

Filling Material

1

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Filling material

- The material that is used to replace a missing part of the tooth which may result from
- dental caries
- trauma
- abrasion.

Filling



Filling material can be divided in to:

- **1. Direct filling materials:** it placed directly into a cavity on a tooth, and shaped to fit it.



Filling material can be divided in to:

- **2. Indirect filling materials:** the dental impression is taken after tooth preparation and sent to a dental technician who fabricates the restoration that place in the prepared tooth.





Requirement of an *ideal* Filling material:-



Requirement of an ideal Filling material:-

1. **Working time** should be sufficiently long, to enable manipulation and placement of material before setting.
2. **Setting time** should ideally be short for comfort of both the patient and clinician.
3. The material must withstand large variation in PH. **(Why???)**
4. Filling should be good **thermal insulator** (low thermal diffusivity). **(Why???)**
To protect the dental pulp from the harmful effect of the hot and cold stimuli
5. Materials should have values of coefficient of thermal expansion similar to those of enamel and dentine. **(Why???)**
6. Metallic material should not undergo excessive corrosion, **(Why???)**
or be involve in the development of electrical currents which may cause "Galvanic pain".

THERMAL Diffusivity

is a measure of transient heat-flow

The thermal diffusivity describes the rate at which a body with a non uniform temperature approaches equilibrium.

COEFFICIENT OF THERMAL EXPANSION

The change in length of a material for a 1 C change in temperature is called the linear coefficient of thermal expansion

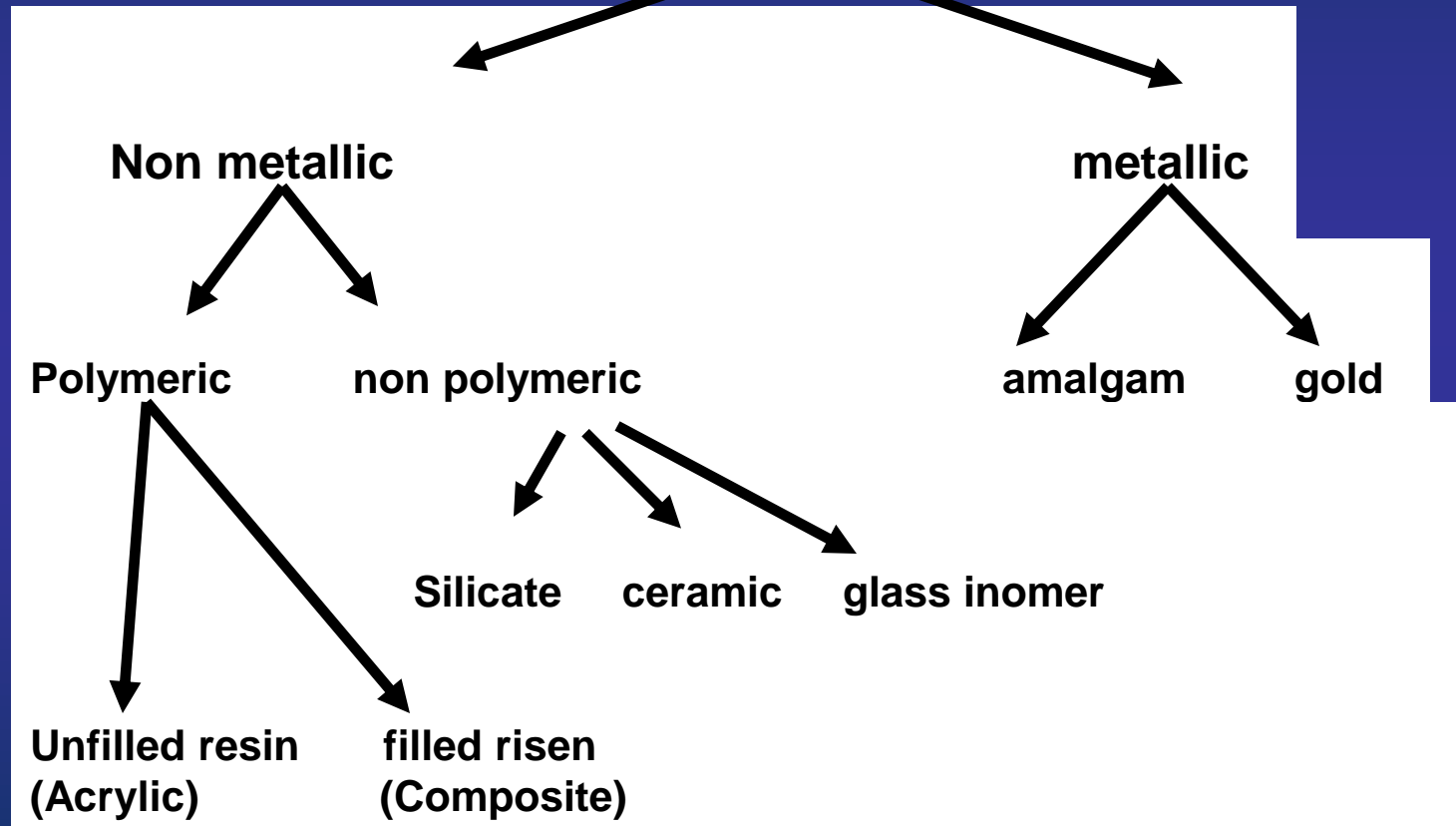
Requirement of an ideal Filling material:-

7. Should have satisfactory **mechanical properties** to withstand the force applied, abrasion resistance, compression and tensile strength, modulus of elasticity.
8. It should adhere well to the tooth walls and seal the margins. **(Why???)**
to prevent ingress of fluid and bacteria.
9. It should be harmless to the operator and to the patient and should not be irritant to dental pulp and soft tissue.
10. It should be radiopaque.
11. It should **bacteriostatic and anticariogenic**.
12. It should be easily polished. **(Why???)**



- ✓ No single restorative material is suitable for all cases.
- ✓ For some situations, the strength and abrasion resistance of material may be the prime consideration.
- ✓ In other situation, appearance and adhesive properties may become more important.

Classification of the Filling Materials



Other classification

*Anterior filling materials.

*Posterior filling materials.

Composite materials

The term composite may be defined as a **compound** of two or more distinctly different materials **with properties that are superior or intermediate** to those of the individual constituents.



Composite materials



Composite materials



Composite materials





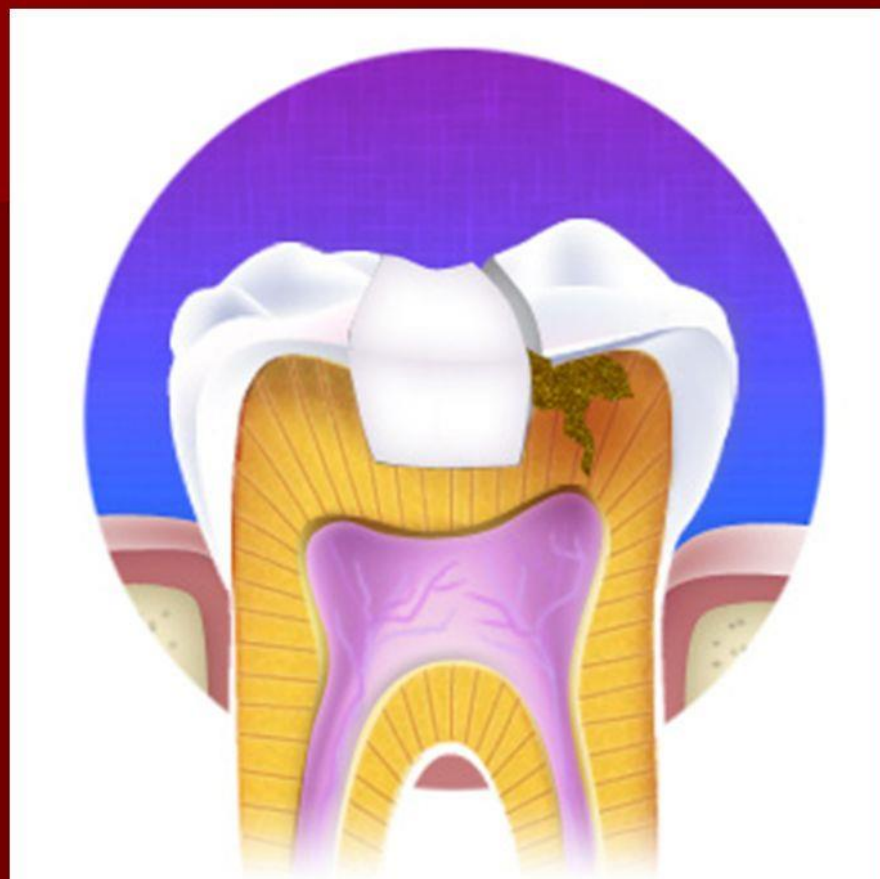
Composite materials

Composite is polymeric filling material reinforced with filler particles used as restorative materials.

The proper term is polymer matrix composite or resin composite.

It has higher mechanical properties than of acrylic filling and of silicate cement.





Composite materials

Modern composite materials have

- excellent esthetics that mimics the natural teeth
- excellent durability
- wear-resistance
- high mechanical properties for stress bearing areas
- So can be used as anterior and posterior filling materials)



Composition

A resin composite is composed of four major components:

1. **Organic resin matrix.** (Bis- GMA or urethane dimethacrylate).
2. **Inorganic filler particles** (Quartz, colloidal silica glasses or ceramic containing heavy metals).
3. **Coupling agent** (organo silanes).
4. **The initiator-accelerator system.**

Also they contain

1. **Hydroquinone** - inhibitor to prevent premature polymerization
2. **UV absorber** - to improve color stability
3. **Opacifiers** - e.g. titanium dioxide and aluminum oxide.
4. **Color pigments** - to match tooth color

Composition



- 1. Organic resin matrix.**
- 2. Inorganic filler particles.**
- 3. Coupling agent.**
- 4. The initiator-accelerator system.**

Composition

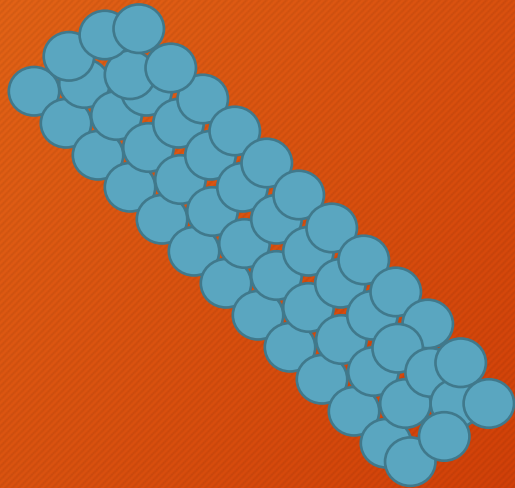
Monomers



- 1. Organic resin matrix.**
- 2. Inorganic filler particles.**
- 3. Coupling agent.**
- 4. The initiator-accelerator system.**

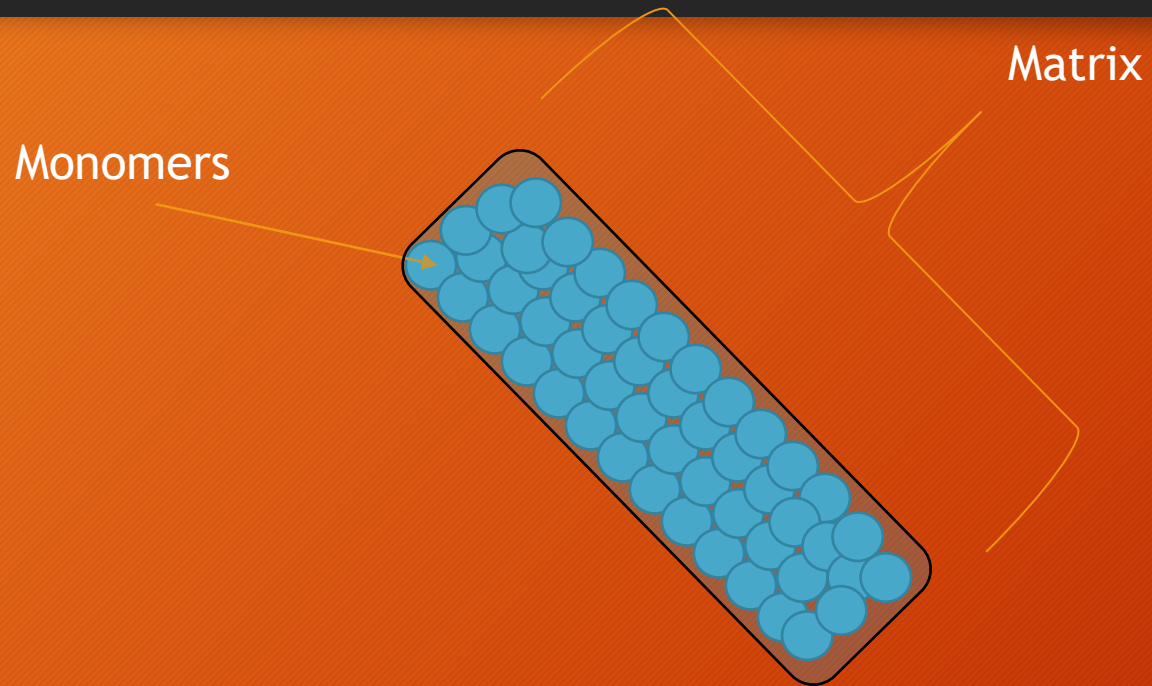
Composition

Monomers



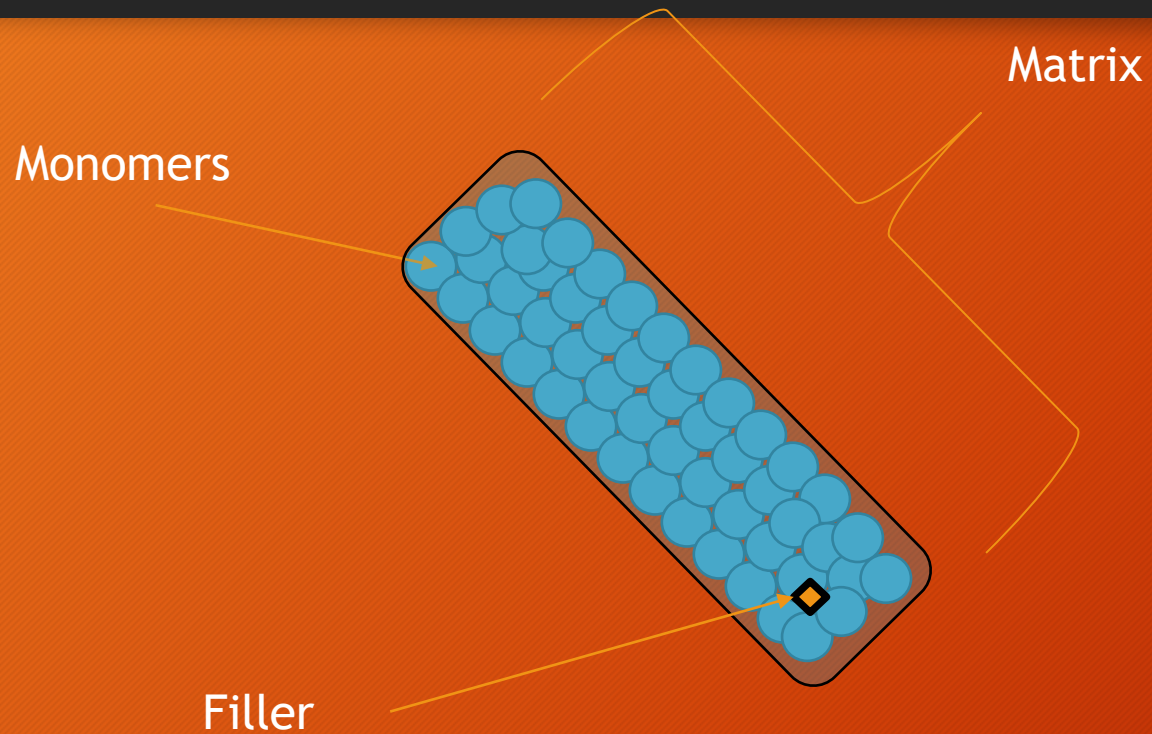
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4. The initiator-accelerator system.

Composition



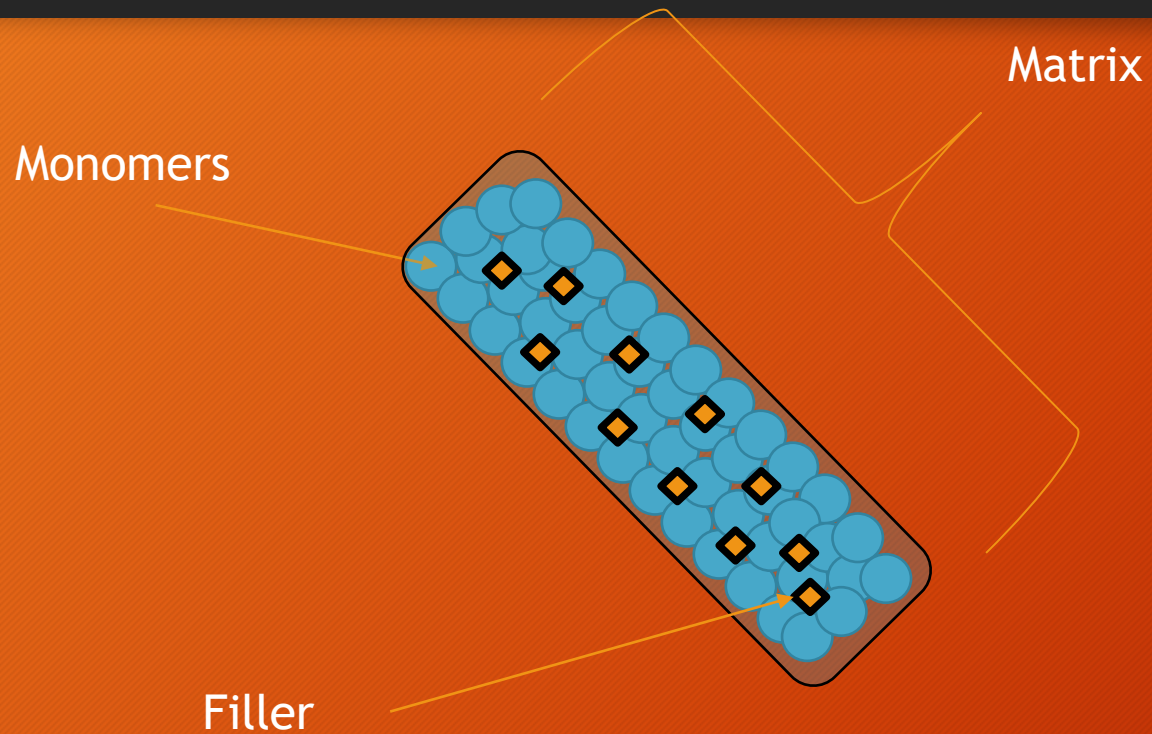
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Composition



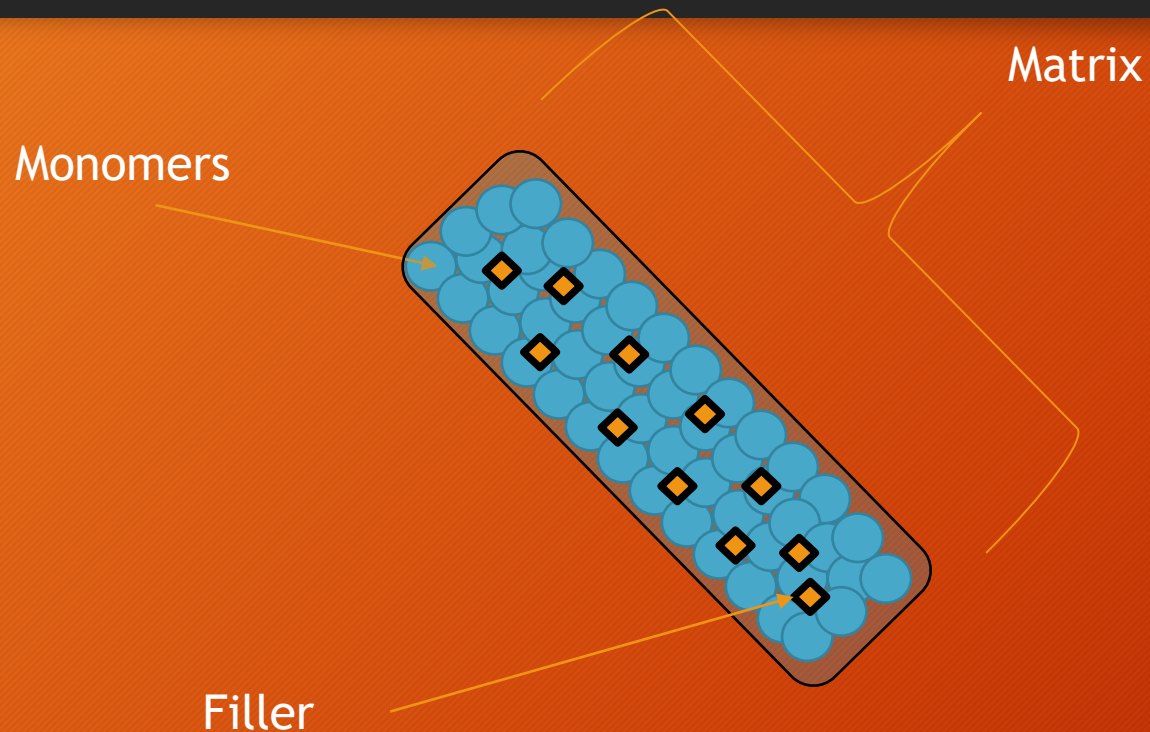
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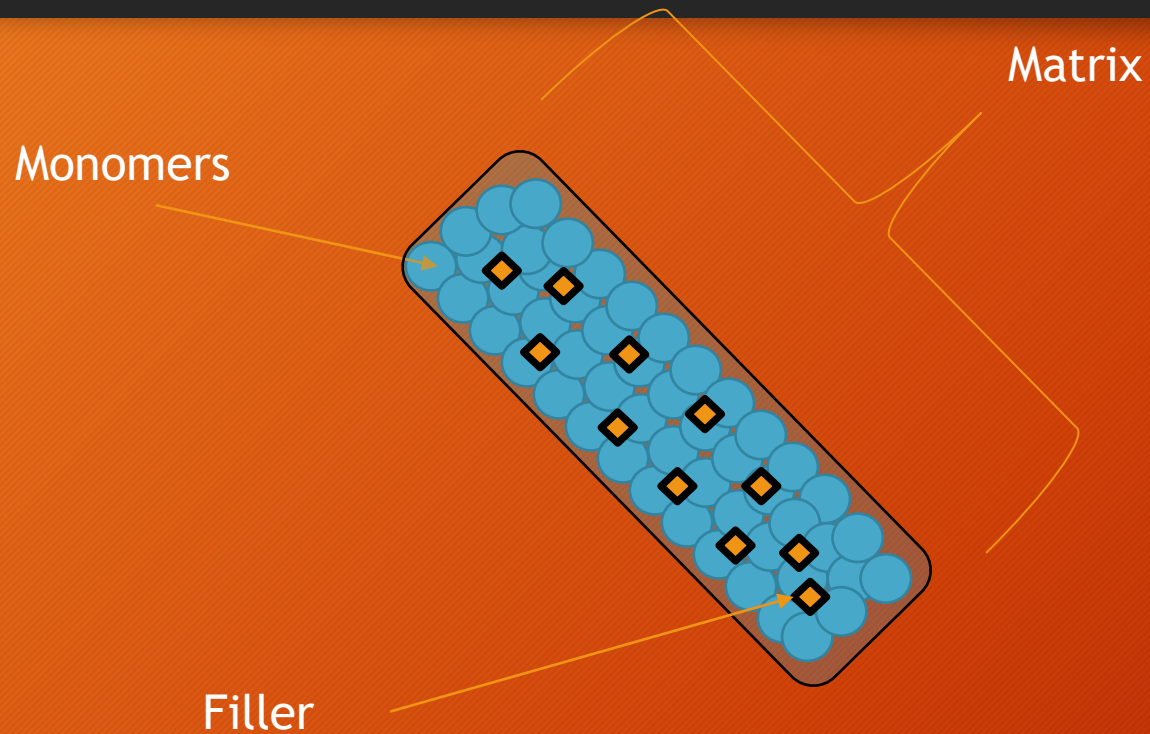


1. Organic resin matrix.
2. Inorganic filler particles.
3. Coupling agent.
4. The initiator-accelerator system.

- Inorganic filler

1- Ground quartz filler: They are chemically inert and very hard. This makes restoration more difficult to polish and can cause abrasion of opposing teeth and restoration. The quartz filler is harder than the glass filler.

Composition



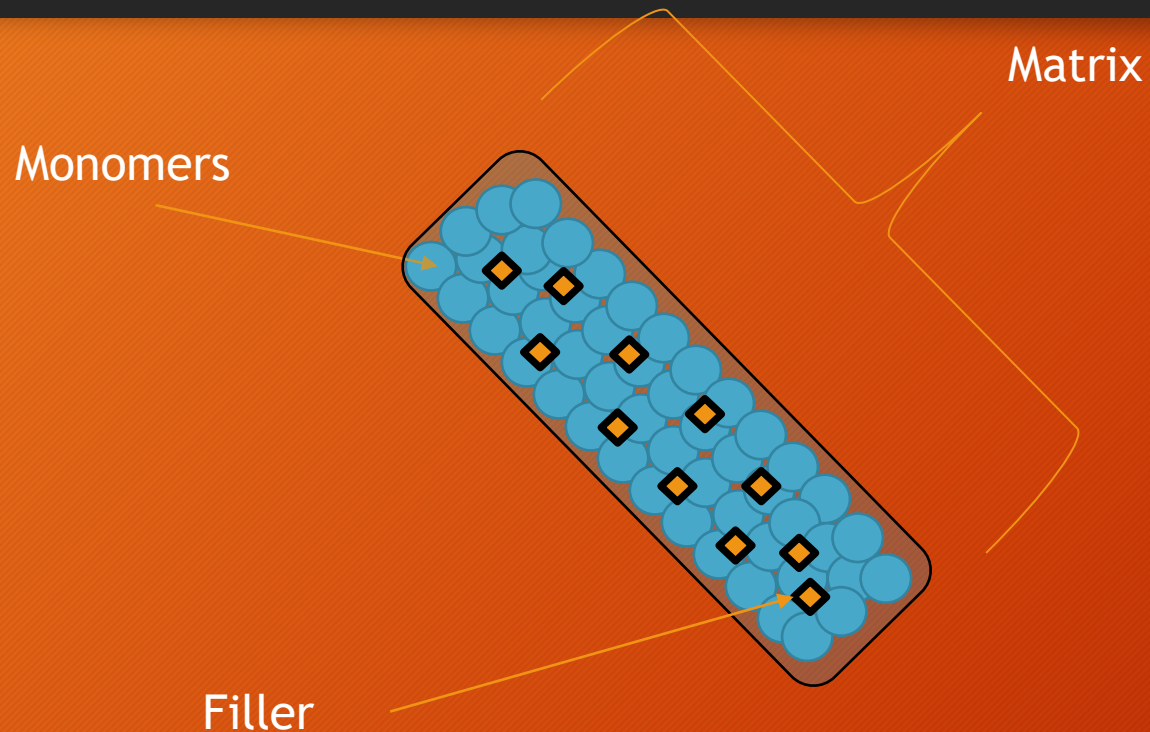
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Inorganic filler

2- Colloidal silica: Referred to as microfillers, they are added in small amount (5 wt %) to modify the paste viscosity.

- Colloidal silica particles have large surface area thus even small amount of micro fillers thicken the resin.
- It used in microfilled composites.

Composition

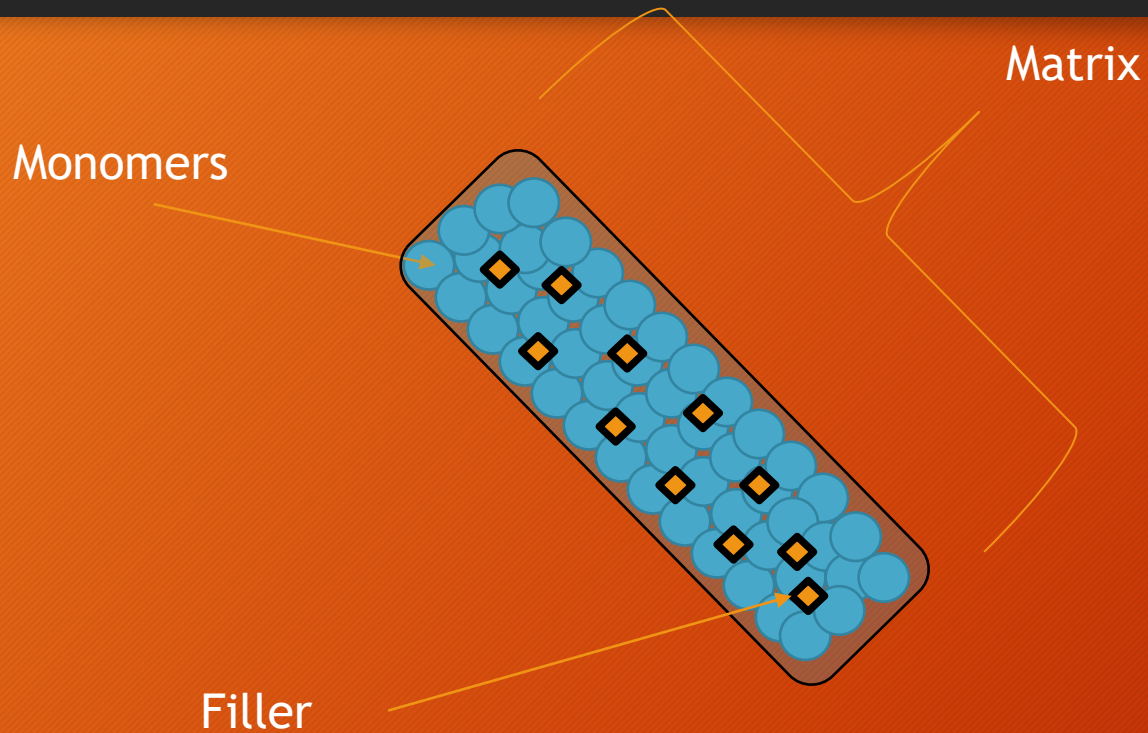


1. Organic resin matrix.
2. Inorganic filler particles.
3. Coupling agent.
4. The initiator-accelerator system.

Inorganic filler

3- Glasses / ceramics containing heavy metal: These fillers provide radiopacity to resin restoration. ex. Barium ; Zirconium.
The most commonly used is barium glass.

Composition



1. Organic resin matrix.
2. Inorganic filler particles.
3. Coupling agent.
4. The initiator-accelerator system.

Inorganic filler

The *type of filler, particle size, and distribution* in resin matrix are the major factors controlling properties.

Composition



- The function of the addition of filler particles:

1. Reinforcement (Improves mechanical properties).
2. Control of workability/viscosity.
3. The radiopacity are improved.
4. Reduction of polymerization shrinkage.
5. Decreases water sorption. Absorbed water softens the resin and makes it more prone to abrasive wear and staining.

Composition



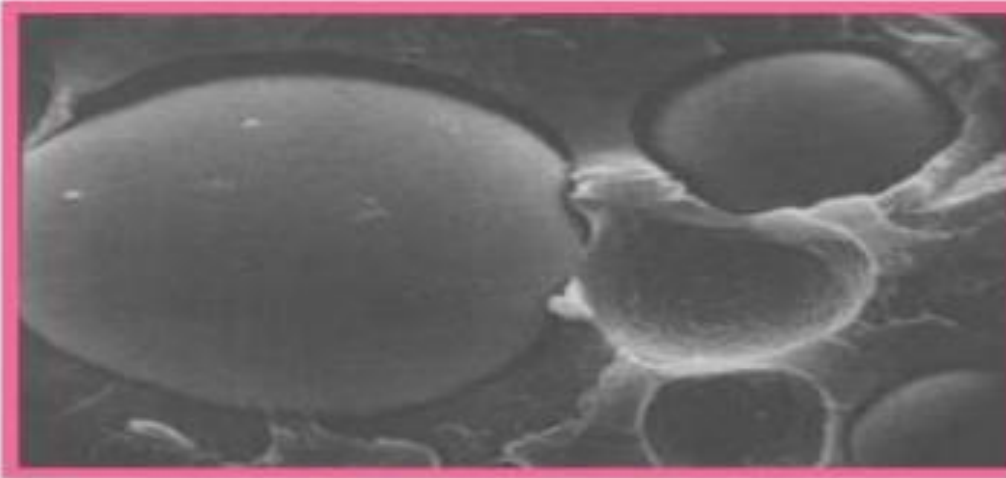
1. Organic resin matrix.
2. Inorganic filler particles.
3. Coupling agent.
4. The initiator-accelerator system.

- Good bond must form between the inorganic filler and the organic resin, The most commonly used coupling agents are organosilanes (often referred to as **silane**).

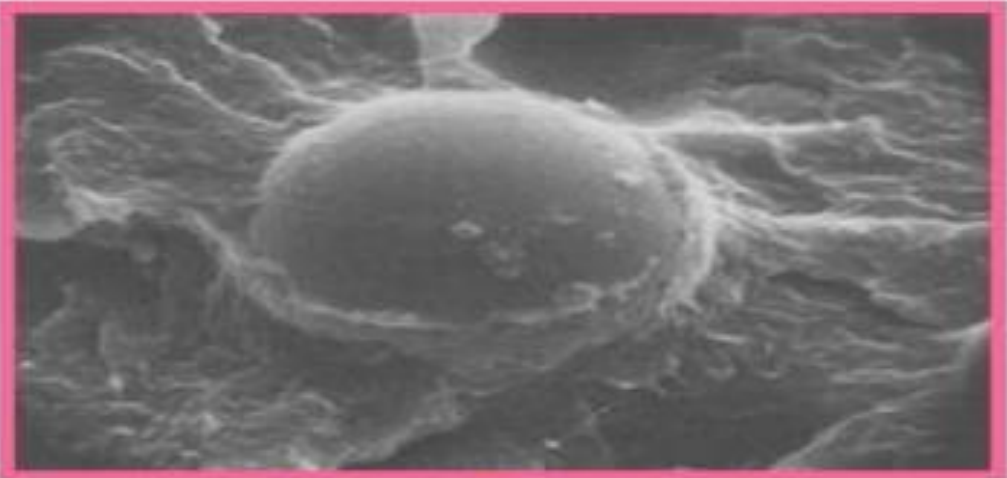
Composition

Mo

Matrix



Untreated



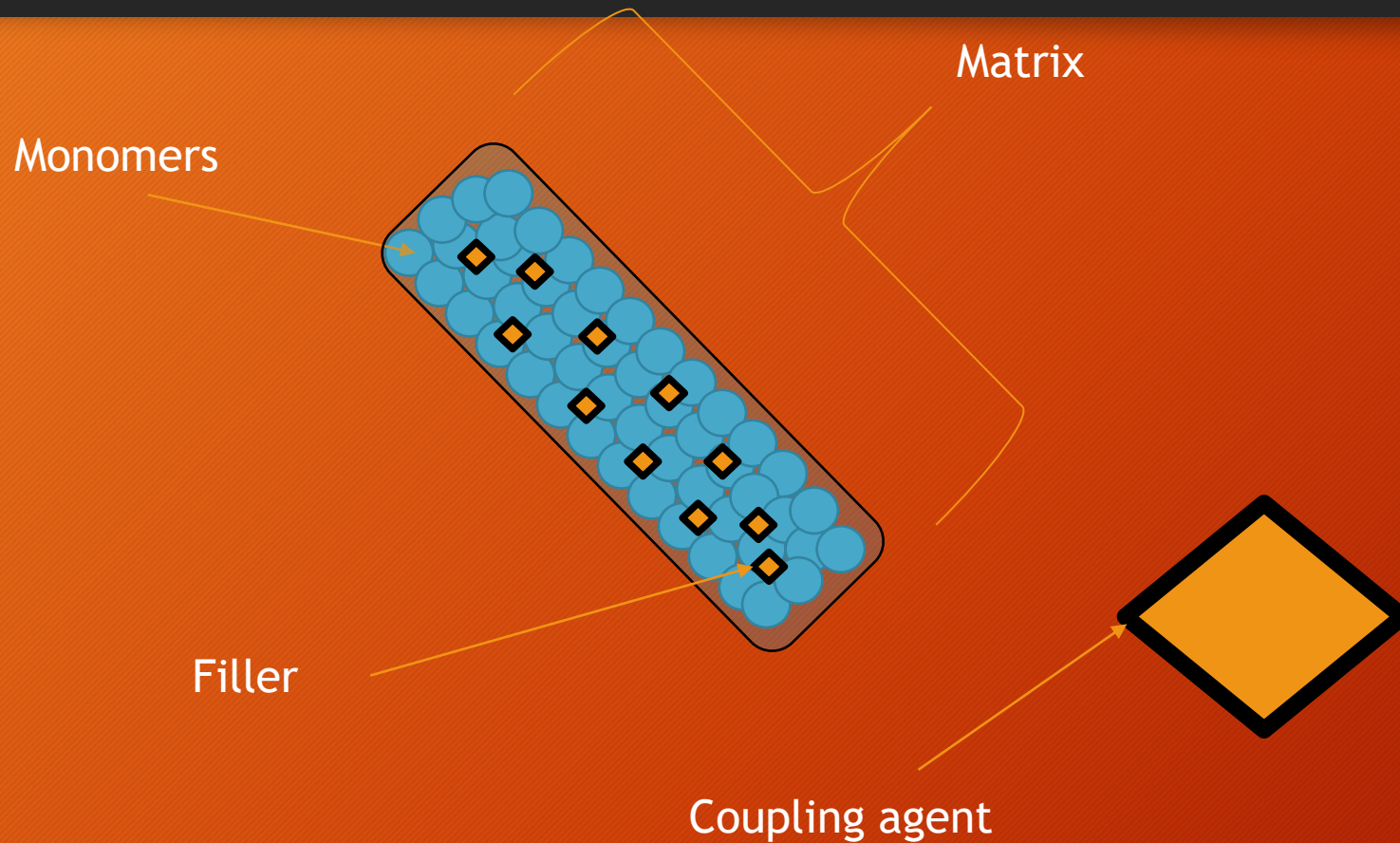
Silane Treated

Coupling agent

system.

When the resin, the most commonly used organic coupling agents are organosilanes (often referred to as **silane**).

Composition



1. Organic resin matrix.
2. Inorganic filler particles.
3. Coupling agent.
4. The initiator-accelerator system.

- The initiator-accelerator system: is to polymerize and cross-link the system into a hardened mass.
- 1. light-activation
- 2. self-curing (chemical activation)
- 3. dual curing (chemical and light-curing)

Properties of the composite

1. Low polymerization shrinkage
2. Low water sorption
3. Coefficient of thermal expansion similar to tooth structure
4. High fracture resistance
5. High wear resistance
6. High radiopacity
7. Good bond strength to enamel and dentin (by using bonding)
8. Good color match to tooth structure
9. Easy to manipulation
10. Easy of finishing and polishing



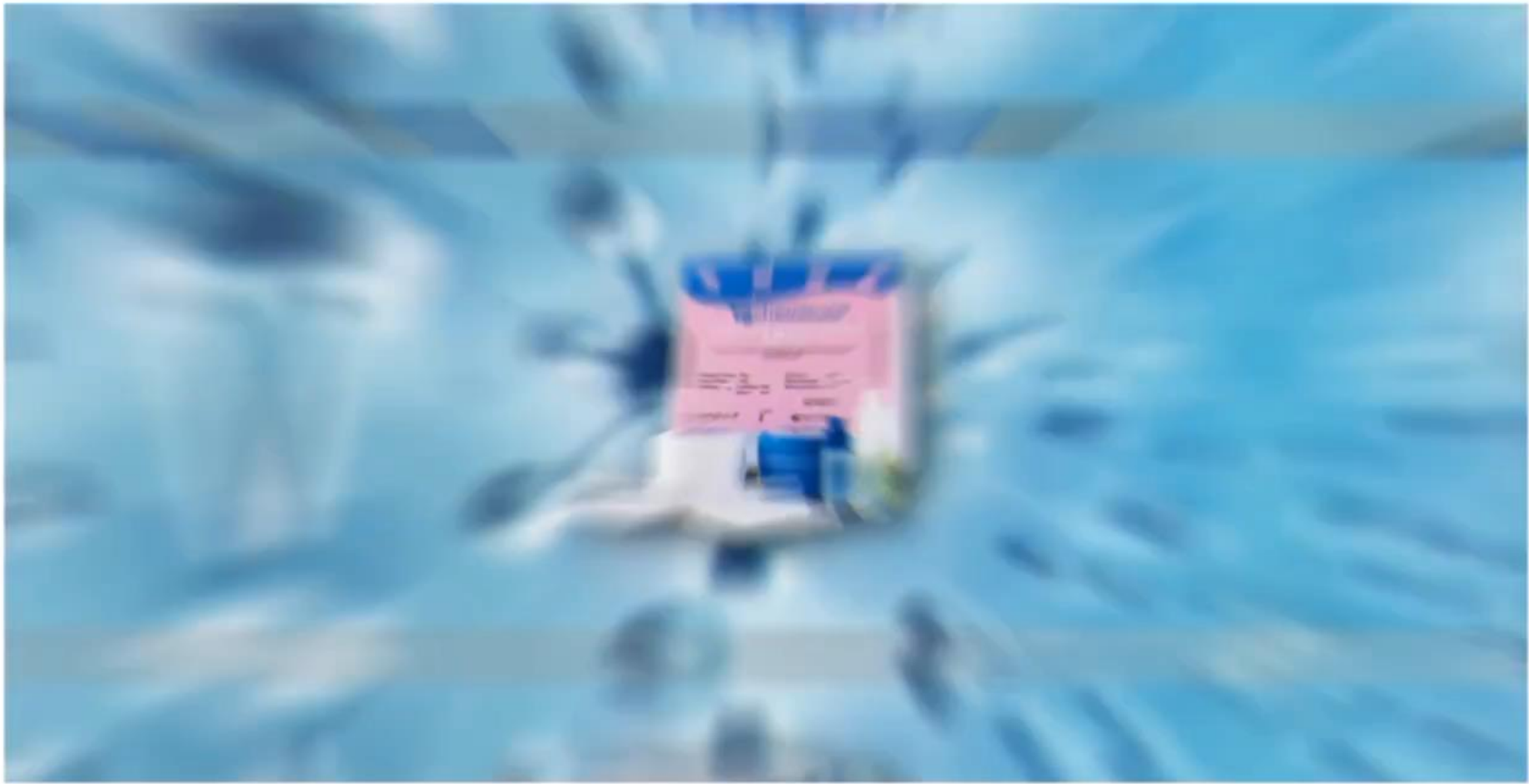
Types of composite

- **Classification of composite based on curing mechanism:**
 1. Chemically activated composite or self cured composite.
 2. Light activated composite.
 3. Dual cured composite

Chemically activated composite resins (self cured composite)

- This is two paste system (base and catalyst) two tubes:
- Base paste: contains benzoyl peroxide initiator.
 - Catalyst paste: tertiary amine activator.



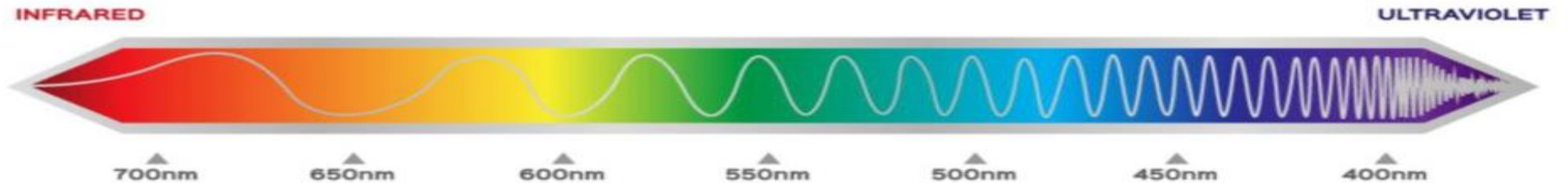


The properties of self cures composite are:

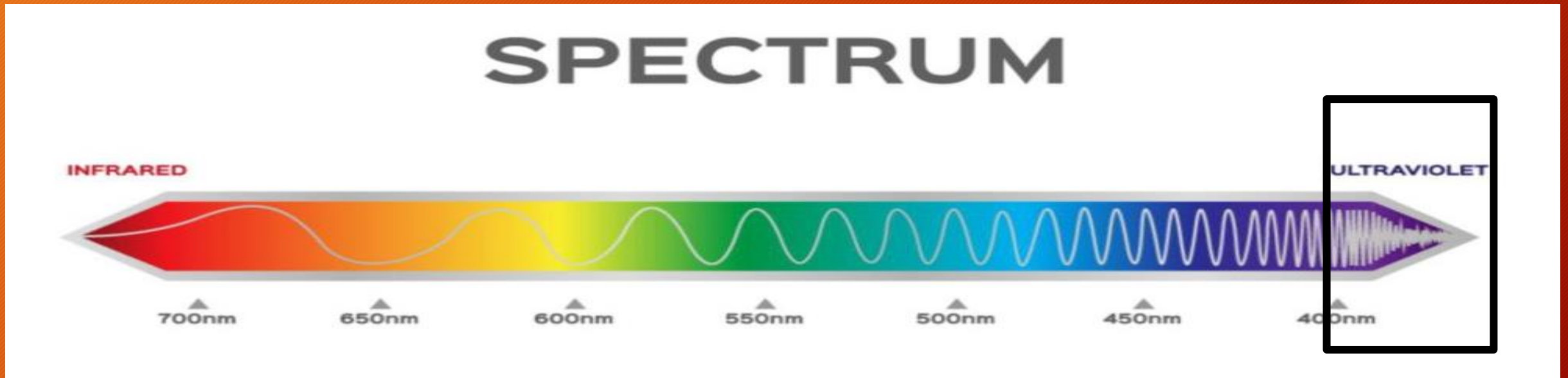
1. Activated by peroxide-amine system.
2. Chemical activation is accomplished at room temperature
3. Cures throughout its bulk.
4. Working time is limited.
5. Supplied as two component system.
6. Air may get incorporated during mixing resulting in reduction of properties.

Light activated composite resins:

SPECTRUM

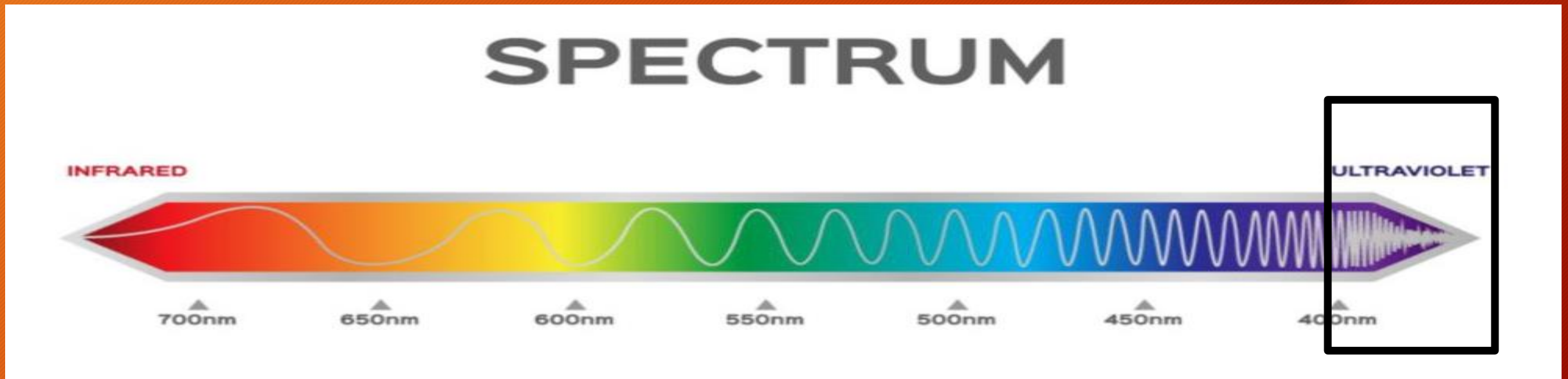


Light activated composite resins:



- UV activated systems: The earliest system used **Ultra Violet light**. Not used now a day because of :

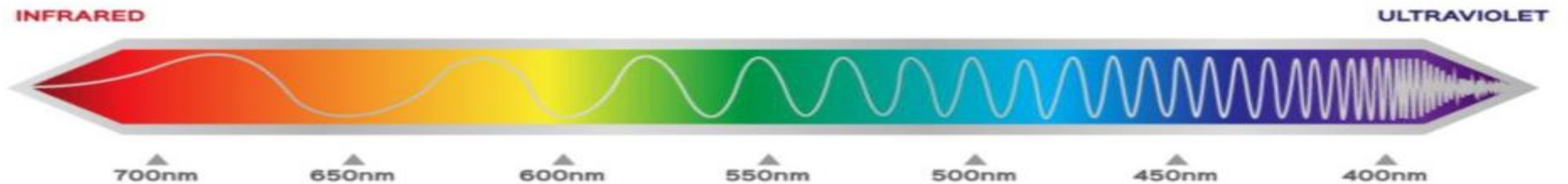
Light activated composite resins:



- **UV activated systems:** The earliest system used **Ultra Violet light**. Not used now a day because of :
 1. Limited penetration of the light into the resin,
 2. Lack of penetration through tooth structure
 3. It irritant to the soft tissue

Light activated composite resins:

SPECTRUM



- Visible Light activated resins

▫ Visible Light activated resins

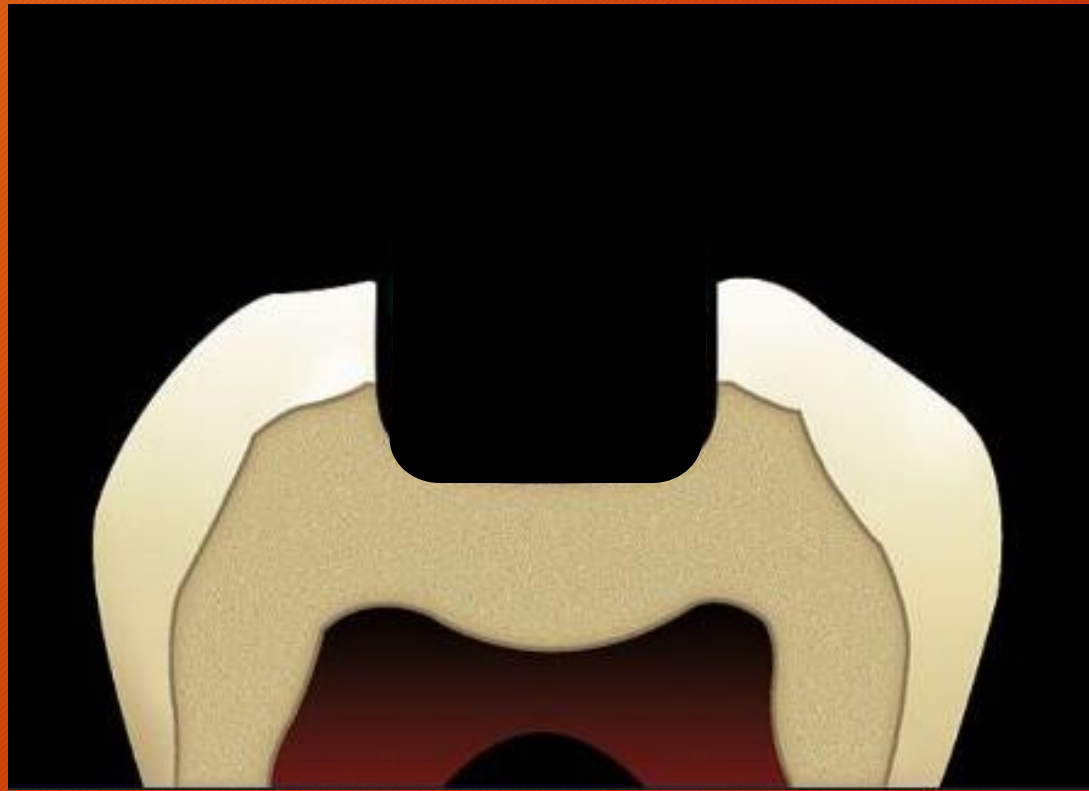
- + They are widely used than the chemically activated resins.
- + These are **single paste system containing photo initiator (camphoroquinone) and Amine accelerator.**
- + Under normal light they don't interact. but when exposed to light of the correct wave length , the photo initiator is activated and reacts with amine to form free radical.
- + **Camphoroquinone has an absorption range between 400-500 nm. This is in the blue region of visible light spectrum.**
- + In some cases inhibitors are added to enhance its stability to room light or dental operatory light.

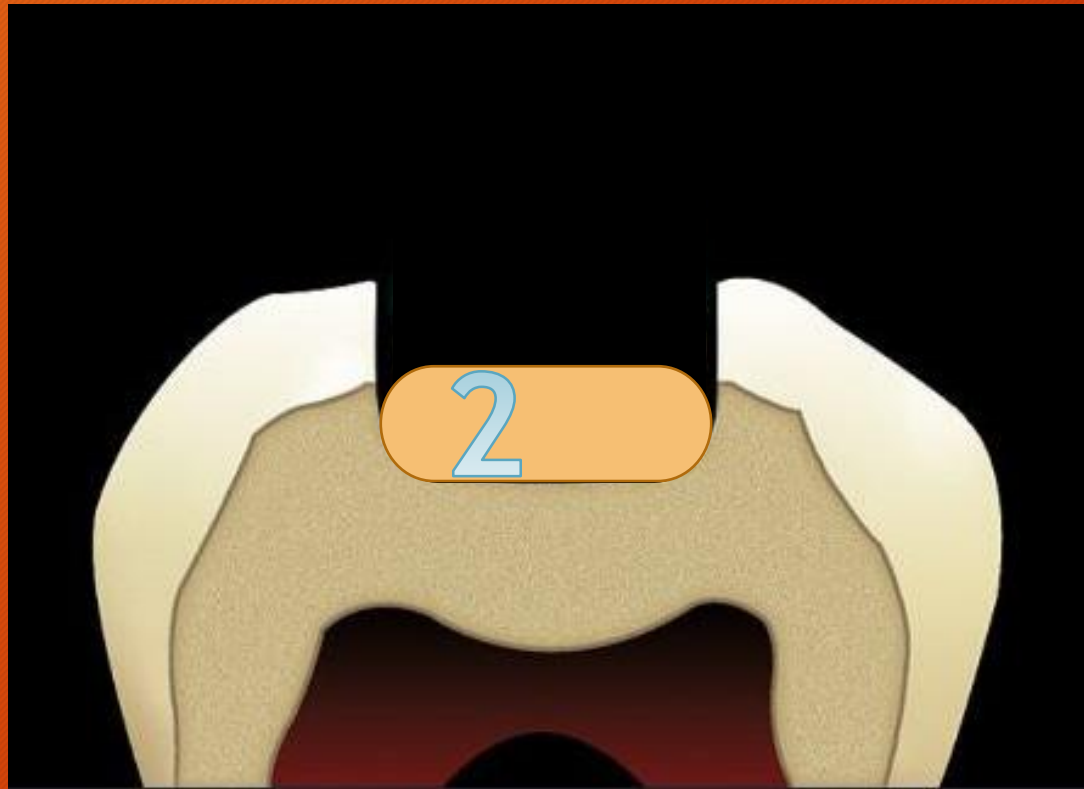
▣ Visible Light activated resins

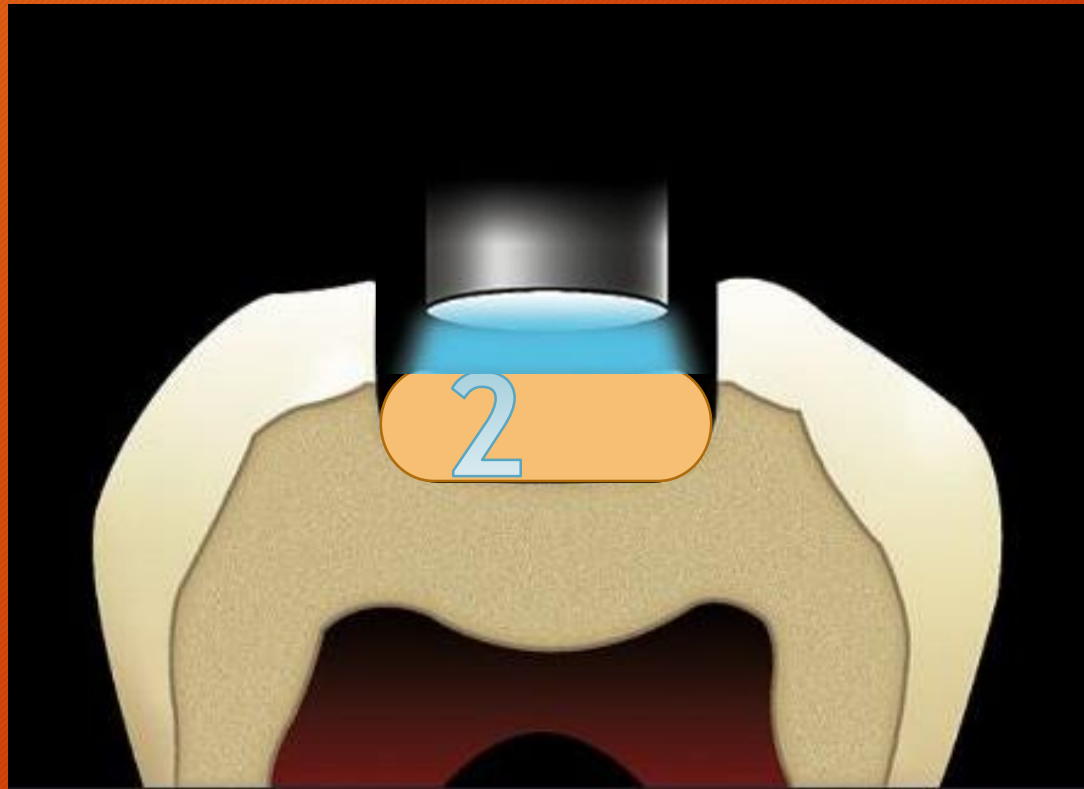


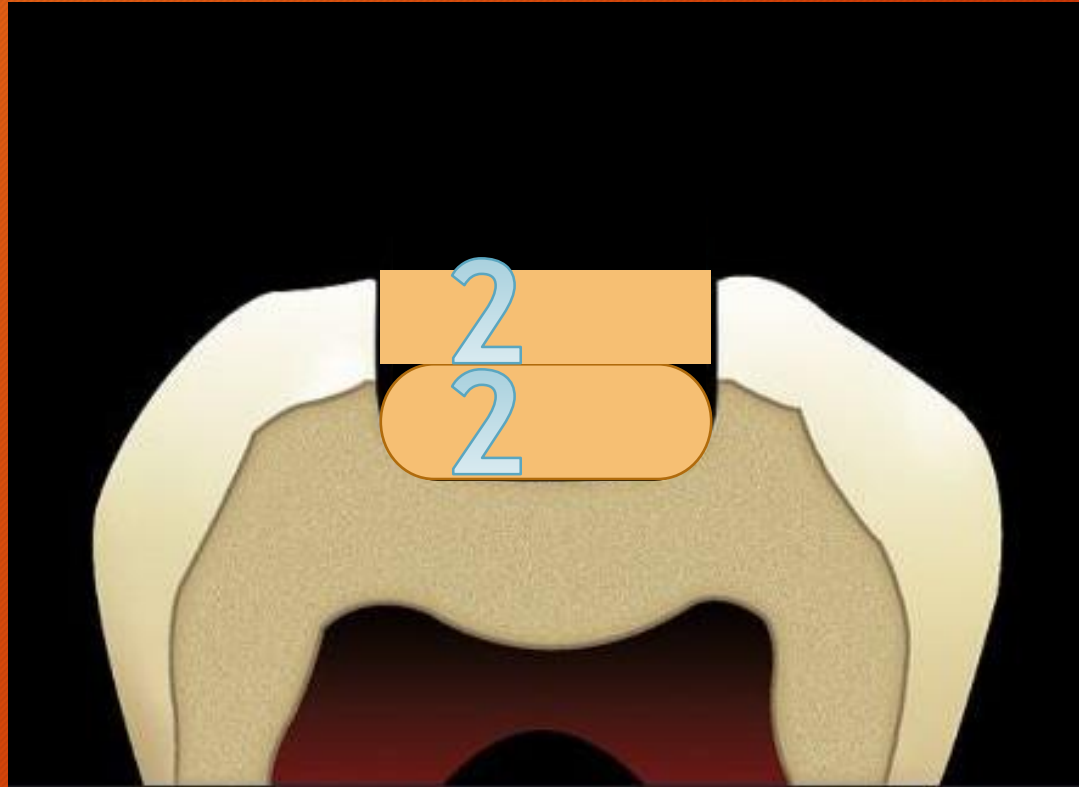
▫ The properties of light cures composite are:

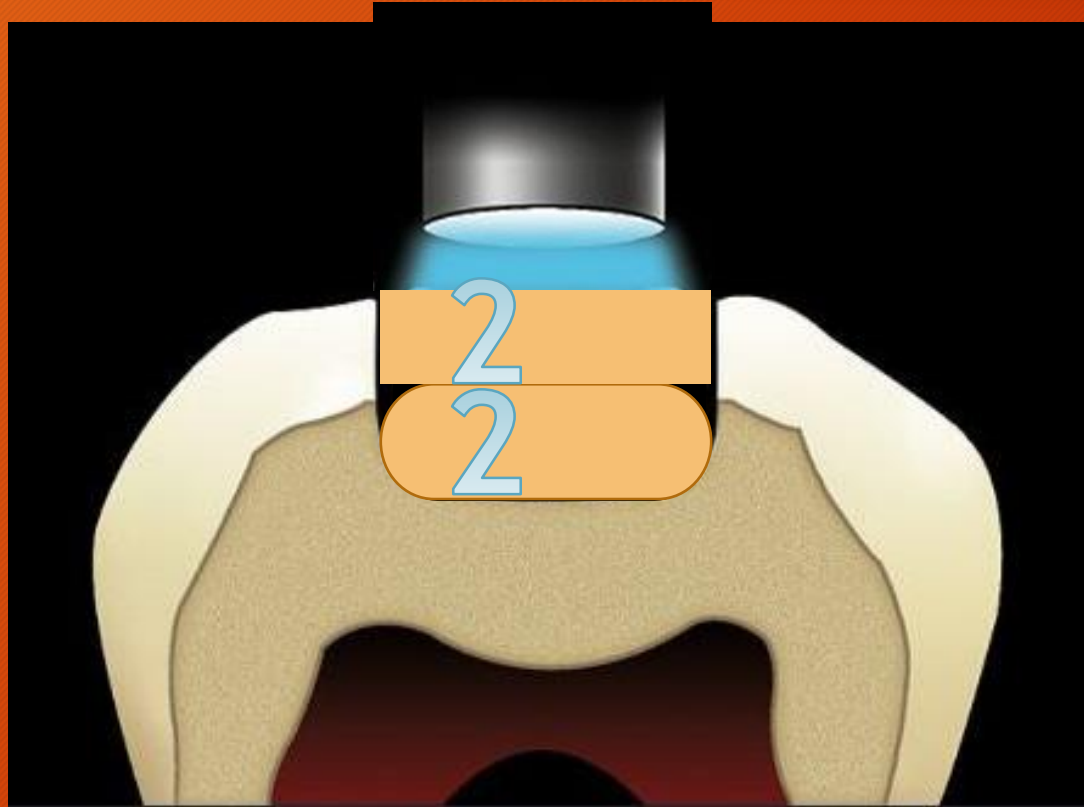
1. Supplied as single component (light tight syringes) or unit-dose capsules.
2. Working time under control of operator.
3. More homogenous mix
4. Required light of correct wave length for its activation.
5. Cure only where sufficient Intensity of light is received.
6. Less chance of air entrapment during manipulation.













▫ Dual cured composite:



▫ Dual cured composite:

Both visible light and chemical reaction to cure the material



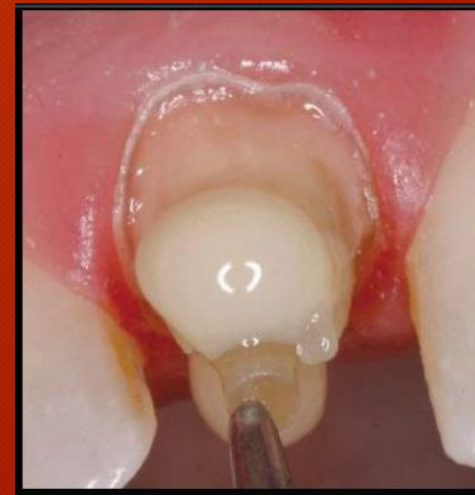
▫ Dual cured composite:

The initial set is made by the curing light and the chemical reaction **finishes the process**



▫ Dual cured composite:

The major advantage of this system is assurance of completion of cure.



▫ Dual cured composite:

The major disadvantage is **porosity** caused by the required mixing. this has been greatly reduced by the use of mixing syringes.



- Dual cured composite:

There is **less color stability** than with the light cure resins due to the accelerators, but this is still better than for self-cure systems.



Filling Material

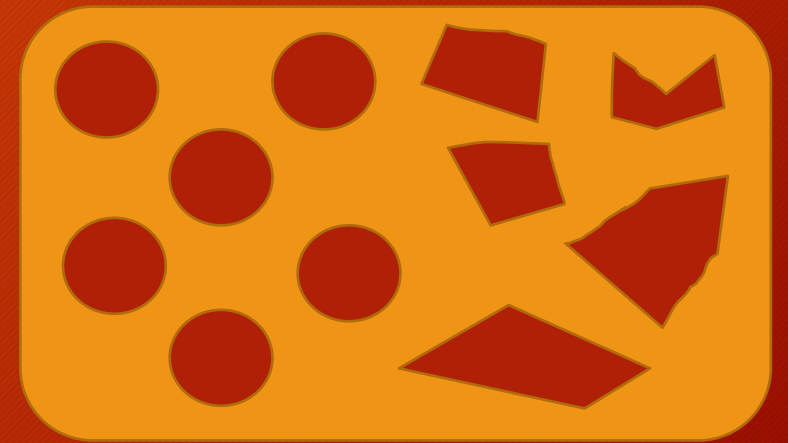
2

Classification of composite based on size of filler particles

1. Conventional composite (Traditional or macrofilled composite)
2. Micro filled composite
3. Small particles composite
4. Hybrid composite
5. Nanocomposite/ Nanofillers

1. Conventional composite (macrofilled composite)

- The early composites were macrofills, these composites contained **large spherical or irregular shaped filler particles.**
- **Ground quarts** are most commonly used as filler **10 to 100 μm .**



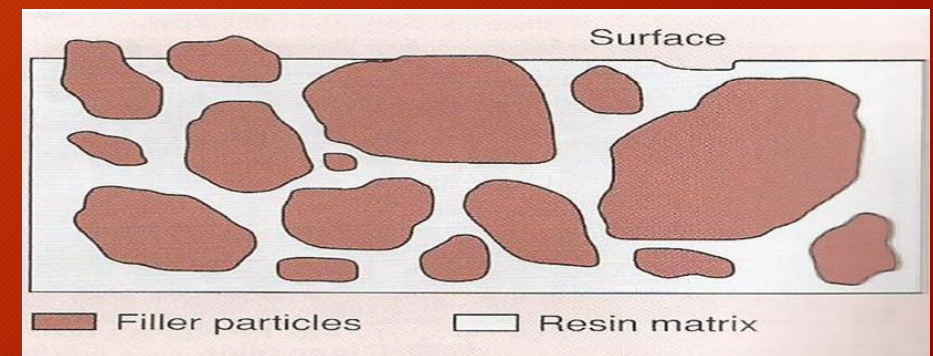
1. Conventional composite (macrofilled composite)

- The conventional composites have improved properties compared to unfilled restorative resin (acrylic) ,
- It has more compressive strength, Tensile strength, Elastic modulus and Hardness.
- It has less water sorption and low coefficient of thermal expansion.

1. Conventional composite (macrofilled composite)

The conventional composites were superior to unfilled resin, they had certain **disadvantages**:

1. Polishing was difficult and results in a rough surface, this is due to selective wear of the softer resin matrix leaving the hard filler particles elevated.
2. Poor resistance to occlusal wear.
3. Tendency to discolor, the rough surface tends to stain.



2. Micro filled composite

They were developed to overcome the problems of surface roughness of conventional composite.

The microfilled composite achieved the smoothness of unfilled acrylic direct filling resins and the advantages of having filler.

The smoother surface is due to the incorporation of micro fillers,



- Colloidal silica is used as micro filler with size 0.01 to 0.1 μm , and the filler loading is 50 vol. wt %.

2. Micro filled composite

The problem with colloidal silica was that it had a larger surface area that could not be adequately wetted by matrix resin.

Thus addition even small amounts of micro filler result in thickening of the resin matrix.

Thus it was not possible to achieve the same filler loading as conventional composite.

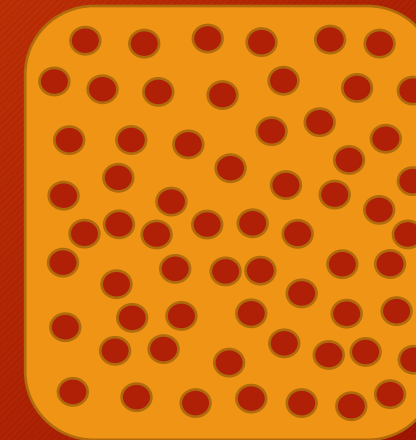


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70-80 wt %



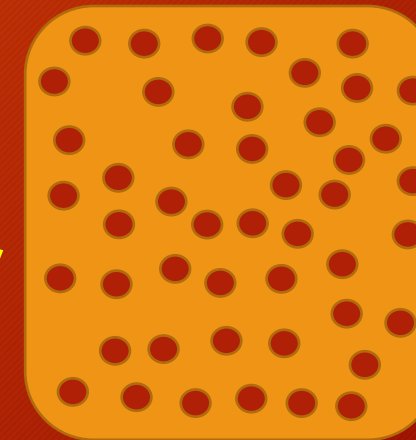
70-80 wt %

2. Micro filled composite

- Their **mechanical properties are inferior** to other composite type (This is because of their higher resin content (50 vol. %)).
- Their biggest advantage is their **esthetics** (the small size of the filler particles means that the composite can be polished to a very smooth surface
- **The microfilled composite is the resin of choice for esthetics restoration of anterior teeth, especially in non-stress bearing area.**



70-80 wt %



50 wt %

3. Small particles composite

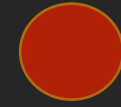
- Small particles composites were introduced in an attempt to have **good surface smoothness (like microfilled composite)** and yet retain or improve the **physical and mechanical properties of conventional composite.**

3.Small particles composite

- The small particles composite use fillers that have been **ground to smaller filler size** to be polished to a smoother surface finish.



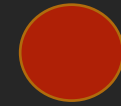
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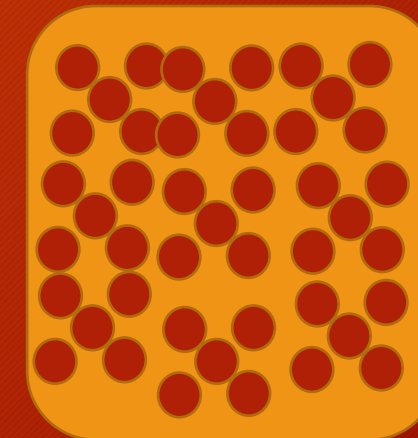
3.Small particles composite



- Due to the **higher filler content** ,the best physical and mechanical properties are observed with this type.
- they can be used in **areas of stress** such as CI II and CI III restorations

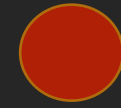


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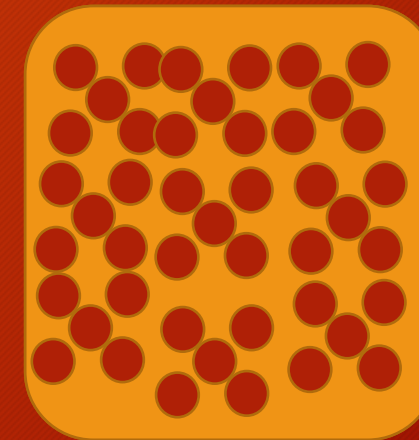
3. Small particles composite



- The filler employed are:
- Glass containing heavy metals,
- Ground quartz
- Colloidal silica is also added in small amount. 5 wt % to adjust the paste viscosity.



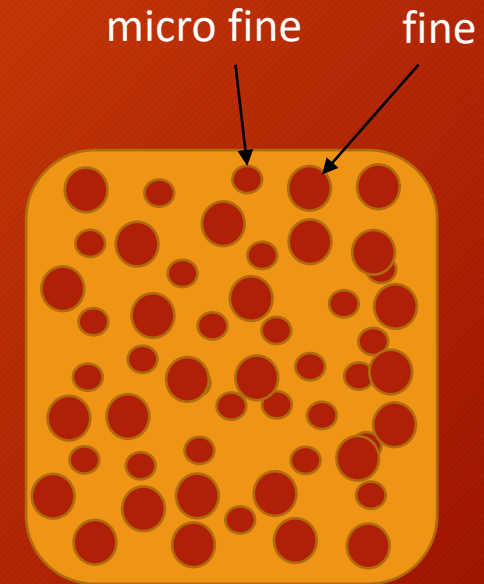
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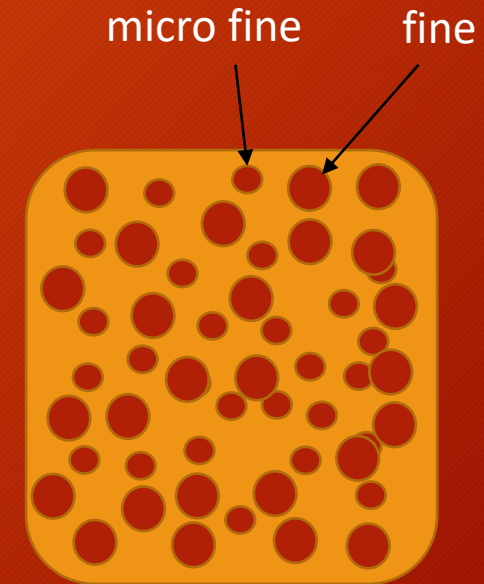
4. Hybrid composite

- **Hybrid composites** are formulated with mixed filler systems containing both **microfine** (0.01 to 0.1 μm) and **fine** (0.1 to 10 μm) particle fillers.
- Most modern hybrid fillers consist of **colloidal silica and ground particles of glasses containing heavy metals.**



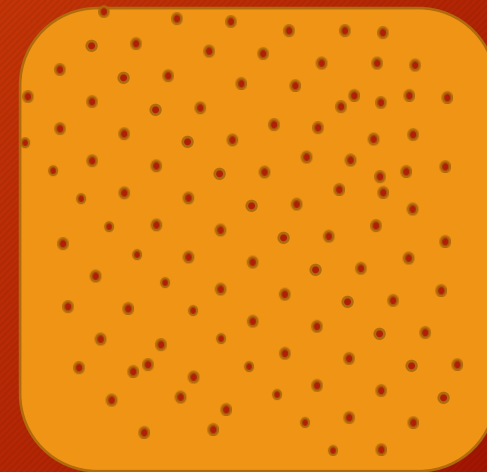
4. Hybrid composite

- **Better surface smoothness** than that of small particle.
- The hybrid are also being widely employed for **stress bearing restoration** ,even though its mechanical properties are somewhat inferior to small particle composites .



5. Nanocomposite

- The latest advancement in composite technology has been the use of nanotechnology in development of fillers.
- it has superior gloss retention, optical properties and superior polish ability (used in anterior restoration) without seriously decreasing in the mechanical properties (used in posterior stress bearing restoration).





Ground quartz
10 to 100 μm





Ground quartz
10 to 100 μm

macrofilled composite



Ground quarts
10 to 100 μm

macrofilled composite

rough surface
discoloration



Ground quartz
10 to 100 μm

macrofilled composite

rough surface
discoloration



Colloidal silica
0.01 to 0.1 μm





Ground quartz
10 to 100 μm

macrofilled composite

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discoloration



Colloidal silica
0.01 to 0.1 μm

Micro filled composite



Ground quarts
10 to 100 μm

macrofilled composite

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discoloration



Colloidal silica
0.01 to 0.1 μm

Micro filled composite

Smooth surface , esthetic



Ground quartz
10 to 100 μm

macrofilled composite

rough surface
discoloration



Colloidal silica
0.01 to 0.1 μm

Micro filled composite

Thick composite
Decrease filler loading
higher resin content
non-stress bearing area



Ground quartz
10 to 100 μm

macrofilled composite

rough surface
discoloration



Colloidal silica
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fillers that have been
ground to smaller filler
size about 0.1 – 10 μm



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macrofilled composite

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Colloidal silica
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Micro filled composite

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Small particles composite

smooth surface but still
not as good as the
microfilled

fillers that have been
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size about 0.1 – 10 μm



Ground quarts
10 to 100 μm

macrofilled composite

rough surface
discoloration



Colloidal silica
0.01 to 0.1 μm

Micro filled composite

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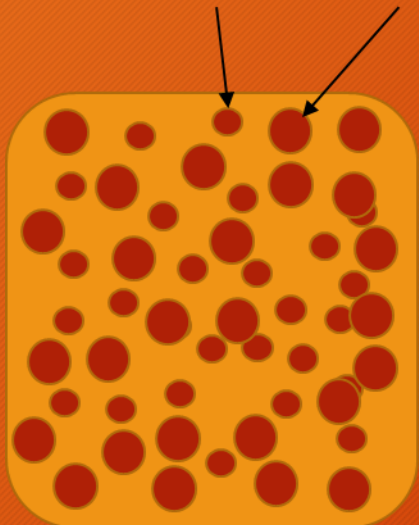


fillers that have been
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size about 0.1 – 10 μm

Small particles composite

smooth surface but still
not as good as the
microfilled

micro fine fine





Ground quarts
10 to 100 μm

macrofilled composite

rough surface
discoloration



Colloidal silica
0.01 to 0.1 μm

Micro filled composite

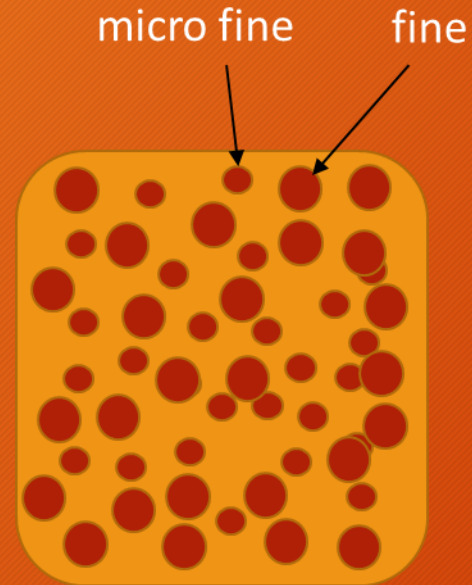
Thick composite
Decrease filler loading
higher resin content
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Small particles composite

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Hybrid composite



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Colloidal silica
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Micro filled composite

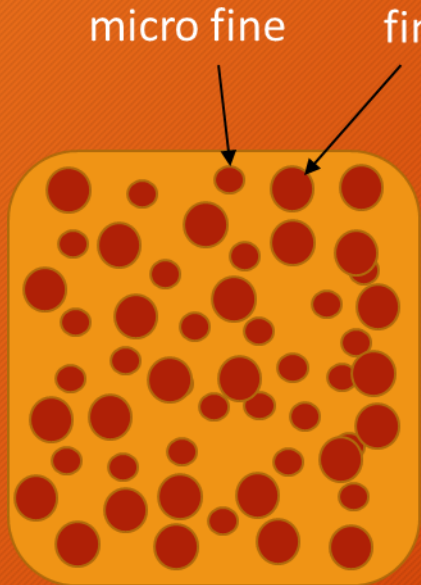
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Small particles composite

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micro fine fine

Hybrid composite

smooth surface and
good strength



Ground quarts
10 to 100 μm

macrofilled composite

rough surface
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Colloidal silica
0.01 to 0.1 μm

Micro filled composite

Thick composite
Decrease filler loading
higher resin content
non-stress bearing area

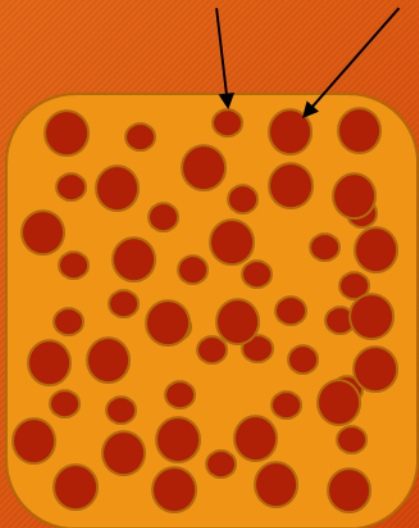


fillers that have been
ground to smaller filler
size about 0.1 – 10 μm

Small particles composite

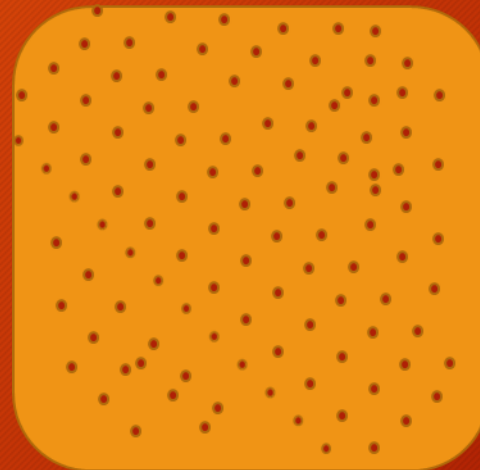
smooth surface but still
not as good as the
microfilled

micro fine fine



Hybrid composite

smooth surface and
good strength



1 -100 nanometers (nm)

Nanocomposite

Manipulation of the composite:

Composites used for restoring teeth are usually supplied in a kit containing the following:

- Syringes of composite resin paste in various shades.
- Etching liquid (37% phosphoric acid).
- Enamel dentin bonding agent.
- Shade guide.



Manipulation of the composite:

- 1. **Pulpal protection:** with cavity liner



Manipulation of the composite:

- **2. Etching:** the enamel at the cavity margins is acid etched with 37% phosphoric acid solution or gel for 30 seconds. Flush the acid away with water, and gently dry the surface with a stream of air.



Manipulation of the composite:

- 3. **Bonding agent** an enamel and dentin bond agent is applied and polymerized that provides micromechanical retention of the restoration. The cavity is now ready for the composite.



Manipulation of the composite:

- **4. Dispensing:** small increments and pack into the cavity preparation.
- **5. Insertion**
- **6. Polymerization**
- **7. Finishing and polishing.**



Flowable composites

- **Low-viscosity, high-flow** composites marketed as flowable composites.
- These resins typically have a lower viscosity through a **reduced filler loading**, which enables the resin to flow readily, **spread uniformly**, intimately **adapt to a cavity form**, and produce the **desired dental anatomy**.

Flowable composites

- Low-viscosity
- These composites are used for filling cavities which are small and shallow.



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Dept of Cons and Endo

posites.

and filler loading,
nately adapt to

Compomers

Compomers

Compo-mers

Compomers

Compo-mers

composite

A diagram consisting of a yellow arrow pointing from the word 'Compo-mers' to the word 'composite'.

Compomers

Compo-mers

composite

Esthetic

Compomers

Compo-mers

```
graph TD; A[Compo-mers] --> B[composite]; A --> C[Esthetic]
```

composite

Esthetic

Compomers

Compo-mers

```
graph TD; A[Compo-mers] --> B[composite]; A --> C[Glass ionomers]; B --> D[Esthetic]
```

composite

Esthetic

Glass ionomers

Compomers

Compo-mers

```
graph TD; A[Compo-mers] --> B[composite]; A --> C[Glass ionomers]; B --- D[Esthetic]; C --- E[Fluoride release]
```

composite

Esthetic

Glass ionomers

Fluoride release

Compomers



- They are used for restorations in **low stress-bearing areas**
- Compomers are recommended for patients at **medium risk of developing caries**.
- setting occurs primarily by **light-cured polymerization**, but an **acid-base reaction** also occurs as the compomer absorbs water after placement and upon contact with saliva.

Glass ionomer cements

Glass ionomer cements

Glass ionomers are **water-based self-adhesive** restorative.

The filler is a reactive glass called **fluoroaluminosilicate glass** and the matrix is polymer or copolymer of **carboxylic acids**.

The setting reaction of these materials involves an **acid-base reaction** and **release fluoride ions**.

There are two main types of glass ionomers:

1. Conventional glass ionomer
2. Resin-modified glass ionomer

Glass ionomer cements

1. Conventional glass ionomers have the following :

- Polycarboxylic acid
- Fluoroaluminosilicate (FAS) glass
- Water
- Tartaric acid

2. **Resin**-Modified Glass Ionomers (RMGI): the essential components of are as follows:

- Polycarboxylic acid polymer
- Fluoroaluminosilicate glass
- Water
- **Hydrophilic methacrylate monomer**
- Free radical initiators

Glass ionomer cements

1. Conventional glass ionomers

Acid-base reaction

2. Resin-Modified Glass Ionomers (RMGI):

- Acid-base glass ionomer reaction.
- Light-activated polymerization
- Chemically activated polymerization

Uses of Glass Ionomers

1. High caries activity or where caries are likely to recur.
2. small caries lesions in non-stress-bearing restorations in permanent teeth
3. interim restoration in permanent teeth,
4. They make an excellent liner or base in all deep lesions
5. Resin-modified glass ionomers are often the material of choice for pediatric restorations and preventive applications

Properties of Glass Ionomers:

1. The physical and mechanical properties of GIs are **lower than that of composite resins** and hence these materials are indicated for **conservative restorations**.
2. The coefficient of thermal expansion has been shown to be **closer to tooth structure (dentin)** than are resin composites. (Serve as **good insulation** against thermal shock, particularly when used as liners and bases).
3. **Fluoride ion release** and uptake these materials act as a reservoir of fluoride ions.

Properties of Glass Ionomers:

4. **Good adhesion to tooth structure** Unlike composite materials (etching of the enamel or dentin surface is not needed). **self-adhesive**

5 -radiopaque

Thank

you

