DENTAL AMALGAM

CONTENTS

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INTRODUCTION

- “Amalgam” - Greek origin “malagma” = soft mass
- “Alloy” - Latin origin “Alligare” = to combine
- Served as restorative material for about 165 years.
- Dental amalgam—An alloy that is formed by reacting mercury with silver, copper, and tin, and which may also contain palladium, zinc, and other elements to improve handling characteristics and clinical performance.

HISTORY OF AMALGAM

MERCURY - Aristotle in 4th century B.C. as “liquid silver.”

AChinese medical text(Material medica) mentions using a “silver paste”, in the 7th century -by Su Kung in 659 AD

1800 : (France) – D’ Arcets mineral cement –
1st dental amalgam alloy of Bi, Pb, Sn & Hg plasticized at 100°C

1818: Sir Regnert – Increased amount of Hg & lower plasticizing temp to 68°C.

1819 - First dental amalgam introduced by Bell of England and known as Bells putty.

1833 – Craw Cour brothers- USA - Royal mineral succedaneum

HISTORY OF AMALGAM

1841 – 1st Amalgam war initiated.
Dr. Chapin Harris reported many cases of systemic effects.

1843 - A resolution was passed by the American society of dental surgeons declaring the use of amalgam as malpractice.
*Every member of ASDC was required to sign a pledge that:
"It is my opinion and firm conviction that any amalgam whatever… is unfit for the plugging of teeth or fangs (retained roots) , and I pledge myself never under any circumstances to make use of it in my practice.."

1850 – Pledge rescinded which marked official end of amalgam war.

1855: Elisha Townsend – Ag-Sn-Hg alloy.
1870 – Elisha Townsend & J.F.Flagg improved amalgam alloy composition

HISTORY OF AMALGAM

1896 G.V Black presented his classic work of systematic cavity preparation and appropriate manipulation of amalgam.
Blacks amalgam: 68.50% - silver, 25.50% - tin, 5% - gold, 1% - Zinc.
improved dimensional stability of amalgam.

In early 1900’s ‘copper amalgam’

1926 - Second Amalgam War: German dentist, Professor A. Stock
Mercury could be absorbed from dental amalgam
All dentists had excess mercury in their urine.

CHARTIE hospital, Berlin appointed a committee to investigate allegations against amalgam and declared in 1930 that there are no reasons to condemn use of newer Ag-Sn amalgams

HISTORY OF AMALGAM

1930- ADA specification No.1 for amalgam.

1935: chemistry of reaction of amalgam & phases by Gaylor.

1962 - Spherical particle dental alloy was introduced

1963 - Innes & Youdelis introduced and proved high copper dispersion alloy is superior to low copper

1970 - Dr. Hal Huggins amalgam restorations caused wide variety of diseases

1974 – Single composition high copper alloy by Asgar.

HISTORY OF AMALGAM

1980 - Third Amalgam War;
Through seminars and writings of Dr. Huggins, a practicing dentist in Colarado
Mercury released from amalgam – affects CVS, nervous system
Alzheimer's disease. Multiple sclerosis.

1977: ANSI – Specification No.1 for amalgam.

1986: Development of high copper amalgams composition
Ag - 41 – 70%,
Sn - 15-30%
Cu - 12-28%.

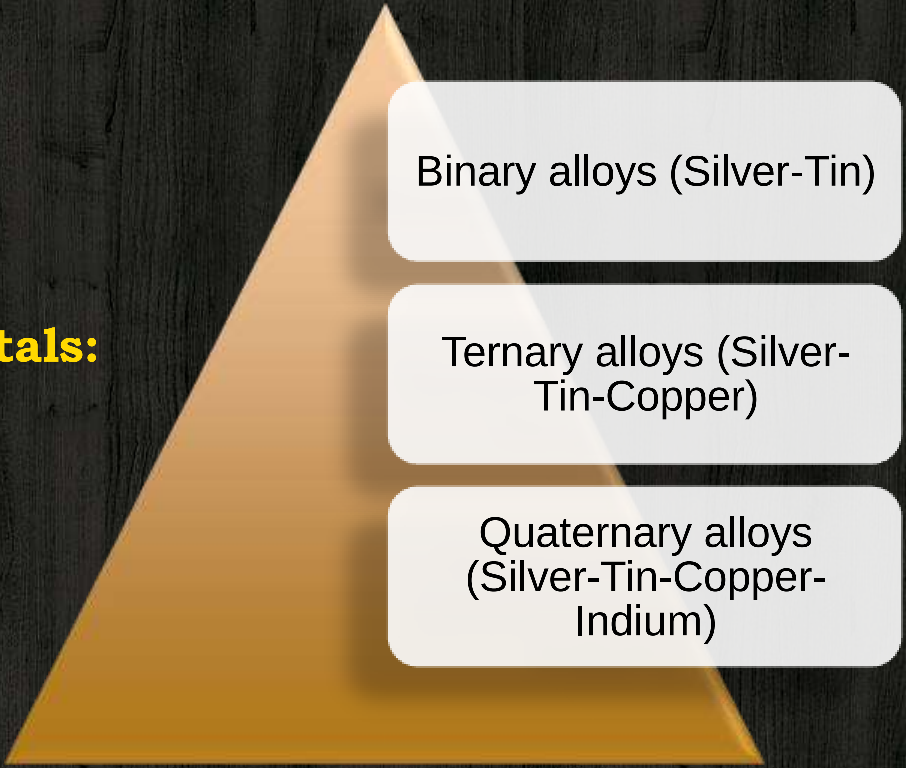
“

Based on available scientific information, amalgam continues to be a safe and effective restorative material

ADA 1998

CLASSIFICATION OF AMALGAM

➤ **According to number of alloy metals:**

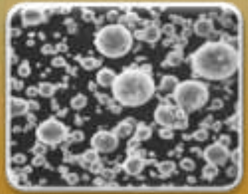


COMPOSITION OF AMALGAM

➢ **According to shape of powdered particles:**

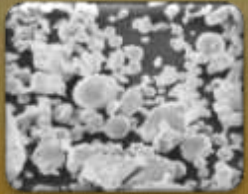
LATHE CUT

- Regular cut, fine cut, and micro-fine cut versions
- Require larger amount of mercury



SPHERICAL

- Increased the fluidity of the mixture
- Reduced the mercury portion of the mixture to less than 50% by weight.



ADMIXED

- Stronger than amalgam made from lathe cut

COMPOSITION OF AMALGAM

- **According to powder particle size:**
  - Micro cut
  - Fine cut
  - Coarse cut

- **According to addition of noble metals:**
  - Platinum
  - Gold
  - Palladium

According to COPPER content of the powder:

Low copper amalgam = 2-5% Cu

- Ag- 69.4%
- Sn- 26.2%
- Cu- 3.6%
- Zn- 0.8%

High copper amalgam = 6-13% Cu

- Ag- 60.0%
- Sn- 27.0%
- Cu- 13.0%
- Zn- 0.0%

➢ According to ZINC content of the powder:

Zinc containing amalgam > 0.01%

- Suppresses oxidation of other elements
- Delayed expansion

Zinc free amalgam < 0.01%

- Favored where isolation is difficult.

GENERATIONS OF AMALGAM

1. 3 parts silver + one part tin (peritectic alloy).
2. 3 parts silver + one part tin + 4% Cu + 1% Zn
3. 1st gen + spherical Ag-Cu eutectic alloy
4. 1st gen + 29% Cu = ternary alloy
5. 1st gen + 29% Cu + indium= quaternary alloy
6. Eutectic alloy
   Pd- 10%
   Ag- 62%
   Cu- 28%

COMPOSITION OF AMALGAM

SIVER

- Strength
- ↓flow and creep
- ↑ Setting expansion
- Tarnish resistant

TIN

- ↑Flow
- Regulates setting time
- Forms weakest phase
- ↓ rate of reaction

COPPER

- hardness and strength
- ↓ flow
- ↑ the setting expansion

COMPOSITION OF AMALGAM

ZINC

- Scavenger
- Decreases marginal failure
- Delayed expansion

PLATINUM

- Hardens the alloy
- ↑ resistance to tarnish and corrosion

PALLADIUM

- ↑ plasticity and the resistance
- hardens and whitens the alloy
- ↓ mercury vapor

INDIUM

- ↑ strength
- ↓ mercury vapor
- ↓ Surface tension
- ↓ Creep
- ↓ Marginal breakdown

COMPOSITION OF AMALGAM

LOW COPPER ALLOYS

SILVER 63-70%	**TIN** 23-28%
COPPER 2-5%	**ZINC** 0-2%

COMPOSITION OF AMALGAM

HIGH COPPER ADMIXED ALOY

SILVER 69%	**TIN** 13%
COPPER 17%	**ZINC** 1%

2 parts by weight lathe cut particles + one part by weight of spheres of a Ag-Cu(71.9% Ag, 28.1% Cu)

COMPOSITION OF AMALGAM

HIGH COPPER UNI COMPOSITION ALLOYS

SILVER 60%	**TIN** 25%
COPPER 15%	**ZINC** 0%

HIGH COPPER UNI COMPOSITION ALLOYS

SILVER 59%	**TIN** 24%
COPPER 13%	**INDIUM** 4%

MANUFACTURE OF ALLOY- *Lathe cut powder*

Ingredient metals are melted and poured into a mold to form ingot of 3-4 cm dia and 20-30 cm length. Ingot is cooled.

HOMOGENIZING ANNEAL: ingot is heated at 400°C

For varying periods about 6-8 hrs Cooled down slowly - $\uparrow\gamma$ phase.

Ingot is cut into filings and ball milled.

50-100 µm in length, 10-60 µm in width and 10-30 µm in thickness.

Particle treatment is done with acids

Annealing - 100°C

MANUFACTURE OF ALLOY- *Spherical powder*

- Atomizing the molten alloy in a chamber filled with an inert gas- argon
- Molten metal falls through a distance of approximately 30 feet and cools
- Particle size ranges form 5 to 40 microns

LATHE CUT ALLOYS vs SPHERICAL ALLOYS

LATHE CUT	SPHERICAL
Spindles to shavings	Spherical
Milling or lathe cutting	atomization
More Hg = Poor properties	Less Hg = Better properties
Mix is less plastic	Mix is more plastic
More condensation pressure	Less condensation pressure
Rough finish	Smoother finish

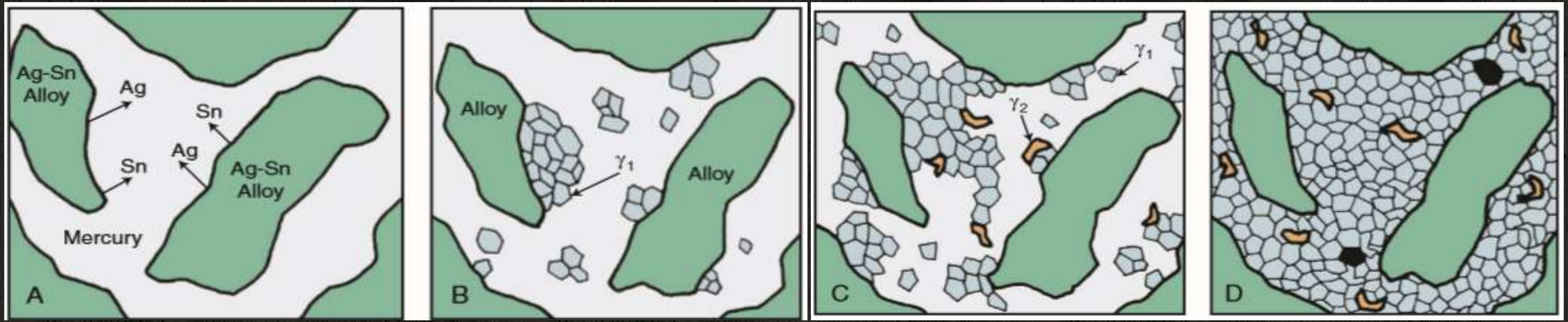
Symbols & Stoichiometry of Phases involved in the Setting of Dental Amalgams:

- γ — Ag_3Sn – strongest
- γ_1 — Ag_2Hg_3 -2nd strongest
- γ_2 — $Sn_{7\text{-}8}Hg$ - weakest
- ε — Cu_3Sn
- η — Cu_6Sn_5 - corrosion resistant
- Ag-Cu

AMALGAMATION REACTION – Low copper alloys

$$Ag_3Sn + Hg \rightarrow Ag_2Hg_3 + Sn_{7\text{-}8}Hg + Ag_3Sn$$

(γ) (γ_1) (γ_2) (γ) **(unreacted)**



Dissolution of silver and tin into Hg

Precipitation of (γ_1) crystals

Growth of γ_1 & γ_2 crystals

Final set amalgam

AMALGAMATION REACTION –High copper alloys

Initial Reaction

$Ag_3Sn + Ag\text{-}Cu + Hg \rightarrow Ag_2Hg_3 + Sn_{7\text{-}8}Hg + Ag_3Sn + Ag\text{-}Cu$

(γ) ... (γ_1) ... (γ_2) ... (γ) (unreacted)

Secondary Reaction

Sn7-8Hg + unreacted Ag-Cu → Cu6Sn5 + Ag2Hg3 + unreacted Ag-Cu

(γ_2) ... (η) ... (γ_1)

Spherical alloys

[Ag3Sn + Cu3Sn] + Hg → Ag2Hg3 + Cu6Sn5 + unreacted [Ag3Sn+Cu3Sn]

(γ) ... (ε) ... (γ_1) ... (η)

PROPERTIES OF AMALGAM

- 36Mpa stress Maximum creep value of 3%
- Minimum Compressive strength of 80 MPa at 1 hr at a rate of 0.25mm/minute
- Dimensional change between 5 min & 24 hrs = ±20µm/cm at 37°C
- ADA specification No.1

STRENGTH

Amalgam	Compressive Strength (MPa)		Tensile Strength - 24h(MPa)
	1 hr	7 days	
Low copper	145	343	**60**
Admixed	137	431	**48**
Single Composition	**262**	**510**	**64**

Factors affecting strength of amalgam:

TEMPERATURE
- Room temp to oral temp = 15% loss
- At 60°C = loss of 50% of RTS

TRITURATION
- type of amalgam alloy, the trituration time & the speed of amalgamator

MERCURY CONTENT
- Too less → corrosion
- >53-55% → loss of 50% CS

CONDENSATION
- Lathe cut - ↑ pressure
- Spherical - ↓ pressure

Factors affecting strength of amalgam:

POROSITY

- Stress concentration, cracks
- decreased plasticity of the mix
- inadequate condensation pressure

INTER PARTICLE DISTANCE

- < 38µm = ↑ CS at 24hrs
- < 32µm = ↑ CS after 1 week
- < 28µm = ↑ TS at 24hrs
- < 39µm = ↑ TS after 1 week

PARTICLE SIZE

- < 12µm = ↑ CS at 24hrs
- < 16µm = ↑ CS after 1 week
- < 18µm = ↑ TS at 24hrs
- < 12µm = ↑ TS after 1 week

- **Low copper = 19.7 µm/cm.**
- **High Cu = 1.9µm/cm**

DIMENSIONAL CHANGES

STAGE-1 INITIAL CONTRACTION

- After 20 mins
- not > 4.5 µm/cm

STAGE -2 EXPANSION

- Growth of crystal matrix
- Low Cu> High Cu

STAGE-3 DELAYED CONTRACTION

- Limited
- Diffusion of excess mercury

Factors affecting dimensional changes

PARTICLE SIZE & SHAPE

- Smaller
- Smoother
- Faster

MERCURY

- Low Hg:alloy ratio

MANIPULATION

- Trituration
- Condensation

Moisture contamination / delayed expansion

$Zn + H_2O \rightarrow ZnO + H_2$

FLOW & CREEP

- Flow = change in dimension of amalgam under load
- Creep = constant change in dimension under static or dynamic loading.
- RANGE = 0.10 – 4%
- Low Cu lathe cut = 6.3%
- High Cu unicomposition = 0.05 – 0.09%

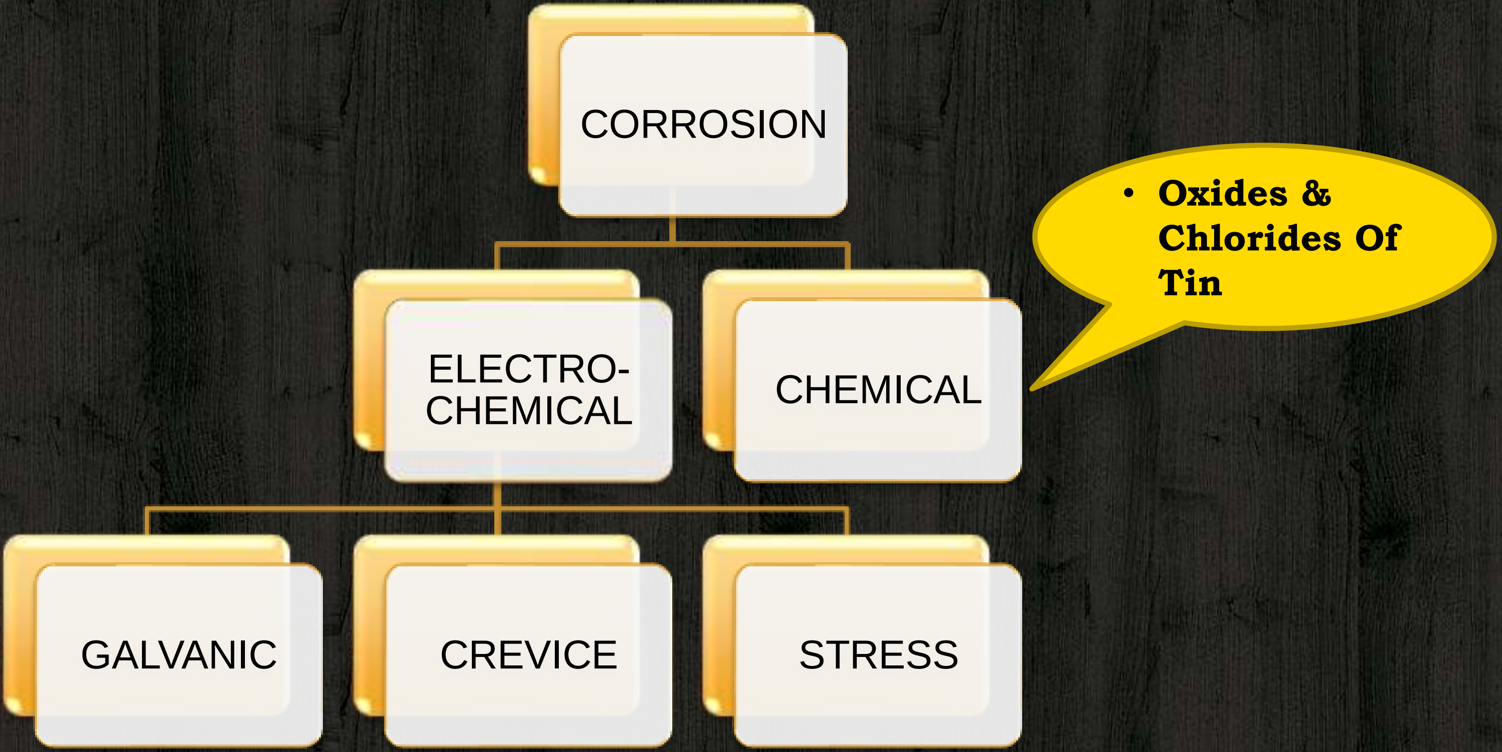
PHASES

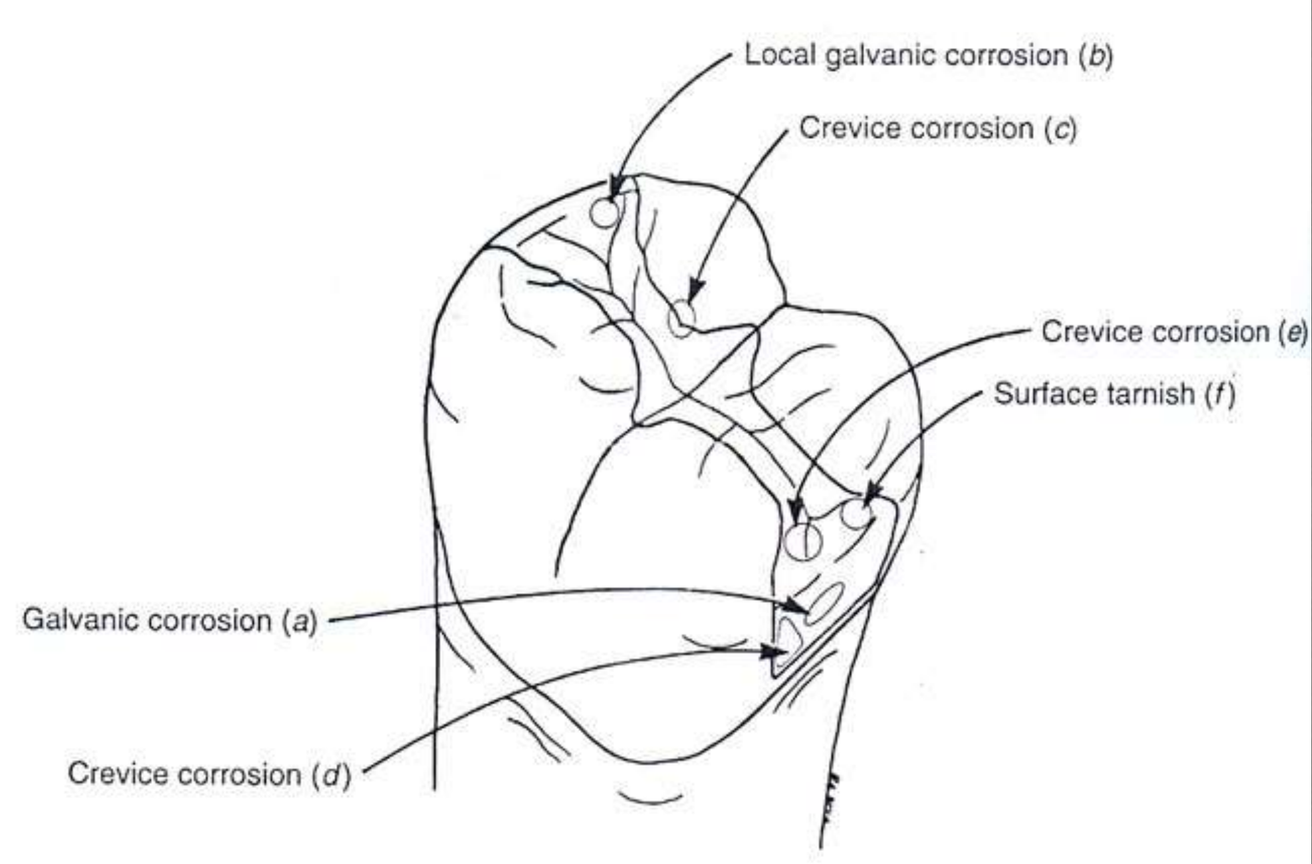
- High creep - γ_2 , Larger volume γ_1
- Low creep –, η, Larger γ_1 grain size

MANIPULATION

- Low Hg:alloy ratio
- Greater cond. pressure

TARNISH & CORROSION




Local galvanic corrosion (b)
Crevice corrosion (c)
Crevice corrosion (e)
Surface tarnish (f)
Galvanic corrosion (a)
Crevice corrosion (d)

CORROSION – Phases

1. Ag2Hg3 (γ_1)
2. Ag3Sn (γ)
3. Cu3Sn (ε)
4. Cu6Sn5 (η)
5. Sn7-8Hg (γ_2)

Low copper

Sn_{7}-$_{8}Hg$ + 1/2$0_2$ + H_2O + Cl- → $Sn_4(OH)_6Cl_2$ + Hg
Tin oxychloride.

High copper

Cu_6Sn_5 + 1/2$0_2$ + H_2O + Cl-→ $CuCl_{2}.3Cu(OH)_2$ + SnO.

Linear coefficient of thermal expansion

Material	CTE [ppm]
GIC	10.2–11.4
Resin composite	14–50
Amalgam	22.1–28.0
Porcelain	12.0
Human enamel	11.4
Human dentin	8.3

COTE of Amalgam 2.5 times > tooth

BIOCOMPATIBILITY OF DENTAL AMALGAM

- SYSTEMIC TOXICITY: Chronic mercury exposure
- LOCAL TOXICITY PULPREACTIONS:

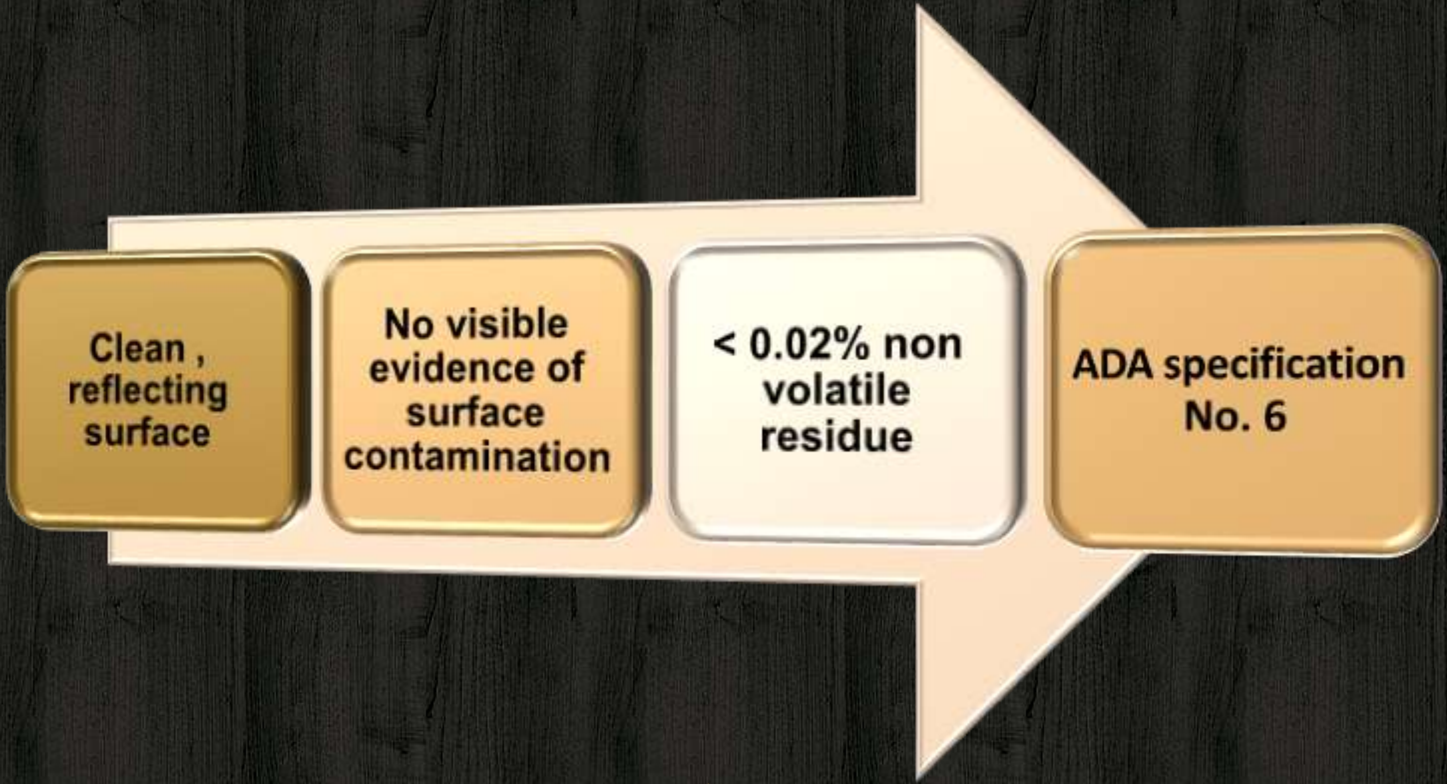
1. Reduced number of odontoblast.
2. Dilated capillaries.
3. An inflammatory cell reaction is seen in the odontoblastic layer, following the direct condensation of amalgam in deep cavities.

- ORALMUCOSAREACTIONS:

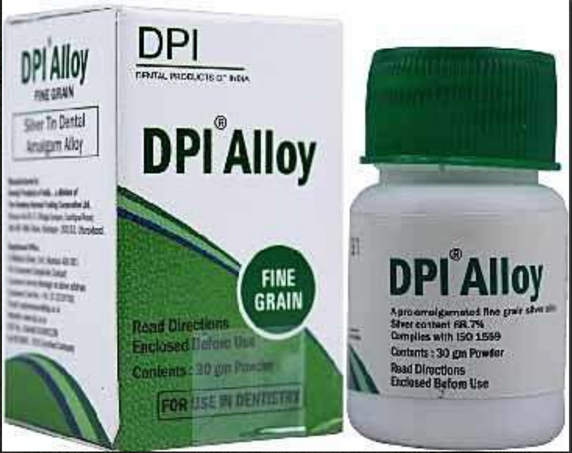
1. Gingivitis
2. Bleeding gums
3. Bone loss around teeth
4. Desquamation of buccal or lingual mucosa

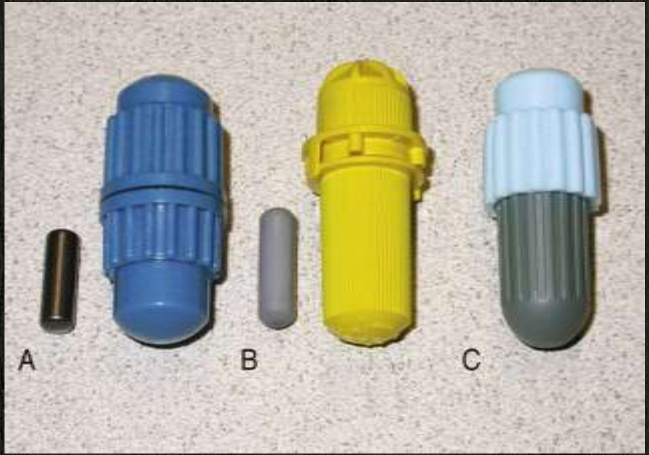
- Allergic reaction Type 1V – Delayed allergic type reaction may be seen in the oral mucosa in contact with the restorations which Oral Lichenoid Reactions, which resolve on removal of the restorations

PROPERTIES OF MERCURY



MANIPULATION & TECHNICAL CONSIDERATIONS OF AMALGAM





BULK POWDER

PRE PROPORTIONED CAPSULES

Selection of alloy

Particle size

- Low Cu lathe cut- finer
- Small – avg = ↑ early strength
- Larger = corrosion

Particle shape

- Lathe cut - rough
- Spherical – smoother , less Hg
- Admixed - tight contacts

Composition

- High Cu alloys
- Zinc content

Proportioning- Mercury : alloy ratio

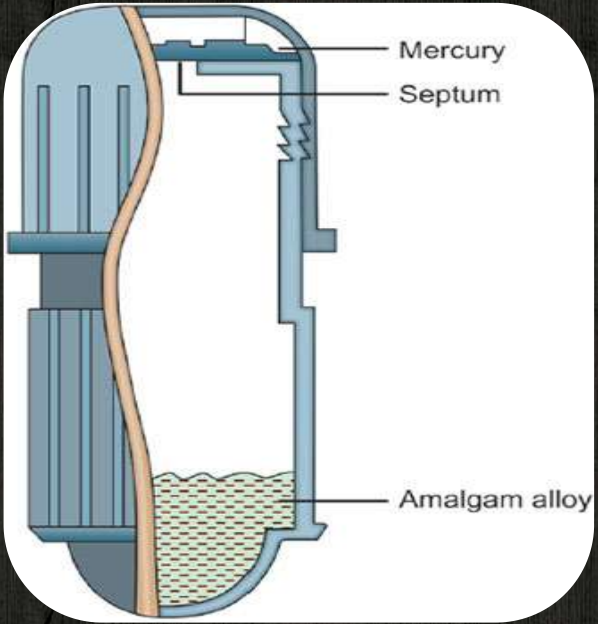
HIGH MERCURY TECH.

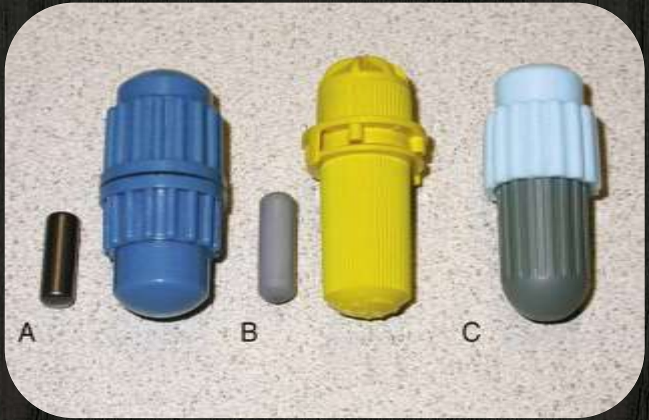
- 52-53% Hg
- Lathe cut low Cu alloys
- Plastic mix
- ↑ corrosion

- 43% = high Cu unic.
- 50% = high Cu admixed
- Hg:Alloy = 1:1
- Increasing dryness technique

MINIMAL MERCURY TECH.

Trituration





Trituration

Low speed: 32-3400 rpm.
Medium speed: 37-3800 rpm.
High speed: 40-4400 rpm.

1. Linear back and forth
2. Figure of 8
3. Centrifugal fashion

1. Speed
2. Thrust
3. Weight
4. Time
5. Difference in size

Under Trituration

- ↓Strength
- ↑ corrosion
- Rough
- Weak matrix interface
- ↓ creep

Normal mix

- Shiny
- Warm
- ↑ CS , TS

Over Trituration

- ↓working time, setting time
- ↑ corrosion
- ↓Strength

Condensation

OBJECTIVES

1. Squeeze the unreacted mercury
2. Bring strongest phases together
3. Adaptation → retention
4. Reduce porosity

Hand Condensation

TYPES OF CONDENSORS

1. ROUND – sizes 15, 25, 35
2. PARALLELOGRAM – 2 pairs

- Smaller – proximoocclusal bicuspids
- Larger – molars
- Hoe – proximal
- Hatchet – occlusal

$$\text{Pressure 'P'} = \frac{\text{Force}}{\text{Area of cross section}}$$

SELECTION OF CONDENSORS

- SPHERICAL – large tips
- LATHE – smaller tips
- ADMIXED – small to medium

FORCE= 15lbs (recommended)

Range = 3-4 lbs

Admixed = 5-10lbs

Spherical = 2-3 lbs

Pre carve Burnishing

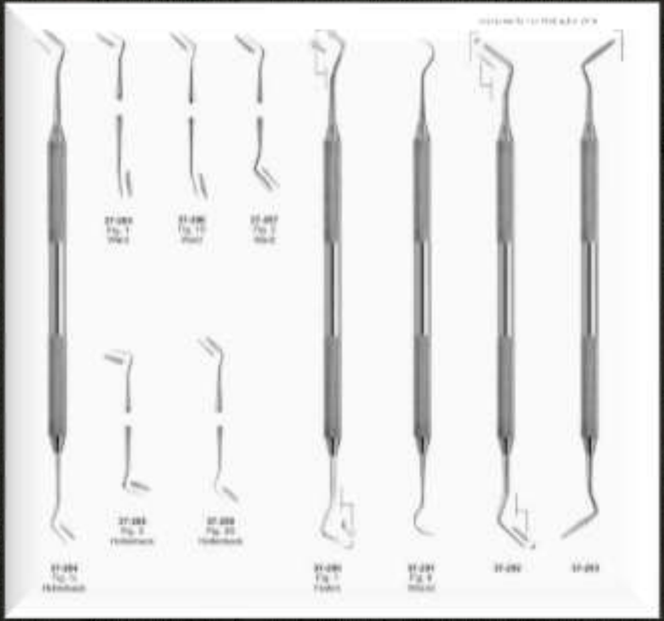
OBJECTIVES

1. Reduce voids
2. Removes excess mercury
3. Adaptation to cavosurface margins
4. Resists carving

Carving

OBJECTIVES

1. No overhang
2. Produce contours
3. Minimal flash
4. Occlusion
5. Marginal ridges
6. Contacts
7. Integrity of PDL



INSTRUMENTS

- Cleoid and discoid- for trimming the bulk
- Spoon excavator no 12, 13.
- Hollenback carver ,no 3
- Explorer no 3
- Curved knives no 14,15
- Evans carver
- Straight or binangle chisel

Finishing & Polishing

Finishing can be defined as the process, which continues the carving objectives, removes flash and overhangs and corrects minimal enamel underhangs

Polishing is the process which creates a corrosion resistant layer by removing scratches and irregularities from the surface.

Indications of amalgam







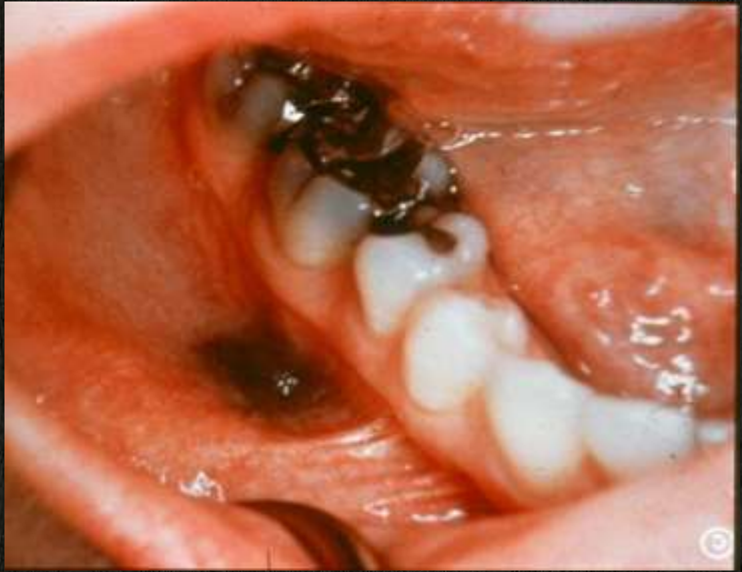
Clinical Considerations

- Marginal adaptation
- Self sealing:
- Low Cu = 2-3 months
- High Cu = 10-12 months
- GIC lining
- Oxalate solutions

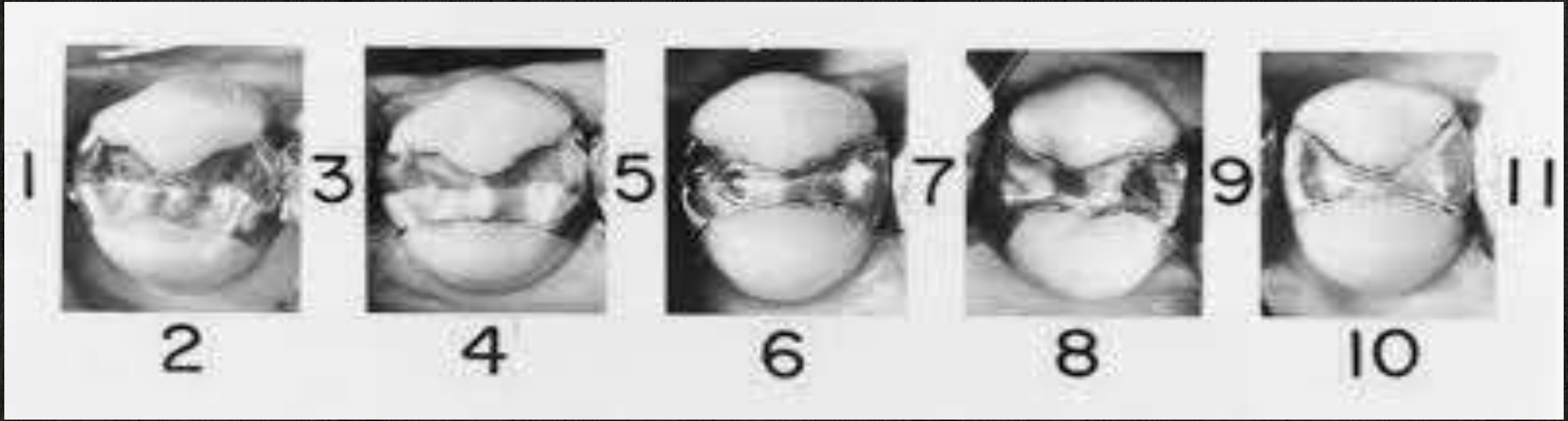
FAILURES OF AMALGAM RESTORATIONS

1. Fracture
2. Secondary caries.
3. Post operative sensitivity and pain.
4. Dislodgment of the restoration.
5. Contribution to periodontal diseases.
6. Discoloration of the teeth.
7. Tarnish and corrosion.
8. Pulpal damage.
9. Plaque formation
10. Occlusal interference.
11. Galvanism.
12. Amalgam tattoo

Amalgam tattoo & Amalgam blues



Marginal Fracture



Mahler's scale

Fracture

1. *Selection of the case:*

(a) Extensive tooth loss and undermined enamel.

(b) Post endodontic restoration.

(c) Cases with poor retention / resistance

(d) Areas of high masticatory load

(e) Spacing

2. *Selection of alloy.*

3. *Due to the improper cavity preparation.*

(a) Over cutting.

(b) Under cutting.

(c) Poor retention and resistance

(d) Improper finishing of the cavity.

4. *Due to physical properties of amalgam.*

(a) Dimensional changes (Delayed expansion).

(b) Strength.

(c) Creep.

Fracture

5. *Improper manipulation of the alloy*.

(a) Improper selection of the alloy.

(b) Improper powder, liquid ratio.

(c) Under trituration.

(d) Over trituration.

(e) Improper condensation.

(f) Improper carrying

(g) Improper finishing and polishing.

6. *Due to improper matrix adaptation:*

(a) Improper covering

(b) Excess thickness

(c) Improper wedging

(d) Premature matrix bond removal

7. *Due to contamination:*

- Moisture
- Instrument indication
- Contamination during manipulation.

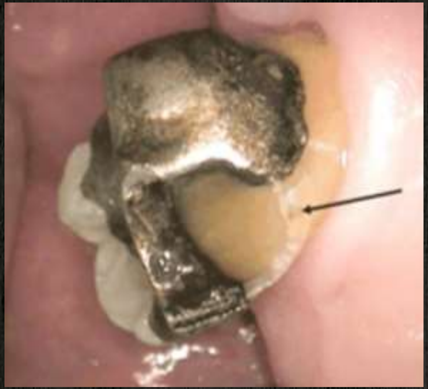
REPAIR OF AMALGAM RESTORATIONS

➢ Replacement of restoration

- secondary caries
- marginal defect
- cusp fracture

➢ Resin composite as repair material

- interfacial bond between amalgam and resin composite
- strengthening of the tooth-material interface
- veneering of amalgam for esthetic



ADVANTAGES & LIMITATIONS

ADVANTAGES:

1. Excellent wear resistance.
2. High compressive strength
3. Insolubility of fluids in mouth
4. Adaptability to cavity walls.
5. Minimal post operative sensitivity.
6. Has well developed sealing ability and marginal
7. Leakage is decreased with age.
8. Adequate resistance to fracture.
9. Economical

LIMITATIONS:

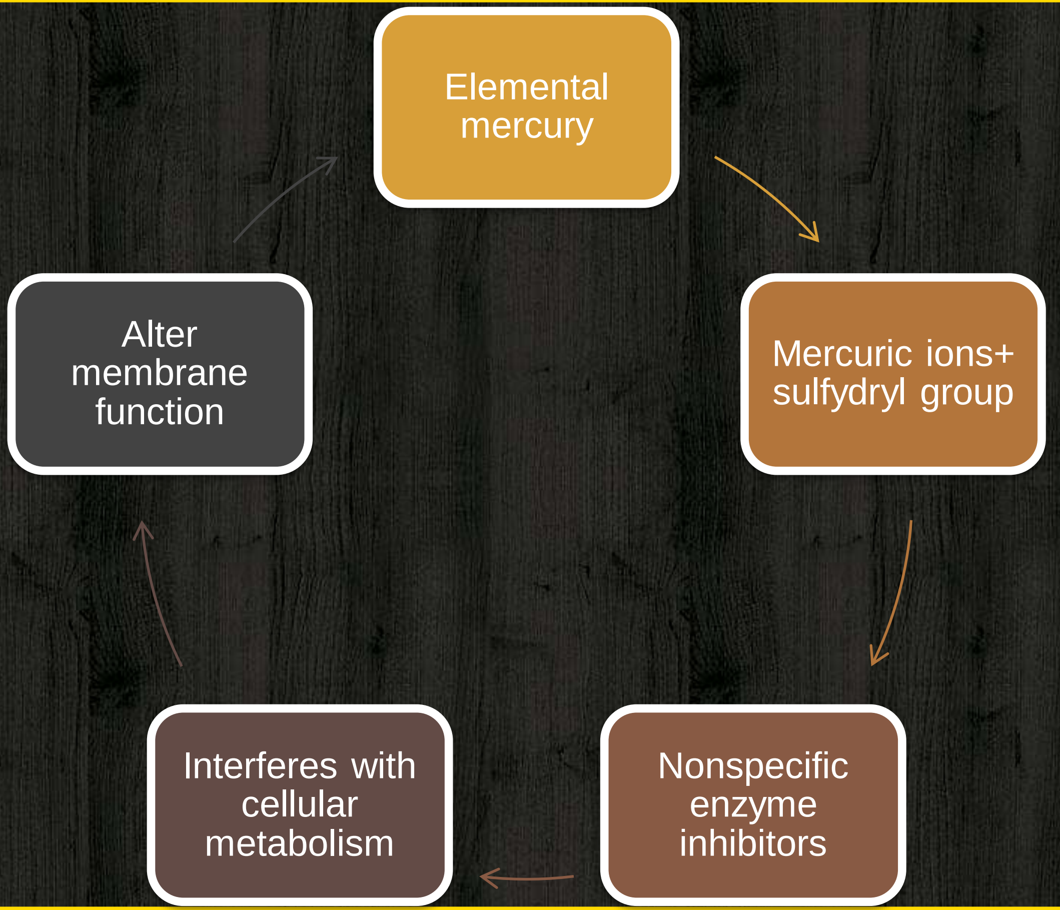
1. Excellent wear resistance.
2. Poor esthetics
3. High thermal conductivity
4. Galvanism
5. Lack of adhesion
6. Marginal integrity
7. Allergy
8. Mercury toxicity

Mercury Toxicity

Mercury	Lungs	GIT
Elemental	80%	0.01%
Inorganic	80%	7%
Organic	--	95 – 98%

- 80% Mercury vapour crosses alveolar cell membranes
- Accumulation- spleen, glands, muscle, kidney, brain
- Biological half life = 50-60 days
- Mercury in urine - 0 to 20 μg/L
- Mercury in blood - 0 to 1.0 μg / 100ml
- 100□g/m^3 – Clinical mercurism threshold
- 50□g/m^3– Nephrotoxicity threshold

MECHANISM OF ACTION



Clinical features:

- Psychological and behavioral changes occur. Symptoms may include
- increased excitability
- loss of memory
- insomnia
- severe depression
- irritability
- excessive shyness and confusion
- ataxia
- speech disorders
- reflex abnormalities
- kidney dysfunction
- visual disturbances and
- impaired nerve conduction

- Oral symptoms include gingivitis,
- excessive salivation,
- metallic taste, and
- loosening of teeth.
- The triad consisting of increased excitability, tremors and gingivitis

Mercury Toxicity

Trituration	→ 1 – 2 mg
Placement of amalgam restoration	→ 6 – 8 mg
Dry polishing	→ 44 mg
Wet polishing	→ 2 – 4 mg
Removal of amalgam under water spray and high volume section	→ 15 – 20 mg
Additional evacuation for 1 minute to remove residual amalgam dust	→ 1.5 – 2.0 mg

Mercury Toxicity

Dental mercury hygiene recommendations:

1. *Ventilation*
2. *Monitor office and personnel*
3. *Office design*
4. *Pre-capsulated alloys*
5. *Amalgamator cover*
6. *Handling care*
7. *Evacuation systems*
8. *Masks*
9. *Recycling*
10. *Spills*
11. *Clothing*
12. *No ultrasonic condensors*

RECENT ADVANCES OF DENTAL AMALGAM
Gallium Alloys

- Suggested by Puttkamer in 1928
- In 1956 – Smith et al produced Gallium alloys = Ga-Sn + Cu-Sn
- Waterstrat then formulated Ga – Pd – Sn alloys
- Tokurike Honten, Tokyo, Japan - Gallium Alloy GF

- POWDER - Wt%
  Ag – 50%
  tin – 25.7 %
  Cu – 15 %
  Palladium -9 %
  Zinc – 0.3 %
- LIQUID – Wt %
  Gallium – 65 %
  Indium – 16 %
  Silver – 0.05 %

- POWDER –Wt%
  Silver – 60.10 %
  Tin – 28.05 %
  Copper – 11.80 %
  Platinum – 0.05 %
- LIQUID – Wt%
  Gallium -61.98 %
  Indium -24.99 %
  Tin – 12.98 %
  Bismuth – 0.05 %

Gallium Alloys

- SETTING REACTION :
- Ga + Cu → $CuGa_2$
- Ga + Ag → $Ag_{72}Ga_{28}$
- Ga + In → Ag_9In_4

A study was done by **Osborne & Summitt** to compare the mechanical properties of Galloy to high copper amalgams and concluded that Mechanical properties of Gallium alloys were equivalent to or even better than high copper amalgams, especially tensile strength and extremely low wear.

Gallium Alloys

ADVANTAGES:

- Marginal adaptation
- Reduced initial leakage
- Greater compressive strength and creep
- Low setting expansion

DISADVANTAGES:

- Technique sensitive
- No moisture contamination
- Reacts with moisture upto 18hrs after placement
- High corrosion
- Whitening of enamel margins
- Expensive
- Faster setting

Consolidated silver alloy systems

- Tin Solution, silver solution, acid, alumina, colloid
- 0.2 – 2 µm dia particles
- 25µm agglomerates
- Annealing = 750°C for 2 hours
- activated in 10% HBF_4 for 4 min and then rinsed in aqueous solution of 2% HBF_4 for 1 min

ADVANTAGES:

- 80% dense compaction
- Increased shear strength, corrosion resistance
- Less microleakage, postop sensitivity
- Polished immediately
- Biocompatible
- Less compaction time

DISADVATAGES

- 2% HBF_4 demineralized dentin upto 2 µm
- More technique sensitive
- High condensation pressure = 35-50Mpa
- Lower compressive strength.

Resin coated amalgam

- **Mertz-fairhurst** and others evaluated bonded and sealed composite restorations placed directly over frank cavitated lesions extending into dentin versus sealed conservative amalgam restorations and conventional unsealed amalgam restorations.

- The results indicate that both types of sealed restorations exhibited superior clinical performance and longevity compared with unsealed amalgam restorations over a period of 10 years (Mertz-Fairhurst, 1998).

Fluoride Releasing Amalgam

- SnF_2 (0.5 – 1 %)
- Bercy and Vreven (1980) - F^- from SnF_2 containing alloys gets incorporated in the cavity walls .
- Inhibition of enamel & root caries was seen with high Cu amalgam with 1% SnF_2
- release of F^- has been restricted only to the first few weeks (10-12) - Forsten 1976
- Reduction in compressive strength upto 13%
- enhanced corrosion

Bonded Amalgam Restorations

- **Baldwin’s technique – 1920 – zinc phosphate cement**
- **Zardiackas** in 1976 - '**selective interfacial amalgamation**‘ = **liner** polycarboxylate cement + amalgam alloy
- tensile bond strengths = 3.5 MPa, shear punch bond strengths =15 Mpa
- '**Superbond**' (which was based on the 4-META-TBB adhesive monomer
- Kuraray's '**Panavia**' (based on the MDP monomer).
- **Varga *et al.*** tested both Superbond and Panavia and found them to bond amalgam to etched enamel surfaces and inhibit microleakage. Bond strengths of up to 17.7 MPa were reported for Superbond.

Bonded Amalgam Restorations

PANAVIA

- First marketed in 1980's
- Contained bi- functional monomer 10 – MDP
- In 1994 – Panavia modified to include primer HEMA which improves bond strength to dentin
- Polymerization requires – exclusion of Oxygen so a covering gel was provided.

AMALGAM BOND

- NAKABAYASHI.
- 10% CITRIC ACID and 3% FERRIC CHLORIDE
- A primer is applied after the dentine is conditioned.
- Self-curing methacrylate resin containing an adhesive monomer called 4-META

Panavia 21


PANAVIA 21
CAT
CATALYST PASTE
PANAVIA 21
TC
UNIVERSAL PASTE

Bonded Amalgam Restorations

Various in – vitro studies have been done:-

- Studies on **fracture resistance** have shown that it is:-
- Greater for teeth restored with bonded amalgams compared to non-bonded. (Eakle & others 1992)
- Greater for bonded amalgam as compared to restorations mechanically retained with pin in case of single cusp capping – (Rauvola , Broome , Simon 1997) .

Bonded Amalgam Restorations

- **Microleakage studies** have shown that Bonded amalgam has less microleakage as compared to varnish lined restorations (Yu, Wei & Xu, 1987).

- Clinical studies have shown that there is low incidence of **secondary caries** around bonded amalgam as compared to non-bonded amalgam after 2 years.

- At three and 12 months, teeth with bonded restorations exhibited **less sensitivity** than those with non-bonded restorations (Davis and Overton study.

- Bonded restorations survived better than non-bonded in teeth with no deliberate retention (Setcos et al 1998)

Bonded Amalgam Restorations

INDICATIONS

- Large compound restorations: In extensive cavities with gross tooth loss.
- Repair of restorations (to bond new to old amalgam and to seal cavity margins in the old restorations).
- Preparations without retention.
- Repeated fracture of amalgam restorations.
- Geriatric and debilitated patients – Bonded amalgam is preferred over more expensive and time consuming cast restorations.
- teeth with low gingival- occlusal height.

Bonded Amalgam Restorations

1. enamel and dentine are both etched with 10% phosphoric acid for 15 seconds
2. three coats of adhesive primer (Primer A + Primer B) are applied.
3. The dentin – enamel bonding agent is applied with a disposable brush
4. Amalgam is condensed into the cavity before the auto curing bonding agent is polymerized.

Bonded Amalgam Restorations

ADVANTAGES:

- conservative cavity preparations
- reduces marginal leakage
- reduces the incidence of postoperative sensitivity
- reduces the incidence of marginal fracture and recurrent caries

DISADVATAGES:

- technique sensitive.
- Cannot be indicated in reinforcing functional cusps
- Expensive

CONCLUSION

- Dental amalgam has been used in dentistry for over 150 years.
- Amalgam has provided valuable and comparatively inexpensive service to patients longer than any other material available. It has many positive attributes and remains an important part of dentist's restorative resource.

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