Dental amalgam
Amalgam restorations

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Requirements

• Biocompatibility

• Adequate mechanical properties:
  - press, strain, flex coefficient, resistivity
  - elasticity
  - surface hardness
  - abrasion resistance

• Shape/form and volume stability
  - tooth-similar thermal expansion
Cariestherapy

Requirements

• Resistance against humidity, indissolubility, bonding

• Thermal and electrical isolation

• Antiseptic effect, caries-prophylactic properties

• Radiopacity

• Tooth-similar optical properties

• Simple application, finishing, polishing

• Easy removal

• Low price
Restorative dental materials

• Temporary restorative materials

• Liners and bases

• Definitive restorative materials
  - Direct restorative dental materials (plastic)

  Amalgams
  Cement
  Cermet Cement
  Polymers
  Composite

  - Indirect restorative dental materials (solid)

    Metal
    Ceramic
    Glass-ceramic
    Direct Ceramic (Cerec)
    Gold-ceramic
    Composite
Indirect restorations

Inlays - Onlays

Metal

Ceramic

Glass-ceramic

Direct Ceramic (Cerec)

Gold-ceramic

Composite
Amalgam

An alloy of mercury with any other metal

Dental amalgam:
mercury and silver-tin alloy,
plus copper and zinc

biner, tertier, quaterner etc.

amalgams
Classification

in terms of

- Dental amalgam alloy particle geometry and size
- Copper content
- Zinc content
Classification

in terms of

- Dental amalgam alloy particle geometry and size
  - filings
  - lathe-cut particles
  - spherical
  - mixed geometries

- Copper content

- Zinc content

by milling  by atomizing  mixture
an ingot  liquid alloy
Classification

in terms of

– Dental amalgam alloy particle geometry and size

– Copper content
  - Low-copper dental amalgams 2-5 %
  - High-copper dental amalgams 12-30 %

– Zinc content
Classification

in terms of

- Dental amalgam alloy particle geometry and size
- Copper content
- Zinc content
  - Zinc-containing
  - Zinc-free
Materials properties

• Physical properties

• Mechanical properties

• Chemical properties

• Biological properties
Materials properties 1.a.

- **Physical properties**
  - Mass
  - Thermal
  - Electrical
  - Optical
  - Surface properties
- **Mechanical properties**
- **Chemical properties**
- **Biological properties**
Materials properties 1.b

• Physical properties
  – Coefficient of thermal expansion/contraction
  • percolation (egress/ingress of fluids)
  • heat flow – thermal conductivity
  – Electrical conductivity
  – Mass properties – density
  – Optical properties – color, radiopacity
  – Surface properties
Materials properties 2.

- Physical properties

- Mechanical properties
  - Stresses and strains within a material as a result of an external force
  - Response to loading, compression, tension, shear, torsion, flexion, hardness

- Chemical properties

- Biological properties
Materials properties 3.

- Physical properties
- Mechanical properties

- Chemical properties
  - Chemical and electrochemical interactions
  - Chemical and electrochemical corrosion

- Biological properties
Materials properties 4.

• Physical properties
• Mechanical properties
• Chemical properties

• Biological properties
  Characterization of
  » toxicity (threshold level) and
  » sensitivity reaction
during clinical use
Jörgensen - equation

\[ 8 \text{Ag}_3\text{Sn} + 33 \text{Hg} = 8 \text{Ag}_3\text{Hg}_4 + \text{Sn}_8\text{Hg} \]

\[ Y \quad Y_1 \quad Y_2 \]

\[ Y_2 \text{ phase is responsible for:} \]

- Corrosion
- Discolouration
- Marginal fracture
- Creep
\[
\text{Ag}_3\text{Sn} + \text{Cu}_3\text{Sn} + \text{Hg} \rightarrow \text{Y} \quad \epsilon
\]

\[
\text{Ag}_2\text{Hg}_3 + \text{Cu}_6\text{Sn}_5 + \text{res. Ag}_3\text{Sn} \quad \gamma_1 \quad \eta \quad \text{Y}
\]
Conventional amalgam filings compound (FDI)

- Ag min 65%
- Sn max 29% time of plasticity shrinkage
- Cu max 6% hardness
- Zn max 2% colour stability
- Hg max 3%
Properties of dental amalgams

1. volumetrical stable
2. indissoluble
3. mechanical resistance
4. ductility
5. thermal and electrical conductivity
6. corrosion
7. non-toxic!!!!
   sensitivity (allergy): rare
8. radiopacity
9. colour
10. amalgam with F⁻ content
11. price
Limit of WHO in urine

Mercury

dentists

fish-eater

μg Hg/l
- initial contraction (1 h)
- transient expansion (1-3 h)
- final contraction (24 h)
  - flow 3-24 h
  - creep after 24 h
- delayed expansion – mercuroscopic expansion