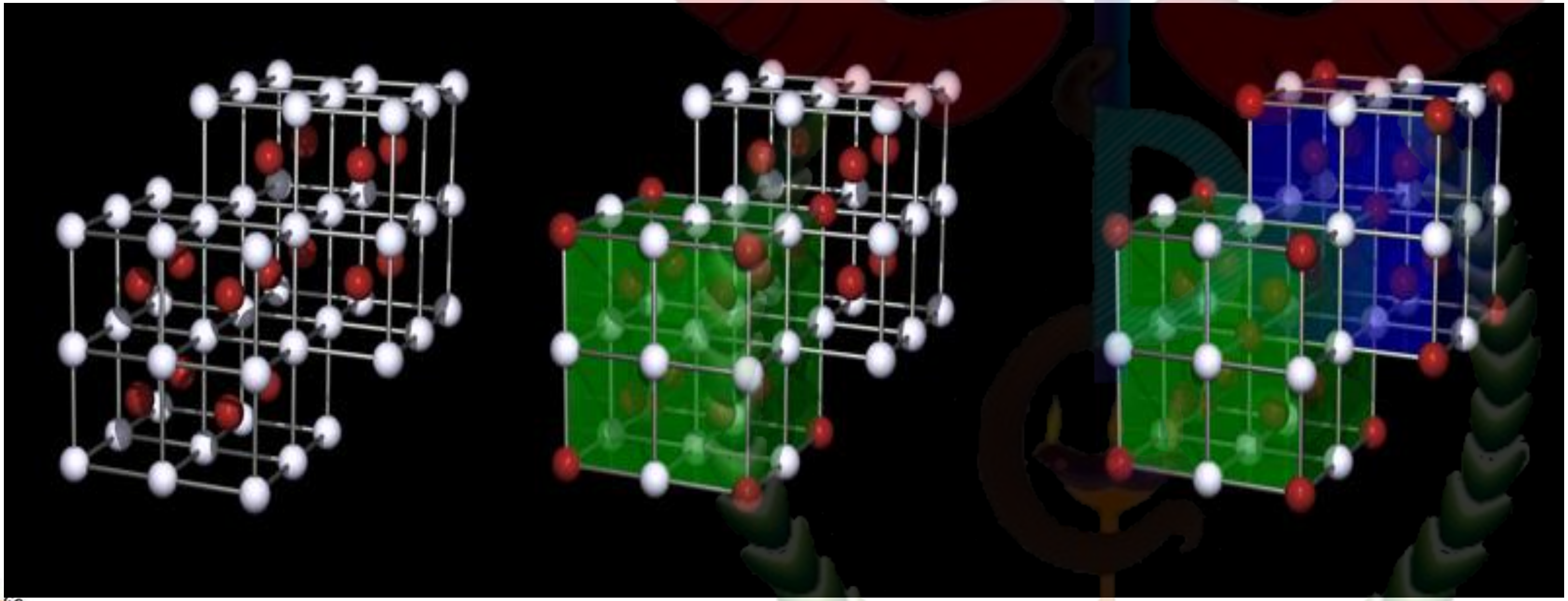
CLASSIFICATION OF DENTAL CASTING ALLOYS



LEARNING OBJECTIVE

- By the end of this session students will learn about method of casting in fpd and its procedure

1. ALLOY TYPES BY FUNCTIONS:

In 1927, the Bureau of Standard established gold casting alloys, type I to type IV according to dental function with hardness increasing from type I to type IV.

Type I (Soft):

It is used for fabrication of small inlays, class III and class V restorations which are not subjected to great stress . These alloys are easily burnishable.

Type -II (Medium):

These are used for fabrication of inlays subjected to moderate stress, thick 3/4 crowns, abutments, pontics, full crowns and soft saddles.

Type I and II are usually referred to as inlay gold.

Type -III (Hard):

It is used for fabrication of inlays subjected to high stress, thin 3/4 crowns, thin cast backing abutments, pontics, full crowns, denture bases and short span FPDs . Type III alloys can be age hardened.

Type-IV (Extra hard):

It is used for fabrication of inlays subjected to high stress, denture bases, bars and clasps, partial denture frameworks and long span FPDs. These alloys can be age hardened by heat treatment.

Type III and Type IV gold alloys are generally called "Crown and Bridge Alloys", although type IV alloy is used for high stress applications such as RPD framework.

Later, in 1960, metal ceramic alloys were introduced and removable partial denture alloys were added in this classification.

Metal ceramic alloys (hard and extra hard):

It is suitable for veneering with dental porcelain, copings, thin walled crowns, short span FPDs and long span FPDs. These alloy vary greatly in composition and may be gold, palladium, nickel or cobalt based.

Removable partial denture alloys :

It is used for removable partial denture frameworks. Now a days, light weight, strong and less expensive nickel or cobalt based have replaced type IV alloys .

2. ALLOY TYPES BY DESCRIPTION:

A) CROWN AND BRIDGE ALLOYS

used in the fabrication of full metal or partial veneers.

1. Noble metal alloys:

i) Gold based alloy - type III and type IV gold alloys , low gold alloys

ii) Non-gold based alloy-Silver -palladium alloy

2. Base metal alloys:

i) Nickel-based alloys

ii) Cobalt based alloys

3. Other alloys:

i) Copper-zinc with Indium and nickel

ii) Silver-indium with palladium

B) METAL CERAMIC ALLOY

1. Noble metal alloys for porcelain bonding:

i) Gold-platinum -palladium alloy

ii) Gold-palladium-silver alloy

iii) Gold-palladium alloy

iv) Palladium silver alloy

v) High palladium alloy

2. Base metal alloys for porcelain bonding:

i) Nickel -chromium alloy

ii) Cobalt-chromium alloy

C) REMOVABLE PARTIAL DENTURE ALLOY

Although type-IV noble metal alloy may be used, majority of removable partial framework are made from base metal alloys:

1. Cobalt-chromium alloy
2. Nickel-chromium alloy
3. Cobalt-chromium-nickel alloy
4. Silver-palladium alloy
5. Aluminum -bronze alloy

3.ALLOY TYPE BY NOBILITY

Alloy Classification of the American Dental Association (1984)

ALLOY TYPE	TOTAL NOBLE METAL CONTENT
High noble metal	Contains ≥ 40 wt% Au and ≥ 60 wt% of the noble metal elements (Au + Ir + Os + Pd + Pt + Rh + Ru)
Noble metal	Contains ≥ 25 wt % of the noble metal elements
Predominantly base metal	Contains < 25 wt % of the noble metal elements

Alloy type	All-metal	Metal-ceramic	
High noble	Au-Ag-Cu-Pd	Au-Pt-Pd	
	Metal ceramic alloys	Au-Pd-Ag (5-12wt% Ag)	
		Au-Pd-Ag (>12wt%Ag)	
		Au-Pd (no Ag)	
Noble	Ag-Pd-Au-Cu	Pd-Au (no Ag)	
	Ag-Pd	Pd-Au-Ag	
	Metal-ceramic alloys	Pd-Ag	
		Pd-Cu	
		Pd-Co	
		Pd-Ga-Ag	
Base Metal	Pure Ti	Pure Ti	
	Ti-Al-V	Ti-Al-V	
	Ni-Cr-Mo-Be	Ni-Cr-Mo-Be	
	Ni-Cr-Mo	Ni-Cr-Mo	
	Co-Cr-Mo	Co-Cr-Mo	
	Co-Cr-W	Co-Cr-W	
	Al bronze		

4. **ALLOY TYPE BY MAJOR ELEMENTS:** Gold-based, palladium-based, silver-based, nickel-based, cobalt-based and titanium-based .

5. **ALLOY TYPE BY PRINCIPAL THREE ELEMENTS:** Such as Au-Pd-Ag, Pd-Ag-Sn, Ni-Cr-Be, Co-Cr-Mo, Ti-Al-V and Fe-Ni-Cr.

   (If two metals are present, a binary alloy is formed; if three or four metals are present, ternary and quaternary alloys, respectively, are produced and so on.)

6. **ALLOY TYPE BY DOMINANT PHASE SYSTEM:** Single phase [isomorphous], eutectic, peritectic and intermetallic.

DESIRABLE PROPERTIES OF DENTAL CASTING ALLOYS

- Biocompatibility
- Ease of melting
- Ease of casting
- Ease of brazing (soldering)
- Ease of polishing
- Little solidification shrinkage
- Minimal reactivity with the mold material
- Good wear resistance
- High strength
- Excellent corrosion resistance
- Porcelain Bonding

GOLD CASTING ALLOYS

GOLD CASTING ALLOYS:

ADA specification No. 5 classify dental gold casting alloys as:

1. High Gold Alloys
   - Type I
   - Type II
   - Type III — Inlay Gold Alloy
   - Type IV — Crown & Bridge Alloy
2. Low Gold Alloys
3. White Gold Alloys

HIGH GOLD ALLOY:

These alloys contain 70% by weight or more of gold palladium and platinum. ADA specification No.5 divides this into four depending upon mechanical properties.

Type I (Soft):-

They are weak, soft and highly ductile, useful only in areas of low occlusal stress designed for simple inlays such as used in class I, III & V cavities.

These alloys have a high ductility so they can be burnished easily. Such a characteristic is important since these alloys are designed to be used in conjunction with a direct wax pattern technique. Since such a technique occasionally results in margins that are less than ideal . At present, these are used very rarely.

PROPERTIES

1. Hardness — VHN (50 – 90)
2. Tensile Strength — Quite Low
   276 MPa or 40,000 PSi
3. Yield Strength — 180 MPa or 26,000 PSi
4. Linear Casting Shrinkage — 1.56% (according to Anusavice)
5. Elongation or ductility — 46% - William O Brien
   18% - Anusavice

COMPOSITION

Au	Ag	Cu	Pt	Pd	Zn&Ga
83%	10%	6%	-	0.5%	balance

Type II (Medium):-

These are used for conventional inlay or onlay restorations subject to moderate stress, thick three quarter crowns, pontics and full crowns. These are harder and have good strength.

Ductility is almost same as that of type I alloy however, yield strength is higher. Since burnishability is a function of ductility and yield strength, greater effort is required to deform the alloy. They are less yellow in color due to less gold.

Properties:

1. Hardness VHN (90-120)
2. Tensile Strength 345 MPa
3. Yield Strength 300 MPa
4. Linear Casting Shrinkage 1.37%
5. Elongation 40.5% - William O Brien

   10% - Anusavice

Composition:

Au	Ag	Cu	Pt	Pd	Zn&Ga
77%	14%	7%	-	1%	balance

Type III (Hard):

Inlays subject to high stress and for crown and bridge in contrast to type I and type II, this type can be age hardened. The type III alloy, burnishing is less important than strength.

Properties:

1. Hardness (VHN)	120 – 150
2. Tensile Strength	360 MPa
3. Yield Strength	331 MPa
4. Linear Casting Shrinkage	1.42%
5. Elongation or ductility	39.4% - William O Brien
	5% - Anusavice

Composition:

Au	Ag	Cu	Pt	Pd	Zn & Ga
75%	11%	9%	-	3.5%	balance

Type IV (Extra Hard):

These are used in areas of very high stress, crowns and long span bridges. It has lowest gold content of all four type (Less than 70%) but has the highest percentage of silver, copper, platinum and Palladium. It is most responsive to heat treatment and yield strength but lowers ductility.

Properties:

1. Hardness	VHN (150-200)
2. Tensile Strength	462 MPa
3. Yield Strength	703 MPa
4. Linear Casting Shrinkage	2.30%
5. Elongation or ductility	17% - William O Brien
	3% - Anusavice

Composition:

Au	Ag	Cu	Pt	Pd	Zn&Ga
56%	25%	14%	-	4%	balance

Type	Hardness	Proportional limit	Strength	Ductility	Corrosion resistance
I					
II		INCREASES		DECREASES	
III					
IV					

Composition Range (weight percent) of traditional type I to IV alloys and four metal -ceramic alloys

Alloy type	Main elements	Au	Cu	Ag	Pd	Sn, In, Fe, Zn, Ga
I	High noble (Au base)	83	6	10	0.5	Balance
II	High noble (Au base)	77	7	14	1	Balance
III	High noble (Au base)	75	9	11	3.5	Balance
III	Noble (Au base)	46	8	39	6	Balance
III	Noble (Ag base)			70	25	Balance
IV	High noble (Au base)	56	14	25	4	Balance
IV	Noble (Ag base)	15	14	45	25	Balance
Metal-ceramic	High noble (Au base)	52			38	Balance
Metal-ceramic	Noble (Pd base)			30	60	Balance
Metal-ceramic	High noble (Au base)	88		1	7 (+4Pt)	Balance
Metal-ceramic	Noble (Pd base)	0-6	0-15	0-10	74-88	Balance

HEAT TREATMENT OF GOLD ALLOYS:

Heat treatment of alloys is done in order to alter its mechanical properties.

Gold alloys can be heat treated if it contains sufficient amount of copper. Only type III and type IV gold alloys can be heat-treated.

There are two types of heat treatment.

1. Softening Heat Treatment (Solution heat treatment)
2. Hardening Heat Treatment (Age hardening)

1. SOFTENING HEAT TEMPERATURE

Softening heat treatment increases ductility, but reduces tensile strength, proportional limit, and hardness.

Indications:

It is indicated for appliances that are to be grounded, shaped, or otherwise cold worked in or outside the mouth.

Method:

The casting is placed in an electric furnace for 10 minutes at a temperature of 700ºC and then it is quenched in water. During this period, all intermediate phases are presumably changed to a disordered solid solution, and the rapid quenching prevents ordering from occurring during cooling.

Each alloy has its optimum temperature. The manufacturer should specify the most favorable temperature and time.

2. HARDENING HEAT TREATMENT

Hardening heat treatment increases strength, proportional limit, and hardness, but decreases ductility. It is the copper present in gold alloys, which helps in the age hardening process.

Indications:

It is indicated for metallic partial dentures, saddles, bridges and other similar structures. It is not employed for smaller structures such as inlays.

Method:

It is done by "soaking" or ageing the casting at a specific temperature for a definite time, usually 15 to 30 minutes. It is then water quenched. The aging temperature depends on the alloy composition but is generally between 200°C and 450°C. During this period, the intermediate phases are changed to an ordered solid solution.

The proper time and temperature for age hardening an alloy are specified by the manufacturer.

Ideally, before age hardening an alloy, it should first be subjected to a softening heat treatment to relieve all strain hardening and to start the age hardening treatment when the alloy is in a disordered solid solution. This allows better control of the hardening process.

METAL CERAMIC ALLOYS

METAL CERAMIC ALLOYS

The main function of metal-ceramic alloys is to reinforce porcelain, thus increasing its resistance to fracture.

Requirements:

- They should be able to bond with porcelain.
- Its coefficient of thermal expansion should be compatible with that of porcelain.
- Its melting temperature should be higher than the porcelain firing temperature. It should be able to resist creep or sag at these temperatures.
- It should not stain or discolor porcelain.

The alloys used for metal-ceramic purposes are grouped under two categories:

i) Noble metal alloys
ii) Base metal alloys.

In case of noble metal alloys for porcelain bonding , addition of 1% base metals (iron, indium, tin etc.) increases porcelain-metal bond strength, which is due to formation of an oxide film on its surface. It also increases strength and proportional limit.

PROPERTIES

Modulus of elasticity:

The base metal alloys have a modulus of elasticity approximately twice that of gold alloys. Thus it is suited for long span bridges. Similarly, thinner castings are possible.

Hardness:

The hardness of base metal alloys ranges from 175 to 360 VHN. Thus, they are generally harder than noble metal alloys. Thus, cutting, grinding and polishing requires high speed and other equipment.

Ductility:

It ranges from 10 to 28% for base metal alloys. Noble metal alloys have an elongation of 25 to 40%.

Density:

The density of base metal alloys are less, which is approximately 8.0 gms/cm3 as compared to 18.39 gms/cm3 for noble metal alloys.

Sag Resistance:

Base metal alloys resist creep better than gold alloy when heated to high temperatures during firing.

Bond Strength: Varies according to composition.

Technique Sensitivity: Base metals are more technique sensitive than high noble metal-ceramic alloys.

Shillingburg HT, Hobo S and Fisher DW (1977)

Studied Preparation design and margin distortion in porcelain-fused-to-metal restorations.

The results of this study suggested that thermal incompatibility stresses were likely to cause margin distortion in metal ceramic crowns.

However, subsequent studies support other potential mechanisms, including the effect of excessive sand blasting time and/or pressure.

The Gold-Platinum-Palladium (Au-Pt-Pd) System:

This is one of the oldest metal ceramic alloy system. But these alloys are not used widely today because they are very expensive.

Composition:

Gold – 75% to 88%

Palladium – Upto 11%

Platinum – Upto 8%

Silver – 5%

Trace elements like Indium, Iron and Tin for porcelain bonding.

Advantages

1. Excellent castability
2. Excellent porcelain bonding
3. Easy to adjust and finish
4. High nobility level
5. Excellent corrosion and tarnish resistance.
6. Biocompatible
7. Some are yellow in color
8. Not "Technique Sensitive"
9. Burnishable

Disadvantages

1. High cost
2. Poor sag resistance so not suited for long span fixed partial dentures
3. Low hardness (Greater wear)
4. High density (fewer casting ounce)

Gold-Palladium-Silver (Au-Pd-Ag) System:

These alloys were developed in an attempt to overcome the major limitations in the gold-platinum-palladium system (mainly poor sag resistance, low hardness & high cost)

Two variations on the basic combination of gold, palladium and silver were created and are identified as either high-silver or low-silver group.

Composition (High Silver Group):

Gold – 39% to 53%
Silver – 12% to 22%
Palladium – 25% to 35%
trace amount of oxidizable elements are added for porcelain bonding.

Advantages

1. Less expensive than Au-Pt-Pd alloys
2. Improved rigidity and sag resistance.
3. High malleability.

Disadvantages

1. High silver content creates potential for porcelain discoloration.
2. High Cost.
3. High coefficient of thermal expansion.
4. Less Tarnish and corrosion resistant.

Composition (Low Silver Group):

Gold – 52% to 77%

Silver- 5% to 12%

Palladium – 10% to 33%

Trace amounts of oxidizable elements for porcelain bonding.

Advantages

1. Less expensive than the Au-Pt-Pd alloys
2. Improved sag resistance
3. High noble metal content
4. Tarnish and corrosive resistant

Disadvantages

1. Silver creates potential for porcelain discoloration (but less than high silver group)
2. High cost.
3. High coefficient of thermal expansion.

Gold-Palladium (Au-Pd) System:

This particular system was developed in an attempt to overcome the major limitations in the Au-Pt-Pd system and Au-Pd-Ag system. Mainly-

-Porcelain discoloration.

-Too high coefficient of thermal expansion & contraction.

Composition:

Gold – 44% to 55%

Gallium – 5%

Palladium – 35% to 45%

Indium & Tin – 8% to 12%

Indium, Gallium and Tin are the oxidizable elements responsible for porcelain bonding.

Advantages

1. Excellent castability
2. Good bond strength
3. Corrosion and tarnish resistance
4. Improved hardness
5. Improved strength (sag resistance)
6. Lower density

Disadvantages

1. Not thermally compatible with high expansion dental porcelain.
2. High cost

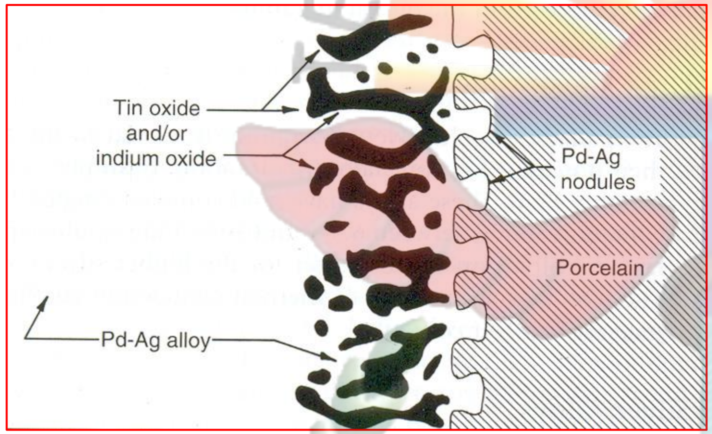
Palladium-Silver (Pd-Ag) System

This was the first gold free system to be introduced in the United States (1974) that still contained a noble metal (palladium). It was offered as an economical alternative to the more expensive gold-platinum-silver and gold-palladium-silver (gold based) alloy systems.

Composition: (available in two compo.)

1. Palladium – 55% to 60% Silver – 25% to 30%
   Indium and Tin
2. Palladium – 50% to 55% Silver – 35% to 40%
   Tin (Little or no Indium)

Trace elements of other oxidizable base elements are also present.


Tin oxide
and/or
indium oxide
Pd-Ag
nodules
Porcelain
Pd-Ag alloy

Advantages

1. Low Cost
2. Low density
3. Good castibility (when torch casting)
4. Good porcelain bonding,
5. Burnishability
6. Low hardness
7. Excellent sag resistance
8. Moderate nobility level
9. Good tarnish and corrosion resistance.
10. Suitable for long-span fixed partial dentures.

Disadvantages

1. Discoloration (yellow, brown or green) may occur with some dental porcelains.
2. Some castibility problems reported (with induction casting)
3. Pd and Ag prone to absorb gases.
4. Require regular purging of the porcelain furnace.
5. May form internal oxides (yet porcelain bonding does not appear to be a problem)
6. Should not be cast in a carbon crucible.
7. Non-carbon phosphate bonded investments recommended.
8. High coefficient of thermal expansion.

Berzins DW, Sarkar NK et al (2000)

Did an in-vitro electrochemical evaluation of high palladium alloys in relation to palladium allergy.

The high incidence of allergic reaction was associated with Pd-Cu based alloys. The "*Pd-skin*" of these alloys when in contact with saliva release some Pd++ ions (an allergen) which can trigger the cascade of biological reaction involved in allergy and hypersensitivity. It is a time dependent process.

In Pd alloys containing Ag, formation of Ag-Cl film on the alloy surface is supposed to prevent Pd in coming in contact with oral fluids, having a masking effect and thus avoiding allergy.

DISCOLORATION OF PORCELAIN BY SILVER:

The colloidal dispersion of silver atoms entering the body and incisal porcelain or the glazed surface from vapour transport or surface diffusion may cause color changes including green, yellow-green, yellow-orange, orange and brown hues. This phenomenon is termed GREENING.

Porcelains with higher sodium content are believed to exhibit more intense discoloration because of more rapid silver diffusion in sodium containing glass.

The intensity of discoloration increases for higher silver content alloys, is more in the cervical region, lighter shades, multiple firing procedures and certain brands of porcelain and also in silver free alloys due to vaporization of silver from the walls of contaminated furnaces.

PREVENTION OF DISCOLORATION:

- Use of ultra low fusing porcelain or non greening porcelain.
- A pure gold film can be fired on a metal substrate to reduce the surface silver concentration.
- A ceramic conditioner can be fired as a barrier between the alloy and the porcelain.
- Use of a graphite block routinely to maintain a reducing atmosphere.

HIGH PALLADIUM SYSTEM

Several types of high palladium systems were originally introduced (Tuccillo, 1987).

More popular composition groups contained cobalt and copper.

Composition (PALLADIUM-COBALT ALLOY):

Palladium – 78% to 88% Cobalt – 4% to 10%

(Some high palladium-cobalt alloys may contain 2% gold)

Trace amounts of oxidizable elements (such as gallium and indium) are added for porcelain bonding.

Advantages

1. Low cost
2. Reportedly good sag resistance
3. Low density means more casting Pd-Cu.
4. They Melt and cast easily
5. Good polishability (Supposed be similar to Au-Pd alloys)
6. Reportedly easier to presolder than Pd-Cu alloys.

Disadvantages

1. More compatible with higher expansion porcelains.
2. Are more prone to over-heating than per ounce than gold based alloys or high Pd-Cu.
3. Produces a thick, dark oxide
4. Colored oxide layer may to cause bluing of the porcelain.
5. Prone to gas absorption
6. Little information on long-term clinical success.

COMPOSITION (PALLADIUM-COPPER ALLOYS)

Palladium – 70% to 80%

Copper – 9% to 15%

Gold – 1% to 2%

Platinum – 1%

Some, but not all, high palladium-copper alloys contain small quantities (1% to 2%) of gold and/or platinum. Trace amounts of the oxidizable elements gallium, indium and tin are added for porcelain bonding.

Advantages

1. Good castability
2. Lower cost (than gold based alloys)
3. Low density means more castings Per ounce
4. Tarnish and corrosion resistance
5. Compatible with many dental Porcelains.
6. Some are available in one unit ingots.

Disadvantages

1. Produces dark, thick oxides
2. May discolor (gray) some dental porcelains.
3. Must visually evaluate oxide color to determine if proper adherent oxide was formed.
4. Should not be cast in carbon crucibles (electric casting machines)
5. Prone to gaseous absorption.
6. Subject to thermal creep.
7. May not be suitable for long span fixed partial denture prosthesis.
8. Little information on long term clinical success.
9. Difficult to polish
10. Resoldering is a problem

Tufekci E, Mitchell JC et al (2002)

Did a study on spectroscopy measurements of elemental release from high palladium dental casting alloys into a corrosion testing medium.

A highly sensitive analytical technique shows that the release of individual elements over a one month period, suggesting that there may be low risk of biological reaction with the Pd-Ga alloys than with the Pd-Cu-Ga alloys tested.

Carr A.B., Cai Z., Brantley W.A. (1993) did a study on new high palladium casting alloys (generation 1&2).

For the 5 high-palladium alloys studied, the following conclusions were drawn:

1. An increase in the investment burn out temperature from 1400°F to 1500 °F had little effect on microstructure and hardness, but grain or dendrites size was found to vary substantially.

2. Hot tears were more prevalent in the alloys when the higher burnout temperature was used.

3. Heat treatment simulating porcelain firing cycles for these alloys generally caused decrease in hardness.

Compositions of Representative High Noble (HN)* and Noble (N)† Alloys for Metal-Ceramic Prostheses

Typical products	Supplier	Principal elements (wt%) Au	Pt	Pd	Ag	Cu	Co	Ga	Sn, Zn, and In
I. Au-Pt-Pd or Au-Pd-Pt (0% to 4.99% Ag)	SMG-3 (Dentsply Ceramco)	81	6	11	—	—	—	—	Bal.
	Jelenko "O" (Heraeus-Kulzer)	87	4.5	6	1	—	—	—	Bal.
	Argedent Y86 (Argen)	86	10	2	—	—	—	—	Bal.
II. Au-Pt-Ag/Au-Pd-Ag (9% to 10% Ag)	Degunorm (Dentsply Ceramco)	74	9	—	9	—	—	—	Bal.
	Argedent 62 (Argen)	62	—	24	9	—	—	—	Bal.
III. Au-Pd-Ag (5% to 11.99% Ag)	Argedent 75 (Argen)	75	—	12	10	—	—	—	2.8
	Rx Sp CG (Pentron Lab Tech.)	75	—	13	10	—	—	—	Bal.
IV. Au-Pd-Ag (12% Ag or more)	Aspire (Dentsply Ceramco)	52	—	26	17	—	—	—	Bal.
	Cameo (Heraeus-Kulzer)	52.5	—	27	16	—	—	—	Bal.
V. Au-Pd (No Ag)	Olympia (Heraeus-Kulzer)	51.5	—	38	—	—	—	1.5	Bal.
	Lodestar (Ivoclar Vivadent)	52	—	37	—	—	—	—	Bal.
	Argedent 65SF (Argen)	65	—	26	—	—	—	—	Bal.
VI. Pd-Au (No Ag)	Olympia II (Heraeus-Kulzer)	35	—	57	—	—	—	5	2.8
	Argedent 35SF (Argen)	35	—	57	—	—	—	5	3.0
VII. Pd-Au-Ag or Pd-Ag-Au	SWCG (Pentron Lab Tech)	32	3	42	14	—	—	—	Bal.
	Pegasus (Sterngold)	5	—	74	6.5	—	—	—	Bal.
VIII. Pd-Ag	Jelstar (Heraeus-Kulzer)	—	—	60	28	—	—	—	12
	Will-Ceram W-1 (Ivoclar Vivadent)	—	—	54	38	—	—	—	Bal.
IX. Pd-Cu-Ga	Liberty (Heraeus-Kulzer)	2	—	75	—	10	—	5.5	Bal.
	Spartan Plus (Ivoclar Vivadent)	—	—	75	—	10	—	9	Bal.
X. Pd-Ga-Ag	Argebond 80 (Argen)	—	—	80	5	—	—	6.3	Bal.
	Argelite 85 (Argen)	—	—	85	1.2	—	—	10	Bal.

Type	Ultimate Tensile Strength (MPa)	0.2% Yield Strength (MPa)	Elastic Modulus (GPa)	Elongation (%)	Vickers Hardness (VHN, kg/mm^2)	Density (g/cm^3)	Casting Temperature (°C)
Au-Pt-Pd	480–500	400–420	81–96	3–10	175–180	17.4–18.6	1150
Au-Pd	700–730	550–575	100–117	8–16	210–230	13.5–13.7	1320–1330
Au-Pd-Ag	650–680	475–525	100–113	8–18	210–230	13.6–13.8	1320–1350
Pd-Ag	550–730	400–525	95–117	10–14	185–235	10.7–11.1	1310–1350
Pd-Cu	690–1300	550–1100	94–97	8–15	350–400	10.6–10.7	1170–1190

Reisbick NH and Brantley WA (1995)

conducted a study on mechanical properties and micro structural variations for recasting low gold alloys.

They concluded that significant decrease in yield strength and percentage elongation were observed for recasting these alloys but not in tensile strength when the Type III gold alloys were recasted upto 3 times.

Scanning electron microscope examination revealed that the number of casting defects (principally porosity) increased with the number of times the alloy was remelted.

terna
KNOWLEDGE TO EMPOWER

CONCLUSION

TO ACHIEVE A CLINICAL SUCCESS THE CLINICIAN SHOULD BE AWARE OF QUALITIES ADVANTAGES AND DISADVANTAGES OF CASTING PROCEDURES

TAKE HOME MESSAGE

- CASTING IS A TECHIQUE SENSITIVE PROCEDURE AND MUST BE DONE CAREFULLY

SAQS AND LAQS

- Laqs
- what are casting defects

- SAQS
- advantages and disadvantages of casting
- explain investing

THANK YOU