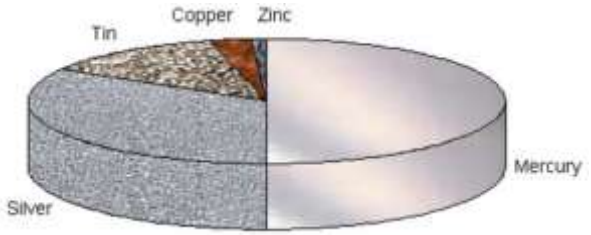
Dental Amalgam

Dental amalgam is an alloy produced by mixing liquid mercury with solid particles of silver, tin, copper and sometimes zinc, palladium and selenium; this combination of solid metals is known as the amalgam alloy. Dental amalgam is the most widely used direct filling material for the posterior teeth since its introduction in the mid of 1800s.



Advantages:

1. Can be easily contoured to resemble the anatomy of the lost part of the tooth.
2. It has a reasonable force resistance.
3. Least technique sensitive of all restorative materials.
4. Applicable to a broad range of clinical situations.
5. Newer formulations have greater long-term resistance to surface corrosion.
6. Ease of manipulation by dentist. Can be easily inserted in the cavity.
7. Minimal placement time compared to other materials.
8. Initially, corrosion products seal the tooth-restoration interface and prevent bacterial leakage.
9. One appointment placement (direct material)
10. Long lasting if placed under ideal conditions (long service life).
11. Economical (Low-cost filling).
12. No sensitivity to the mouth tissue and, it is not irritant.

Disadvantages:

1. Some destruction of sound tooth tissue.
2. Poor esthetic qualities.
3. Long-term corrosion at tooth-restoration interface may result in "ditching" leading to replacement.
4. Galvanic response potential exists.
5. Concern about possible mercury toxicity.
6. Marginal breakdown.

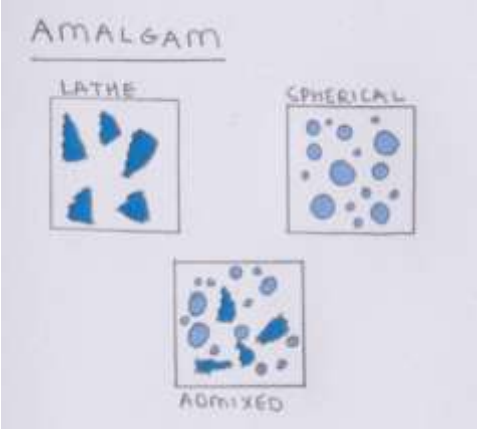
Composition of dental amalgam:

A. **Powder**: The alloy powder composed of:

1. **Silver**; it is about 40-70% w.
   - ✓ Gives strength.
   - ✓ Produce high expansion of the restoration.
2. **Tin**; it is about 20-30%w.
   - ✓ Gives contraction.
   - ✓ Increase affinity for mercury.
   - ✓ Speed the amalgamation.
   - ✓ Reduce compressive strength
   - ✓ Increase the flow of the amalgam.
3. **Copper**; if its concentration is between 15-30% called high copper alloys, and if the concentration is less than 5% called low copper alloys, Copper led to:
   - ✓ Reduce corrosion of the restoration.
   - ✓ Minimize the flow.
   - ✓ Increasing setting expansion.
4. **Zinc**; if its concentration more than 0.01% the alloy classified as zinc containing alloys, and if it is less classified as zinc free alloys. Zinc:
   - ✓ Acts as a scavenger for oxides formed during manufacturing.
   - ✓ Help the process of amalgamation.

The alloy particles have different sizes and with different shapes according to the manufacture. If the shapes of the particles are irregular so the alloy is called lath-cut alloy, and if they have spherical shape called

spherical alloy, or it may be a mixture of both (lath-cut and spherical particles) so called admixed alloy.



B. **Liquid**: is pure mercury which is highly dense liquid, very toxic if it's improperly handed. It can be absorbed by skin and it may inhale of its vapor during placing or removal of amalgam restoration. The mercury must be very pure because its impurities may reduce its combination with the alloy.

Amalgam alloys can be classified basically according to:

1. Alloy particle geometries, into lathe cut, spherical (these alloys called uni-compositional alloys), and admixed alloys.

2- Zinc content, into zinc containing, and zinc free alloys.

3- Copper content, into high copper and low copper alloys

Amalgamation:

It is the process of reaction between the mercury and the amalgam alloy. The amalgamation reaction consists of two phenomena which include solution and crystallization. The amalgam alloy is intimately mixed with liquid Hg to wet the surface of the particles and leads to form at the surface a silver-mercury and tin mercury phases and this crystallization growth leading to cause a hard amalgam. The amalgamation of conventional or low copper amalgam can be described by this equation:

$Ag_3Sn + Hg \longrightarrow Ag_2Hg_3 + Sn_{7-8}Hg + Ag_3Sn(\text{Unreacted})$

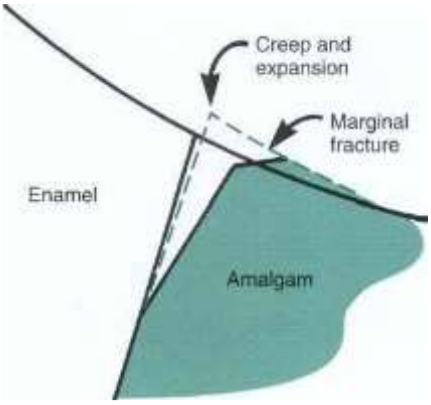
- (Ag3Sn) gamma (У) phase a silver-tin compound that forms a substantial part of the amalgam alloy
- (Ag2Hg3) gamma 1 (У1) phase A silver-mercury compound that is a reaction product in dental amalgam.
- (Sn8Hg) gamma 2 (У2) phase A tin-mercury compound the weakest compound and is least stable to corrosion process.

The alloy particles do not react completely with mercury; about 27% of the original Ag3Sn remains as unreacted particles. Set amalgam consist of unreacted particles (У) surrounded by matrix of the reaction products (У1 & У2). If more (У) phase is present, the stronger the amalgam.
While in the high copper alloys the amalgamation process differs in that these alloys contain proper amount of copper causes most, if not all, of the (У2) phase to be eliminated within a few hours after its formation or prevents its formation entirely, therefore, high copper amalgams tend to have superior physical and mechanical properties.

Properties of dental amalgam:

1. **Compressive strength:** amalgam has high compressive strength for high copper alloy and less for low copper alloy. Because amalgam is brittle material therefore a sudden application of excessive forces to amalgam tend to fracture of amalgam restoration.
2. **Tensile strength:** Because amalgam is strongest in compression and much weaker in tension and shear, the prepared cavity design should maximize the compression forces in service and minimize tensile and shear stresses resulted from bite forces.
3. **Creep**: Is permanent deformation under static loads. Under a continued application of force in compression, an amalgam shows a continued deformation, even after the mass has completely set. The maximum allowable creep value for dental amalgam should not exceed 3%. After aging of the amalgam restoration at oral temperature for 6 months the creep value will be reduced. High copper alloys have lower creep values in compared with low copper alloys. So low copper alloys may have high incidence of marginal

fracture (ditching of the margin) in compared with high copper alloys.



4. **Dimensional changes**: The amalgam undergo shrinkage at the first time after setting (first 20 min.) and after this period the expansion will occur, although, the total change remain negative, and the dimension become constant within 24 hours. If a contamination of the amalgam with moisture will occur during mixing or condensation, the zinc in the amalgam will decompose water into H2 and O2 gases which will lead to excessive delay expansion of the amalgam restoration and this may cause; marginal discrepancy, pitting of the surface of the restoration, compression on the surrounding tooth surface, post- operative pain, fracture of the restoration, and recurrent caries.
5. **Corrosion**: It is a progressive destruction of the metal by chemical or electrochemical reaction with its environment. The early corrosion products are important to reduce the marginal leakage of the freshly placed restoration. Excessive corrosion can lead to increase porosity, reduce marginal integrity (ditching of the restoration margins), loss of strength, and release of metallic products into the oral environment.
6. **Tarnish of the amalgam:** is black discoloration of the surface due to chemical corrosion with the sulfide.

Manipulation of Amalgam:

The manipulation of amalgam involves the following sequence of events.
(1) Packing of the amalgam alloy;
(2) Trituration (Amalgam mixing);
(3) Condensation;
(4) Carving;
(5) Polishing.

Packing of the amalgam alloy:

The amalgam alloys are packed either as powder alone or as a pre weighted capsules containing both the alloy and mercury. The alloy is separated from mercury by membrane which is ruptured during mixing. Manufactures commonly supply capsules containing 400, 600, or 800 mg of alloy with appropriate amount of mercury. The alloy/mercury ratio is determined by the manufacture according to the type of alloy and the size and shape of its particles

Amalgam mixing (triturating):

In the past the alloy and mercury are mixing manually with mortar and pestle. But now mechanical amalgamator machines give standard produces and can save time. Two types of amalgamators are present; one type used for mixing of the powder and liquid in different containers, and the other for mixing of pre weighted capsules, or both types are present in one machine. The speed (if possible) and time of mixing should be adjusted according to the manufacture before starting of mixing.
Three types of mixing may be resulted with different appearance and properties:

1. **Undermixed (under-triturated) amalgam**: which appear dull and crumbly. The mercury does not completely wet the outer surfaces of the particles, so the mass remains soft for a longer period of time, producing an amalgam with a longer working time. Such an amalgam mass contains excessive amounts of porosity, has lower strength, and possesses poorer corrosion resistance.
2. **Normal mix**: which appear shiny and separated in one mass from the capsule.

3. **Overmixed (over-triturated) amalgam**: which appear soupy and tend to stick to the inside of the capsule. Over-trituration reduces working time, causing the reaction rate to increase because the amalgamated mass becomes hot. The resulted amalgam has low compressive strength and high creep.



Amalgam condensation:

Condensation of the amalgam inside the cavity is important for:

- ✓ Good adaptation of amalgam to cavity walls and margins.
- ✓ To get compact and homogeneity amalgam restoration and minimal voids, this can effect on the strength of filling.
- ✓ To remove excess of mercury and this reduce the dimensional changes, creep and increase compressive strength of filling. After mixing, the amalgam must be used immediately without prolonging the time between mixing and condensation because this will lead to condensation of partially set amalgam and that may lead to break and fractures in the matrix that has been formed in the mixed amalgam. Cavity to be filled should be kept completely dry during amalgam condensation.

A-Hand condensation:

1. There are many hand instruments with many tip shapes and with different sizes.
2. Lateral and vertical direction of the condensation provides better adaptation of the amalgam to the cavity walls and floor.
3. Amalgam should never be touched with hands to eliminate contaminations.
4. The amalgam carried to the cavity in small amount by using of amalgam carrier and condensation should be done immediately to each small increment, because if large amount of the amalgam is

putted in the cavity, the condensation will be ineffective to have a properly condensed restoration with low amount of mercury.

5. After condensation of each amount, the surface of the amalgam will appear shiny because there is excess of mercury present at the surface. This excess mercury should be removed from the surface of each amount of amalgam before applying the next increment.
6. Condensation is continued till we have over-filled cavity, this mean put amount of amalgam above the occlusal surface and this overfilling is important for:
   - ✓ To ensure that the cavo-surface margins are completely covered to avoid exposure of that margins.
   - ✓ To be able to do good carving.
   - ✓ Get rid of excess mercury.

B- Mechanical condensation:

Many mechanical devices are available for condensing amalgam. These devices are more popular and more useful for condensing irregularly shaped alloys when high condensation forces are required.

Amalgam carving:

The main aim of carving the amalgam is for removal of the excess material and maintains the structure of the tooth. There are many instruments that can be used for carving such as carver and spoon excavator.

1. After ending of the condensation, the surface of the overfilled amalgam should be burnished by using of a large burnisher with high force moving from the center of the restoration to the margins, this will produce denser amalgam at the margins of the cavity.
2. Carving should begin immediately after condensation with suitable size carver. All carving should be done with the edge of the blade perpendicular to the margins as the instrument is moved parallel to the margins. Part of the edge of the carving blade should rest on the unprepared tooth surface adjacent to the preparation margin. Using this surface as a guide helps to produce a continuity of surface contour across the margins.

3. Over-carving or deep occlusal grooves carving should not be done on the restoration, because these may thin the amalgam at the margins, invite chipping, and weaken the restoration.
4. Under-carving leaves thin portions of amalgam (subject to fracture) on the unprepared tooth surface. Such margins give the appearance that the amalgam has expanded beyond the preparation.
5. The mesial and distal fossae should be carved slightly deeper than the proximal marginal ridges.
6. After end of carving, post carving burnishing is done by lightly rubbing the carved surface with a burnisher of suitable size and shape to improve smoothness and produce a satin (not shiny) appearance. Post carve burnishing may improve the marginal integrity of high-copper amalgams; it may also improve the smoothness of the restoration.
7. After that the occlusion of the restoration must be evaluated, it's done by telling the patient to do light closing to check if there are any high spots in the restoration and this spot look shinier; also, can be checked by articulating paper, any high spot should be removed before beginning of the initial setting of amalgam.
8. Finally; the grooves are enhanced with conical amalgam burnisher and the restoration smoothed by small damp ball of cotton.
9. In cervical cavity; the edge of carving instruments must be rested on the external tooth surface to prevent over carving; under carving should be avoided as well.

Filling cavities using matrix band:

The matrix-bands are used in compound or complex cavities:

- ✓ To have the desired contour of the restoration.
- ✓ To substitute the lost wall of tooth cavity especially in class II (mesial or distal or both) also in complex cavities; and also keeps the amalgam in the needed place and contour during condensation.

Matrix bands: They are used for class II cavity fillings; its position must be 2 mm above the marginal ridge. They are available in many thicknesses; thin bands are widely used. The thicker bands leading to

difficulty in establishing good contact point. The band are either precut or been cut from a ribbon or as a copper ring or band



Matrix retainer: It's a mechanical device retained the band in its selected position. Retainers classified into:

1- **Ivory No.1**: Used to surround tooth from one surface mesial or distal, and the perforated bands are used with this retainer.



2- **Ivory No.8 and ivory No.9 (tofflemire retainer):** these retainers can be used in MOD cavities. The band surrounds the tooth and the retainer lie in muco-buccal fold. The contrangle-tofflemire can be placed at the lingual side. When there is one missing wall of the tooth circumferential retainer can be used. Attention must be given to have the proper contour of matrix band bucco-lingual and occluso-gingival direction, otherwise the restoration will have defects in its contour. Contouring occurs by burnishing the band in the areas corresponding to the proximal surface or surfaces to be restored once the band is positioned around the tooth.

Burnishing means that the metal band has been deformed occluso-gingivally with a suitable burnisher to produce a rounded or convex surface that (when in place around the tooth) will produce a restoration that is symmetric in contour with the adjacent proximal surface.



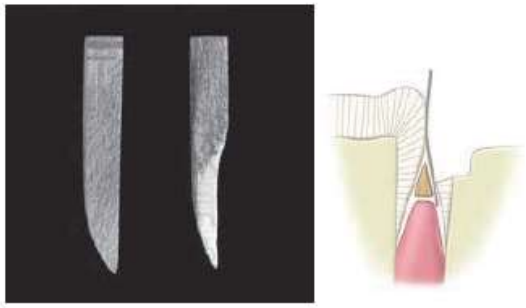


Wedge: It's a triangular or circular cross section wooden or plastic piece located interproximaly to:

- ✓ Hold the band tightly against the gingival margin of the cavity.
- ✓ Prevent an over hanged filling.
- ✓ Provide sufficient separation of teeth to compensate the thickness of band.

The wedge is placed in the gingival embrasure, from the lingual or facial embrasure (whichever is larger), slightly gingival to the gingival margin of the cavity, however the lingual embrasures are larger than the buccal in the posterior teeth. Wedge the band tightly against the tooth and margin, if the wedge is placed occlusal to the gingival margin, the band will be pressed into the preparation, creating an abnormal concavity in the proximal surface of the restoration.

Figure (4) A- wedge B- correct wedge position.



Filling done without wedge cause:

- ❖ No contact point with the adjacent tooth, and that leads to food impaction causing gingivitis and caries
- ❖ Overhanging restoration. A contoured matrix putted in place with wedge and with a probe check the adaptation of the band to the cavity gingival margin. After that relaxation of the band quarter or half turn to be sure that a good contact point is obtained. Condensation of amalgam must start at the box of the cavity until the cavity is over filled. At each stage of condensation excess mercury must be removed from the surface because if this excess left it may cause weakness of the restoration. Carving of the filling: Means bringing the filling as near as could to the tooth shape; and that done by removing the excess material then the outer inclination of the marginal ridge is established by carver or probe while the matrix band is still in place. We must not try to remove the band before the reduction of the marginal ridge to its approximate height, else fracture of that margin may occur, as well gross contouring of occlusal surface with large excavator must be done. And then the wedge and retainer removed, after that the band removed bucco-occlusally or lingo-occlusally. Checking of the gingival margin should begin immediately after removal of the band and that done by using a probe; then the carving of the restoration is completed.

Finishing and polishing:

This can be done at least 24 hours later; and it is done for:

1- Well finished and polished restoration this will keep the surface smooth and clean so less tarnish and corrosion occur.
2- Rough surface may cause accumulation of food particles leading to secondary caries.
3- Polished surface gives better response to the surrounding soft tissues.
4- We can have more ideal carving and contouring.
5- A small feather edges of amalgam excess left beyond the margins may fractured under stress leaving rough surface and that can be removed during polishing.

For finishing and polishing we use the following:

1- Tapered stone bur.
2- Round or flamed finishing bur with deferent sizes.
3- Rubber cup and pumice with water.
4- Thin zinc-oxide with soft cup brush for final shine.

