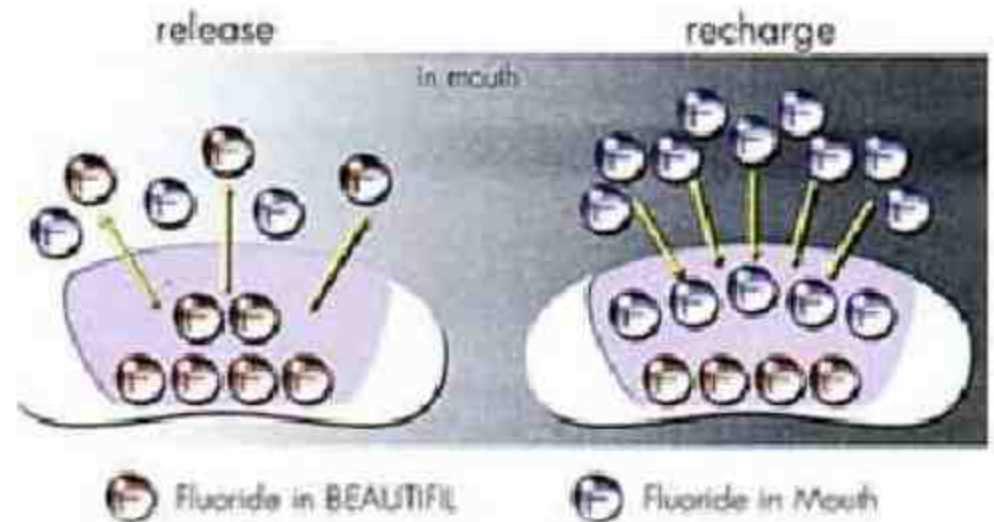


INDICATIONS

- **Restoration of root caries**
- **Non-carious cervical lesions**
- **Class V cavities**
- **Deciduous tooth caries**



- Flouride release
- Flouride recharge
- Bio- compatability
- Excellent aesthetics
- Smooth finish line
- Excellent bonding
- Clinical stability and durability
- Better than microfilled composite



➤ **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

Bioactive glass

- Bioactive glasses (BG) are based on "biological fixation" or "bioactive fixation" where the interface between implant and tissue develop a type of biologic (bony) bond (Hench 1998).
- Implants made of Bioactive glass are based on the ion leachable glass property of the GIC

- When the silica structured network on the surface of a bioactive glass implant comes in contact with body fluids, the hydrogen ions replace the Na^+ ions in the glassy network which are released into the solution.
- This reaction produces hydroxyl ions which leads to a dissolution or breakdown of the silicon-oxygen bonds (Si--O--Si) to form silanols (Si--OH) on the surface of the bioactive glass.
- This then permits Ca and PO_4 ions within the implant to migrate to its surface (leaching) & are precipitated, on top of the silica-rich layer to begin the formation of a carbonate hydroxyapatite (HCA) layer.
- This layer functions as an osseoconducting agent acting as a bridge between the implant & host tissue

- Hench & Ethridge (1982) proposed that the gel bonding layer results in a gradient of elastic compliance (springiness)
- Permits a favorable stress (load) transfer from the implant to the newly formed bone, much like a natural tooth surrounded by a periodontal ligament (Gross et al 1997)

- They don't induce bone necrosis
- They are non-toxic
- Simply activated by body (tissue) fluids on contact.
- Don't induce extreme exothermic temperatures, they induce proliferation of osteoblasts
- Increase alkaline phosphatase activity to a greater extent than any other known bioactive material, (Vrouwensvelder et al 1993)

- The major drawback of bioactive glasses is the length of time for the bone to form.
- It takes months (6.5 – 9) to produce enough bone to provide a weight-bearing capacity.

- To solve the limitations encountered with bioactive glasses
- New compositions comprising of bioactive glasses with a powdered or particulate form of activators, such as biological fluid components or components of SBFs, to speed up bone formation.
- As the tissue fluids interact with the closest bioactive glass particles, such powdered "activators" come into play to reach the less accessible bioactive glass particles, thereby bringing about a greater and more uniform release of appropriate ions to enhance osseointegration.

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THANK YOU