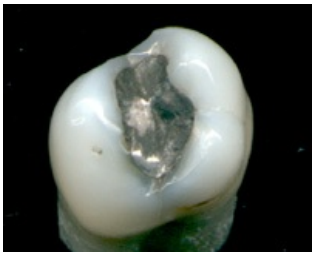
Amalgam

Properties



We classify **amalgam** among the definitive filling materials. There are several types of amalgams available today. The first amalgams were used already 150 years ago. It is an alloy of mercury and other metals, mainly silver, copper and tin.

- **Silver** is used for its mechanical and chemical resistance. Furthermore, it accelerates solidification and increases the resulting expansion of the filling.
- **Copper** increases the strength of the filler and also increases the resulting expansion of the filler.
- Tin, on the other hand, reduces mechanical and chemical resistance, increases plasticity and, compared to copper and silver, increases contraction.

Amalgam filling is held in the cavity by macroretention, so it is necessary to prepare the cavity with sub-skewers. Amalgam matures in the cavity for more than 24 hours. This process ends between the third and sixth month. After one hour, the amalgam filling can withstand a pressure of 150 MPa, after twenty-four hours a pressure of 300 MPa. Unlike modern amalgams, conventional amalgam undergoes mercuroscopic expansion - during gamma 2 phase corrosion, mercury is released, which reacts with the unreacted alloy and expands the filling. Amalgam has an excellent self-sealing effect, which is ensured by gradually emerging corrosion products.

Composition

Conventional *(γ2 amalgam)*

- Ag 66-73% (increases mechanical resistance, higher expansion)
- Sn 25–29% (Ag antagonist)
- Cu < 6%!! (works as Ag)
- Zn < 2%, absent in modern alloys, late expansion, internal corrosion → H_2 release → filling disruption, formerly in place of inert gases as an antioxidant. It was used until the 60s, it increased creep
- Hg < 3%, is in the powder as a result of pre-amalgamation, i.e. exposure of the alloy particles to mercury vapor in order to combine the particles with liquid mercury faster and solidify faster

Amalgams with increased copper content (over 10%)

Disperse Amalgam *(γ2 phase reducing)*

- a mixture of conventional (γ2) amalgam in the form of sawdust and eutectic (AgCu) in spherical form, therefore has a higher copper content

Ternary amalgam *(non γ2)*

- Ag > 40%
- Sn 25-29%
- Cu 10-30%
- Zn < 2%
- Hg < 3%

Amalgam types and their classification

According to the percentage of copper in the amalgam, amalgams are divided into conventional amalgams (low copper content) and high copper amalgams.

Classification

According to copper content

- Conventional amalgams - contain less than 6% copper
- Dispersion amalgams – contain 6 to 10% copper
- Ternary non gamma 2 amalgams - contain between 10% and 30% copper

According to the shape and size of the powder particles

- Sawdust - length of sawdust (3-6) μm, they have different shapes, must be condensed under high pressure (sawdust is created by cutting and has internal tension, therefore artificial aging is carried out by heating, which equalizes the tension)
- Spherical - diameter (5-50) μm, requires less condensing pressure, but still condenses poorly due to its shape
- Blend (*blend*) – combines the ideal properties of both (consists of 30% sawdust and 70% spherical amalgam)

By type of liquid component

- Traditional - contain mercury as a liquid component
- Mercury-free - contain a mixture of gallium, indium and tin as a liquid component, which is liquid even at room temperature (but this type is still in the development phase and due to the rising prices of silver and the improvement of alternative materials and processes, this is probably a dead end)

Solidification reaction of conventional amalgam

$$Ag_3Sn(\gamma) + Hg \longrightarrow Ag_3Hg_4(\gamma_1) + Sn_7Hg(\gamma_2) + Ag_3Sn(\gamma)$$ [1]

Solidification reaction of dispersion (γ_2 reducing) amalgam

$$Sn_8Hg(\gamma_2) + AgCu \longrightarrow Ag_2Hg_3(\gamma_1) + Cu_6Sn_5(\eta)$$ [1]

Solidification reaction of ternary non-γ_2 amalgam

$$Ag_3Sn(\gamma) + Cu_3Sn + Hg \longrightarrow Ag_2Hg_3(\gamma_1) + Cu_6Sn_5(\eta)$$ [1]

Preparation

Amalgam shaker

Previously, amalgam was prepared in an amalgamator (in a ratio of 1:1.1 (powder : mercury) at 1800-6600 revolutions per minute), today it is possible to use only '*encapsulated* amalgam, which is mixed in an amalgam shaker. A properly mixed amalgam should have the consistency of marzipan. An excess of mercury leads to a decrease in mechanical and chemical resistance and a high final expansion. A lack of mercury leads to a decrease in pressure and corrosion resistance.

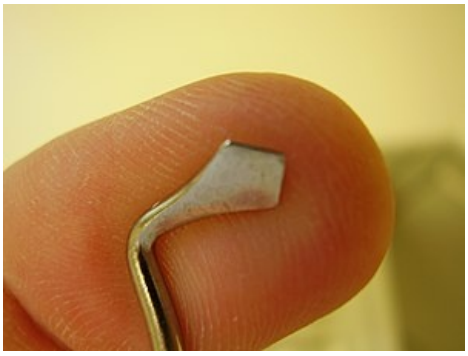
Application and processing in the cavity

The amalgam must properly condense and adapt to the cavity walls during application. The cavity for the amalgam filling must be at least 2 mm deep and even 3 mm deep when the bump is completed. Amalgam is condensed with a straight-faced plug or amalgam machine hammer. The application can be divided into two phases. We refer to the first phase as condensing and lasts about 3 minutes (its length is determined by the Ames test) and the second phase is called modeling, which lasts a maximum of 5 minutes from the end of condensation.'*Amalgam pad*

Since amalgam is thermally conductive, it could irritate the pulp when applying the amalgam filling near the pulp, so we have to use a pad for deep cavities. Previously, zinc oxide phosphate cement was used, today's choice is RM GIC. The pad does not need to be applied if there is sclerotic dentin at the bottom of the cavity.

Processing tools

We divide the processing tools into '*carvers* and *burnishers*.


Frahm carver

- **Trimmers**: discloid-cleoid, Frahm, Wieland's crescent, Hollenback
- **Coolers**: ball-football, Westcott

Amalgam trimming is possible after 15-20 minutes, we do not strive for extremely precise fissural relief, as this would increase the notch stress, which could lead to fracture of the filling and the tooth. After smoothing is complete, it is necessary to check the **articulation**. Polishing of the amalgam filling is only possible after 24 hours, when the material acquires resistance to pressure of 300 MPa.

Indication

- Class I according to Black, as an option covered by the insurance company
- Class II according to Black, for occlusal, MO or DO cavities. If it is not possible to provide a dry work area, amalgam is the first choice.
- Class V according to Black in the distal section, especially if the caries is subgingivally.

- Patients with poor hygiene.
- Adult patients requiring an insurance-reimbursed filling (in the distal section).

Contraindications

- Frontal section, purely from the unaesthetic appearance of the amalgam. If it is a case of cavities located orally (typically *foramen caecum* in I_2), then amalgam is of course an option.

- Adjacent to another metal, as galvanic currents and electrogalvanic corrosion could occur.
- Allergy to metals contained in amalgam.
- Extensive cavities (typically MOD) and other situations where the tooth is weakened. Unlike composite fillings, amalgam is not supposed to strengthen the dental tissues, on the contrary, a tooth fracture would occur.
- Temporary teeth, children under 15, pregnant and breastfeeding women.

Links

Related Articles

- Classification of carious cavities
- Composite
- Compomer
- Glass ionomer cement

References

- DOSTALOVÁ, Tatjana, et al. *Dentistry.* 1. edition. Prague : Grada Publishing, a.s, 2008. 196 pp. ISBN 978-80-247-2700-4.

- MÁZANEK, George – URBAN, Francis, et al. *Stomatological refresher course.* 1. edition. Prague : Grada Publishing a.s, 2003. 456 pp. ISBN 80-7169-824-5.

References

1. MÁZANEK, George, et al. *Dentistry : propaedeutics.* 1. edition. Prague : Grada Publishing a.s, 2014. 257 pp. ISBN 978-80-247-3534-4.