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As we know there is two types of filling:

1- The composite filling (white filling).

2- The Amalgam filling (silver filling).

In this lecture we are going to talk about the composite filling and its history.

**What is the dental composite filling?**

It is an aesthetic filling material that has the same color and transparency of the teeth.

**\*What can we get from this filling?**

It can restore the internal structure of the teeth by restoring the exact shape, length and everything related to the natural teeth measurement and structure.

**\*How to treat a patient by composite filling?**

In general the treatment goes through this procedure :first the dentist should determine the caries location in the teeth and then he/she should remove it from the teeth , after that there will be an empty area inside the teeth and that area should be filled with composite filling so the teeth will be normal again.

You as a dentist should be very careful during dealing with such filling in the future.

Diastemia: is the space that is located between the two central incisors and can be treated by composite filling.

***\*\*Now what is the definition of the composite material ?***

A composite material is a product which consists of at least two distinct phases normally formed by blending together components having different structures and properties.

***\*\*Why two phases?***

The purpose of this is to produce a material having properties which could not be achieved from any of the individual components alone.( so when we mixed the two materials together we will have one material with desirable proprieties ).

Dental composites were developed in the early 1960s.

Amalgam were introduced way before composites so composites the relatively the new one material.

From 1960s till now the use of composites expanded hugely, and in some countries like Scandinavian countries they don’t even place amalgam restorations, all they use is composites .

Now a day we still use amalgam, amalgam has certain indications, but in general you need to understand that composites application is more versatile. ( so if you have whatever shape of a cavity , whatever shape of defect , you can place a composite filling inside it , but the amalgam filling requires a certain cavity design in order for the material to be placed in that tooth .

We usually say composites are more conservative than amalgams, because we don’t remove so much of the tooth structure in order to restore it properly, but with the amalgam sometimes we need to.

In the early 1960s the first two tooth covered materials that were introduced before the composites were the:

1- Silicate Cements (it is not used now).

2- Acrylic Resin (it is used till now).

\*The problem with acrylic resin is that it has a very high wearing rate that could cause the cusps to become flat instead of pointed and it also could remove the features and details of the occlusal aspect after locating it for a long period of time in the mouth, while composites tend to have a much harder surface, it has a much higher mechanical properties , so it does have less wear than the acrylic resin .

Now the newest fillings are composed of acrylic resin and composite resin and this combination wears less.

The phases of the composite filling are:

1-Matrix which is composed of:

a. Principle monomer

b. Diluent monomer

c. Initiator/activator

d. Silane coupling agent

since we have monomers that tells us that the matrix is a polymer.

2) Filler

\*\*The matrix binds the fillers and surround them.

While using a Scanning Electron Microscope the fillers of the composite will be appeared.

Components of the matrix:

1-**The principle monomer** is typically *bis-GMA* (Bisphenol A and glycidylmethacrylate) or urethane dimethacrylate (UDMA). ( the principle monomer is very viscous)

2- **The diluent** is an organic chemical added to control the viscosity of the final product and make it more workable (e.g triethylene glycol dimethacrylate (TEGDMA)).

*C = C* (the carbon double bond) is the functional group of both principle monomers and the diluents.

*3-****Activator/initiato****r*: Polymerization is achieved via two systems; a *chemical reaction* (chemical cure) or*light activation* (light cure).

4-**Silane coupling agent:** very important for the reinforcement of the polymer by the fillers. The two constituents should be bonded together. To achieve this, the filler is usually treated with silane coupling agent. ( it surrounds the fillers and binds the fillers to the matrix )

\*\*No by products produced during the reaction because it’s a addition polymerization.

The problem with the regular ones (bis GMA) , (UDMA) and (TEGDMA) , the addition polymerization reaction tends to cause shrinkage , so the monomers will pull together , so clinically this thing tend to clear some problems for example if you built a tooth with certain contact with the adjacent tooth , once you polymerize this filling , the filling will get smaller , so the contact will open .

That is why there is a new monomers that was introduced in to the market which called silorains , that replaces the (UDMA ) and (bis-GMA), they have a different molecular structure ,so they tend to produce less shrinkage upon polymerization , however this thing is not scientifically proven yet .

***First, The Matrix:***

The matrix of a dental composite polymerizes via chemical reaction or light activation and is called *addition polymerization.*

**Shortcomings of the Matrix:**

The matrix of dental composite has several important functions. The matrix is the phase that is moldable, polymerizes to form a solid mass at ambient temperatures and bonds to tooth structure.

However, the matrix has many shortcomings:

1-The weakest

2-The least wear-resistant phase of dental composite

3-Absorbs water

4- Stains and discolors.

**Therefore, manufacturers minimize the matrix content of composite materials by maximizing the filler contents. ( as much as you introduces fillers to the composites the stronger the composites is , the least water absorption it will have and also it will have less wear )**

***Second,The fillers:***

Filler materials are:

1. Quartz materials (sand), or

2. Engineered glass materials

Fillers affect the mechanical and physical properties of composites:

-increase the Hardness (higher Rigidity and Strength)

-Coefficient of thermal expansion (will be less if you have more fillers) ( if it increased it won’t be good , because the filling will shrink and expand , so the filling won’t stick to the tooth anymore , so we will have a gap between the tooth and the filling structure , and this gap might be full of bacteria or food particles , so we will have carries and sensitivity and other things .

-decreases the Setting contraction

***Fillers types:***

1- Natural **quartz** materials (sand). They are strong, hard and chemically stable in the oral environment.

2- **Engineered glass materials** which are formulated to have the proper strength, hardness, chemical and optical properties for use in dental composite.

The Engineered glass is ground to have properly sized particles and **it is silanated** .

The silanated filler is mixed with monomers, diluents, coloring agents, and other chemicals to form the paste received from the manufacturer.

The type, concentration, particle size and particle size distribution of the filler used in a composite material are major factors controlling properties.

*The size of the filler* in a dental composite determines the surface **smoothness** of the resulting restoration and larger particles result in a **rougher** surface.

Composites are most often classified by the **size of their filler particles**:

If you have large fillers you will have more wear than have small fillers.

\*having large fillers on the surface if the filling , once you have occlusal load on the tooth surface , these large fillers ( remember they are made of **Engineered glass or quartz)** the filler itself will tend to come out of the matrix, so once it comes out it leaves the matrix exposed ( the matrix have low wear resistance) so large amount of the matrix will be lost .

***Types of Dental Composite:***

1- Chemical Cure composite

2-Light cure composite

3-Dual cure composite

***Chemical Cure system:***

*They are* ***two-paste systems****:*

\*One paste contains the tertiary amine (activator) ( N, N-dimethyl-p-toluidine), while the other paste contains the Benzoyl peroxide (Initiator).

\*The pastes have different colors and are mixed at chair-side until the two colors blend into one.

Why each one has a different color?

Anything requires mixing usually comes with two different colors in order to guarantee that you mixed them probably, as long as you can see the color of both pastes it means they still haven’t mixed, when you have homogenous color it means you mixed them properly

\*\*The pastes are supplied in small plastic jars or screw-type syringes.

When the two pastes are mixed, the inhibitor destroys the free radicals produced for a short period of time. This results in a limited amount of working time to place and contour the restoration.

When the materials are mixed, air bubbles are unavoidably incorporated. Care must be taken to minimize these defects in the final mix*.*

Dentists prefer light cure materials.

***Light Cure materials:***

Light -cure materials are **single-paste** materials mixed by the manufacturer.

Because no chair-side mixing occurs, manufacturers can make the paste thicker with less matrix and more filler particles.

In addition, voids are minimized by the manufacturing process and then a stronger restoration results.

\*\*one of the most important advantages of the light cure that it doesn’t stain or change colors.

The wave length of the light source is matched to the chemical initiator in the composite.

The initiator system composed of a mixture of a di ketone and an amine.

**\*\*Camphor Quinone(initiator that starts the reaction)** is a commonly used diketone which rapidly forms free radicals in the presence of an amine and radiation of the correct wavelength and intensity.

The wavelength of the light source is around **470 nanometers;** The light is **blue** light that is visible to a human eye.

\*\*IMPORTANT:

"As the light is very bright, direct viewing of the light source will damage the eye, so even indirect (reflected) observation of the curing light is contra-indicated ⇒ light shields should be used."

***Inhibitors:***

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

Inhibitors have a strong reactivity potential with free radicals.

Thus inhibitors have two functions:

1- They extend the storage lifetime for all resins.

2- They ensure sufficient working time*.*

*\*\*The thickness of composite cured by a typical light source is called the depth of cure:*

The depth of cure varies depending on:

1. The time of light exposure

2. The composite products

3. The shade of the composite ( in general the darker the composites the less depth of cure it has ).

***Incremental addition:***

Placing dental composites in layers or what is commonly called incremental addition has two benefits:

1. Assures adequate polymerization.

2. Minimizes polymerization shrinkage.

*Composites shrink approximately 2% when they set so that the polymerization shrinkage continues to be problem with dental composites just as it was with acrylic resin materials. The first layer is placed into cavity preparation and cured and the second layer and any subsequent layers are placed and cured until the tooth is adequately restored.*

***Air Inhibition:***

\*When composite materials are placed in increments, each increment chemically bonds to the previous increment.

\*Chemical bonding occurs because **addition polymerization is inhibited by the atmosphere’s oxygen.**

\*This inhibition of the reaction results in a thin layer of not reacted material on the surface of a newly set composite (if the surface was exposed to air when it sets).

The thin air-inhibited ***layer does not cure*** whether the material is light-cure or chemical cure.

When a second layer is added, it excludes oxygen; the air-inhibited layer and the new material are chemically bonded together when the second layer is cured.

The air-inhibited layer on a dental composite has a slimy or tacky feel.

