DENTAL MATERIAL 2 .Lec1

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Types of Dental Fillings

- **Dental amalgam: Amalgam, also known as silver fillings, are the least expensive type of filling.**

- **Tooth-colored composite resin: Composite resin fillings are more pleasing to the eye but are more expensive than dental amalgam fillings**

- **Glass ionomers: This type of filling is primarily used in fillings below the gum line and in small children; the cost is comparable to composite resin.**

- **Gold fillings:** **These fillings are well tolerated by sensitive patients and are resistant to corrosion, tarnishing, and wear and tear but are among the most expensive filling materials.**

- **Ceramic or porcelain: Ceramic and porcelain fillings most closely mimic natural tooth color and can be as expensive as gold fillings.**

Dental amalgam

What is dental amalgam?

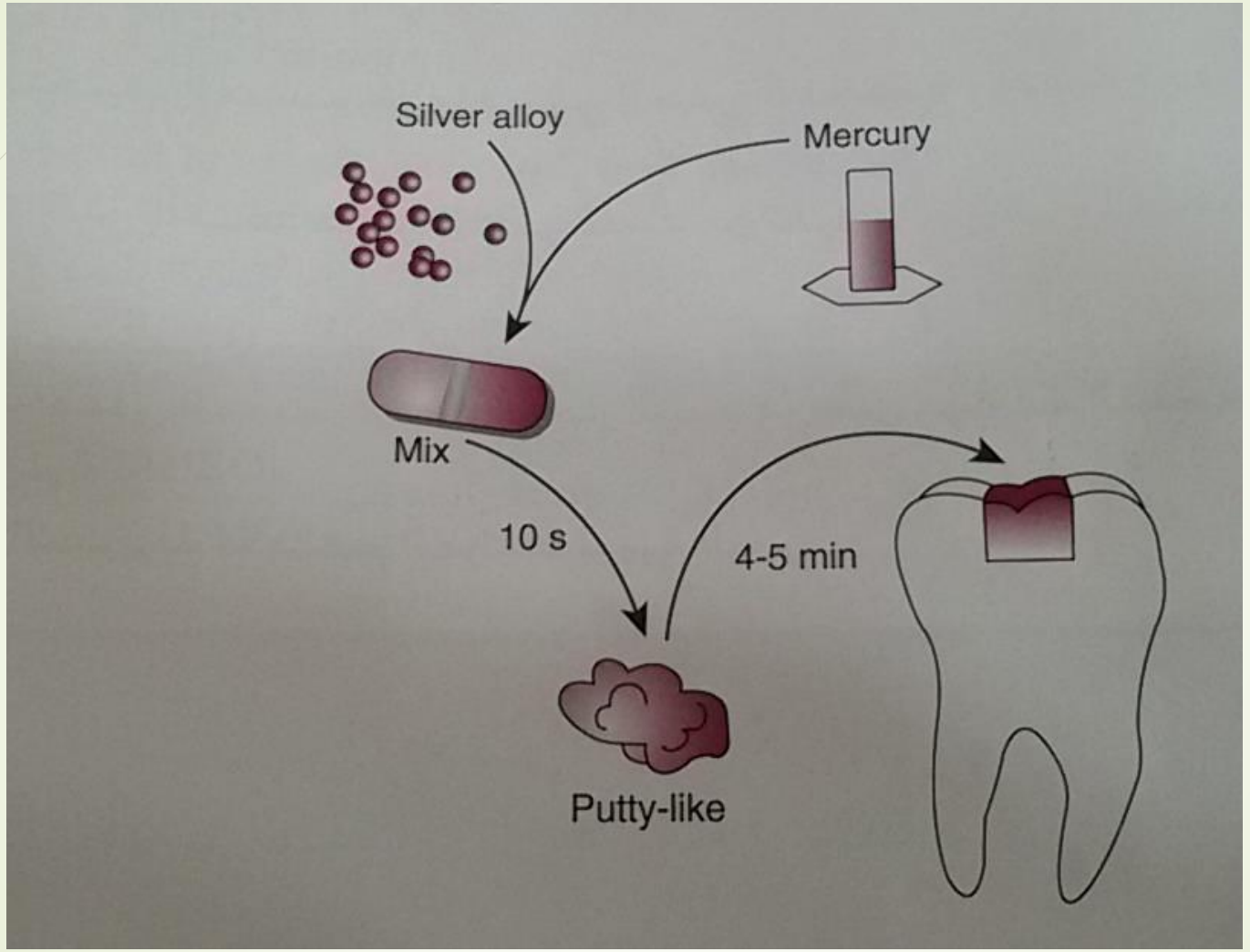
Dental amalgam is a dental filling material used to fill cavities caused by tooth decay.

It has been used for more than 150 years in hundreds of millions of patients around the world.

An amalgam is a solution of any metallic element in mercury.

Dental amalgam is a mixture of a silver alloy with mercury.

When the silver alloy which is a powder comprised of silver ,copper, and tin, is mixed with mercury , which is a liquid, a comical reaction ensues that form dental amalgam.


Silver alloy
Mercury
Mix
10 s
4-5 min
Putty-like

COMPOSITION OF DENTAL AMALGAM

- **A) Mercury:**

- **Used to liquefy and react with dental amalgam alloy production a plastic mix, which remains workable at room and body temperature for a reasonable period of time.**

Properties of mercury:

- The only metal which is liquid at room temperature with melting point -37.87ºC.
- Pure Hg (triple distilled) has a shiny reflective surface should be used for dentistry.

- **It is highly toxic as death occurs at exposure levels of 4000 µg/ kg of body weight.**

- It combines readily with metal such as Ag, Sn, Cu, and Zn to form amalgams. It is readily contaminated with sulphur compound.

- It does not combine with Cr, Ni, Co, and Fe under normal conditions.

- It has high surface tension (465 dynes/ cm).
- Its boiling point is 356.9 ºC, and significantly high vapor pressure at room temperature.

B) Amalgam Alloy powder:

Each element composing amalgam imparts certain properties to the mix. finished product:-

1. Silver:

- **Increases: → Strength, hardness, resistance to tarnish and corrosion, and setting expansion.**
- **Decreases:→ Flow and creep Setting time.**

2. Tin:

- **Facilitates the reaction because of its affinity to Hg.**
- **Increases: → Flow, creep, corrosion, and setting time.**
- **Decrease: → Strength and setting expansion.**

- **3. Copper:**
- **Increases: → Strength, hardness, and resistance to tarnish, setting expansion and corrosion.**
- **Decrease: → Creep, Flow, and setting time.**

- **4. Zinc:**
- **a- Scavenger for oxides.**
- **b- Increases workability (plasticity).**
- **c- Causes delayed expansion if contaminated with moisture.**
- **5. Other elements (Indium, Palladium and Platinum):**
- **Increases: → Strength and corrosion resistance.**

Classification of Amalgam

Composition

A. Cu content:	B. zn content:
1. Low Cu: <6% wt Cu	1. Zn containing: Zn >0.01% wt
2. High Cu: >6% wt Cu	2. Zn free< 0.01% wt

Amalgamation of low Cu amalgam

1) Trituration stage: The amalgam alloy triturated (vigorous mixing with Hg) to wet the surface of the particles.

2) Dissolution stage: Hg attacks alloy surface and leads to dissolution of Ag and Sn.

3) Crystals formation stage: During this process Hg starts reacting with dissolved Ag and Sn portion of the particles forming predominantly $Ag_3Hg_3(\gamma_1)$ and $Sn_{7\text{-}8}Hg\ (\gamma_2)$compounds.

While crystals of the γ_1 and γ_2 phases are being formed the amalgam is relatively soft, easily condensable and carvable.

4) Crystal growth and hardening stage: As time progresses, more crystals of γ_1 and γ_2 are formed and the amalgam becomes harder and stronger and it is no longer condensable.

- **Amalgamation of low Cu amalgam can be represented by the following equation:**

$$Ag_3Sn\ (\gamma) + Hg \rightarrow Ag_2Hg_3(\gamma_1) + Sn_{7\text{-}8}Hg\ (\gamma_2) + \text{unreacted } Ag_3Sn\ (\gamma) + \text{voids}$$

Microstructure:

It is a cored structure formed of a core of unreacted γ particles that are held together by a matrix of (γ_1)+ (γ_2) phases.

II. Amalgamation of high Cu amalgam

- In High copper alloy: high copper is added to improve mechanical properties, resistance to corrosion and marginal integrity.

It has 2 types:

- **Admixed alloy [2 Powders with different contents are mixed with mercury]**
- **Uni/single-composition alloy [1 powder is made available instead of 2 to mix with mercury].**

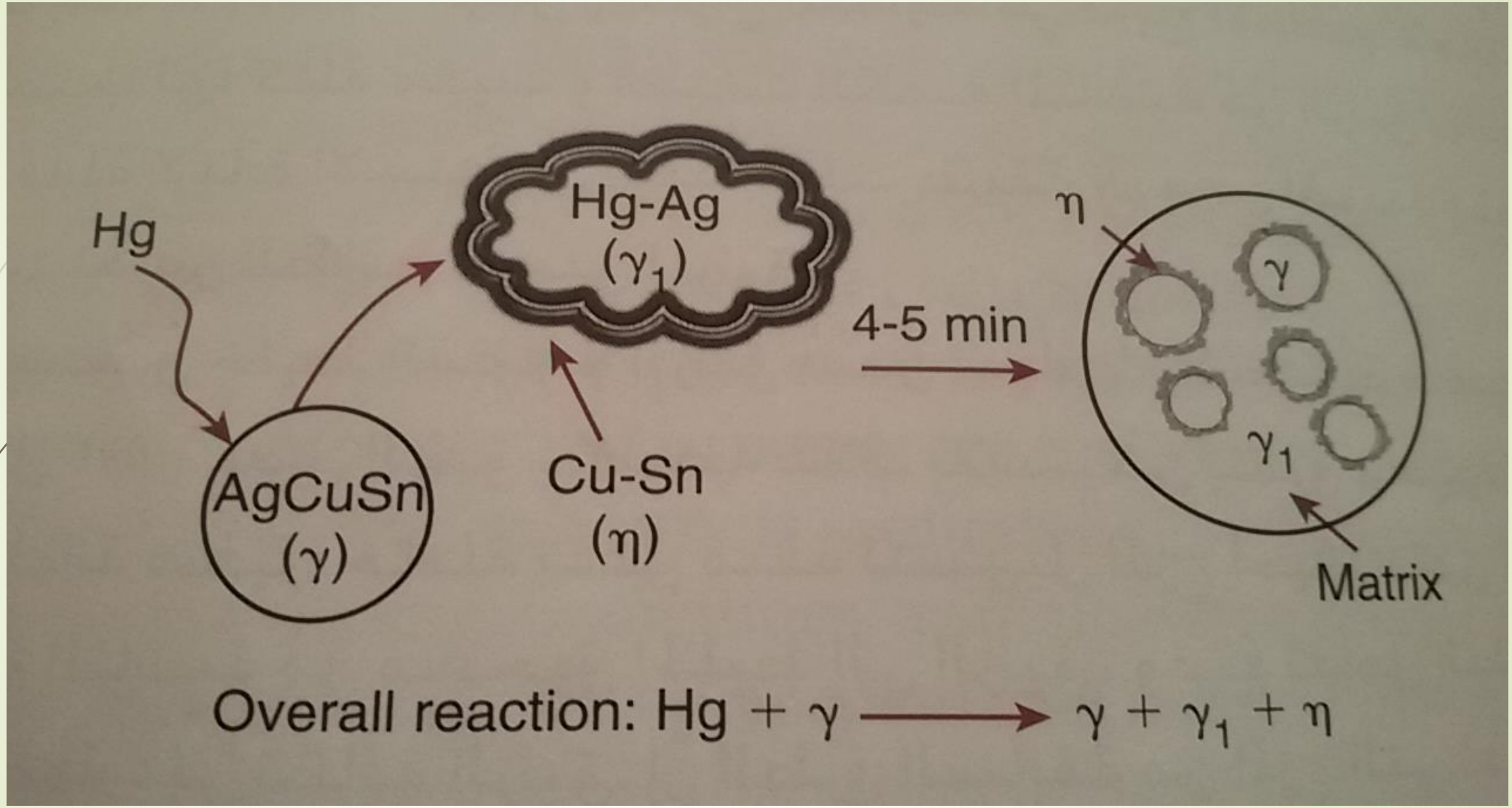
A. Admixed high Cu amalgam

γ + eutectic Ag- Cu $\rightarrow \eta + \gamma_1$

B. Unicomposition high Cu amalgam

Ag-Sn-Cu + Hg $\rightarrow \gamma_1 + \eta$ + unreacted Ag-Sn-Cu.

- **γ=AgCuSn** (powder form so strongest phase)
- **γ1=AgHg** (Noble phase, main constituent of set amalgam)
- **γ2=HgSn** (weakest phase, causes tarnish and corrosion so undesirable)
- **β=AgSn**
- **η=CuSn**


Hg
Hg-Ag
(γ_1)
AgCuSn
(γ)
Cu-Sn
(η)
4-5 min
η
γ
γ_1
Matrix
Overall reaction: Hg + γ ⟶ $\gamma + \gamma_1 + \eta$

Admix high Cu amalgams	Unicomposition high Cu amalgams
1) γ_2 phase elimination: γ_2 phase are formed around (γ) and are eliminated around eutectic Ag-Cu particle. 2) Fate of (η) phases: Forms halo around unreacted eutectic Ag-Cu alloy.	They are formed temporarily and consumed around the same particles, i.e around (γ). Form rods interlock (γ_1) grains together in case on incomposition one

Particle size

a. Fine cut
b. Coarse cut
c. Admixed

Particle shape:

a. Lath cut.
b. Spherical
c. Admixed

Trituration

Aim of trituration:

1) Allows rubbing of surface oxide in amalgam powder particles, explosion an active surface, hence Hg is allowed to react with the alloy powder particles.

2) Forces Hg to wet powder particles, i.e, overcome the high surface tension of Hg.

Methods of trituration:-

1) Hand mixing [mortar & pestle]: not widely used today.

2) Mechanical mixing using mechanical amalgamator, which eliminates human variability, and a uniform and reproducible mix is proposed. A greater alloy/ Hg ratio can be used.

Duration of trituration:-

- Reducing 2 to 3 seconds from those recommended by manufacturer leads to undermixed (dry and crumbly)
- Increasing 2 to 3 seconds from those recommended by manufacturer leads to undermixed (soupy and tends to stick to the capsule)
- Following manufacturers directions leads to normal mix (Appears shiny and separates in a single mass from the capsule).

- When placing dental amalgam, the dentist first drills the tooth to remove the decay and then shapes the tooth cavity for placement of the amalgam filling. Next, under appropriate safety conditions, the dentist mixes the powdered alloy with the liquid mercury to form an amalgam putty.

Condensation

Condensation:

* **Objectives of condensation**:-

1. Adaption of the amalgam to the prepared cavity walls.
2. Development of compact mass and elimination of voids.
3. Reduction of excess Hg.

Lath cut alloys	Spherical particles alloys
Small diameter condenser (1-2 mm) with large force applied in a vertical direction is used.	Larger diameter condenser with light force is applied because their mix flows more readily under light pressures.

Trimming and Carving: the cavity is overfilled. The top Hg-rich layer can be trimmed away and the filling carved to the correct contours.

Amalgam prepared form a coarser alloy is difficult to crave, as caving instrument may pull out large pieces of alloy from surface to become rougher

Finishing and polishing:

Conventional amalgams are polished not led than 24 hours after condensation when the material have gained enough strength. Copper enriched amalgams are polished in the same visit because they gain enough strength very rapid.

Properties of dental amalgam

I. Dimensional stability

Ideally, an amalgam should set, without change in dimensions and them. However, dimensional changes that take place in amalgam are of two types:-

A. Immediate dimensional changes.

B. Delayed or secondary expansion

A. Immediate dimensional changes

1) **Initial coantraction occurs**

2) **Subsequent expansion**

3) After a rigid matrix has formed, growth of γ_1 and γ_2 crystals cannot force the matrix to expand. Instead, γ_1 and γ_2 crystals grow into Hg filled spaces, consuming Hg and producing a continued contraction.

The signification of dimensional changes:-

a) Contraction leads to leakage around the margins and subsequent caries recurrence.

b) Expansion during hardening leads to post-operative and may result in tooth fracture.

c) With current alloys and proper techniques of trituration, all alloys show some dimensional changes which are within ADA Specification #1 allowance, hence no detrimental effect will occur.

B. **Delayed or secondary expansion**

It starts after 3-5 days and may continue for months, reaching values greater than 400 μm/ cm

Mechanism of delayed expansion:-

When zinc-containing amalgam is contaminated by moisture during trituration or condensation, an electrolytic reaction takes place (zinc acts as anode and the other constituents of amalgam act as cathode). H_2 gas is a product of this reaction.

Consequences of secondary expansion:-

The produced hydrogen gas produces pressure causing severe pain, amalgam protection, pitted surface and may end tooth fracture

Benefits

- Dental amalgam fillings are strong and long-lasting, so they are less likely to break than some other types of fillings

- **Dental amalgam is the least expensive type of filling material.**

- **The procedure is shorter than the composite treatment.**

- **The silver filling treatment requires less skill and technology than the composite technique.**

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- **Silver fillings have been used for decades, and many patients are more comfortable with the materials long-term safety record.**

Potential Risks

- Dental amalgam contains elemental mercury. It releases low levels of mercury in the form of a vapor that can be inhaled and absorbed by the lungs. High levels of mercury vapor exposure are associated with adverse effects in the brain and the kidneys .

- **Although metal fillings have been shown to be safe in patients, many believe that use of mercury in the amalgam material may lead to future health problems.**

- **The metal material can expand and contract over time, and could potentially cause damage to the structure of the tooth.**

- **The dentist must remove more of the tooth structure than is required when composite material is used to fill in the cavity.**

- **Teeth may be more sensitive to hot and cold foods in the weeks following treatment.**