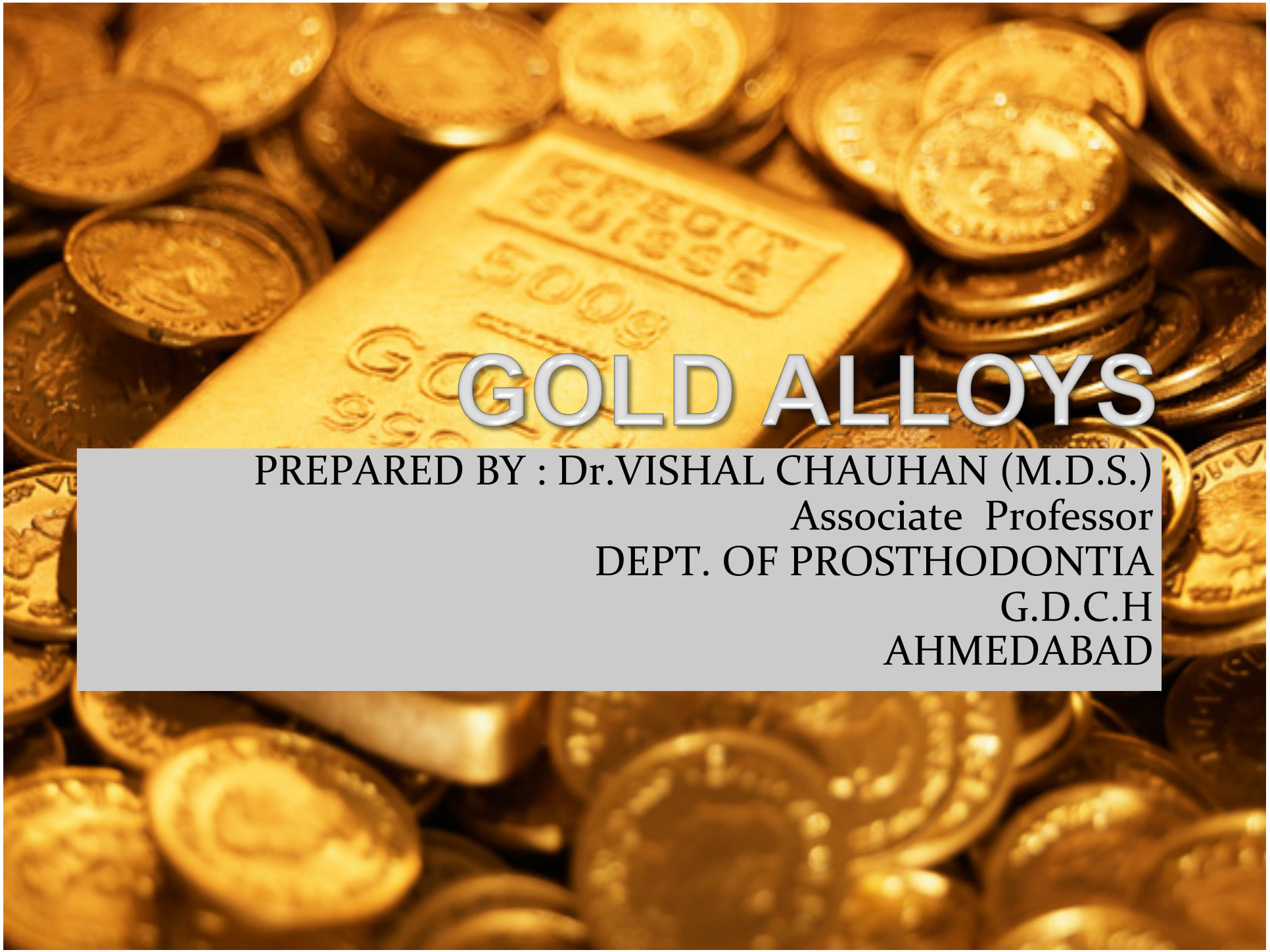

GOLD ALLOYS

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INTRODUCTION

- Pure gold is soft and ductile metal and so it is not used for casting restorations.
- It is alloyed with other metals which not only increases it's properties but also reduces its cost.
- Yellow gold alloys and White gold alloys.

APPLICATIONS

- Inlays and onlays
- Crown and bridges
- Removable partial denture framework

GOLD CONTENT

KARAT

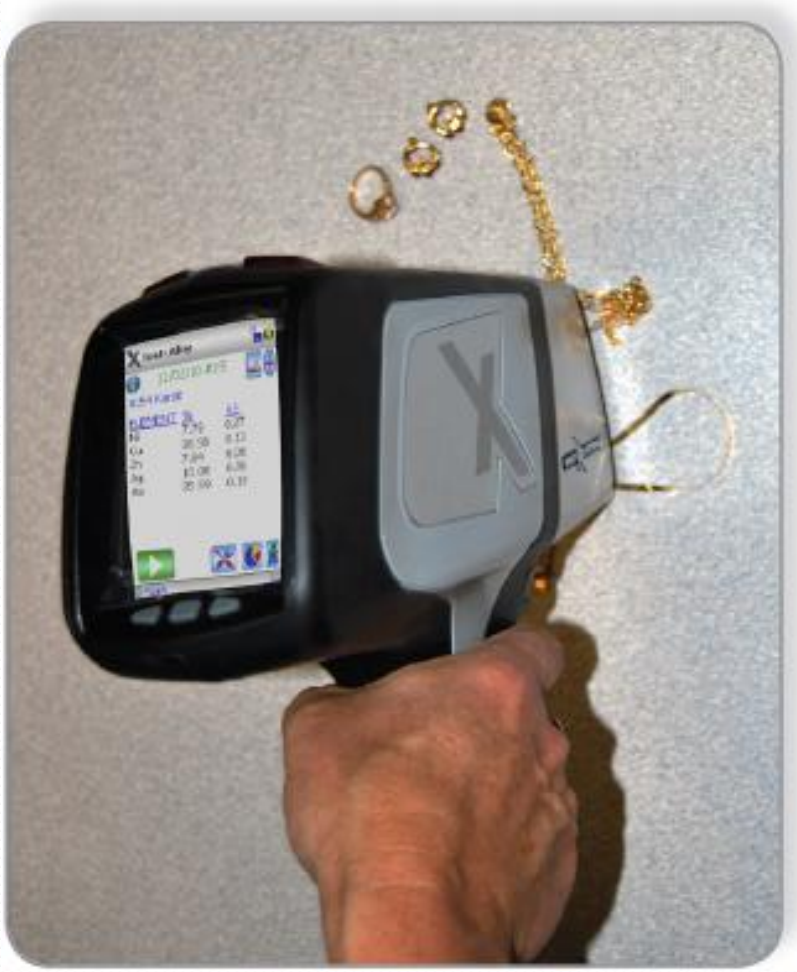
- It is the parts of pure gold in 24 parts of alloys.
- E.g. 24 karat is pure gold and 22karat gold is 22 parts of pure gold and 2 parts of other metal.
- Term karat is rarely used to describe gold content in current alloys.

Carat	Composition %, wt.		Condition	Hardness HV	Tensile Strength N/mm²
	Silver	Copper			
24	-	-	Annealed	20	45
			Worked	55	200
22	5.5	2.8	Annealed	52	220
			Worked	138	390
	3.2	5.1	Annealed	70	275
			Worked	142	463
21	4.5	8.0	Annealed	100	363
			Worked	190	650
	1.75	10.75	Annealed	123	396
			Worked	197	728
18	12.5 0	12.5	Annealed	150	520
			Worked	212	810
	4.5	20.5	Annealed	165	550
			Worked	227	880

GOLD CONTENT

FINENESS

- Fineness of a gold alloy is the parts per thousand of pure gold.Pure gold is 1000 fine. Thus ,if ¾ of the gold alloys is pure gold ,it is said to be 750 fine.
- The term fineness is also rarely used to describe gold content in current alloys.However ,it is often used to describe gold alloy solders.



PERCENTAGE COMPOSITION

- This is preferred to the karat and fineness rating.
- Since 1977,A.D.A. has required manufacturers to specify the percentage gold , Palladium, and Platinum on all dental alloy packaging.
- KARAT*100/24= % Gold
- Similarly FINENESS*100/1000= % Gold

CLASSIFICATION

- In 1932, the dental materials group at the National Bureau of Standards surveyed the alloys being used and classified them as
- Type 1 : SOFT
- Type 2: MEDIUM
- Type 3: HARD
- Type 4: EXTRA HARD

Other classifications

American Dental Association(1984)

- High Noble(HN): Must contain >= 40 wt% Au and >=60 wt% noble metal elements (Au,Pt,Pd,Rh,Ru,Ir,Os)
- Noble (N) :): Must contain >=25wt% of noble metal elements (Au,Pt,Pd,Rh,Ru,Ir,Os)
- Predominantly Base Metal (PB): Contain < noble metal elements (Au,Pt,Pd,Rh,Ru,Ir,Os)

The I.S.O.
(International Organisation for Standerdization)
1562 Standard for casting gold alloys

- TYPE 1: Low Strength- for casting subjected to very less stress(e.g. inlayso
- TYPE 2: Medium Strength-for casting subjected to moderate stress (e.g. inlays ,onlays, full crowns)
- TYPE 3: High Strength –for casting subjected to high stress(e.g. onlay , thin coping,pontics,crowns and saddles)
- TYPE 4 :Extra- High Strength- for casting subjected to very high stress(e.g.saddles,bars,clasps,certain

Composition of Gold alloys

TYPE	%Au	%Cu	%Ag	%Pd	%Pt	%In,Sn, Fe,Zn,Ga
1	83	6	10	0.5	--	Balance
2	77	7	14	1	--	”
3	75	9	11	3.5	--	”
4	69	10	12.5	3.5	3	”

FUNCTION OF EACH COMPONENT

- **GOLD** :Provides tarnish and corrosion resistance and has a desirable appearance. Also provides ductility and malleability.
- **COPPER**: It is a principal hardener, reduces the melting point and density of the gold. If present in sufficient quantity, it provides the alloy a reddish color. It also helps to age harden gold alloys. In greater amounts it reduces resistance to tarnish and corrosion of the gold alloy, therefore the maximum content should not exceed 16%.

FUNCTION OF EACH COMPONENT

- **SILVER**: It whitens the alloy, thus helping to counteract the reddish color of copper. To a slight extent it increases strength and hardness.
- **PLATINUM**: It increases the strength and corrosion resistance. It also increases the melting point and has a whitening effect on the alloy. It helps to reduce the grain size.

- **PALLADIUM**: It is similar to platinum in its effect. It is less expensive than Platinum ,thus reducing the cost of the alloy.

Other minor additions are;

- **ZINC**: It acts as a scavenger for oxygen. Without Zinc ,the silver in the alloy causes absorption of oxygen during melting .Later during solidification, the oxygen is rejected producing gas porosities in the casting.

- **INDIUM,TIN AND IRON**: They help to harden the metal ceramic gold-palladium alloys, iron being the most effective.
- **GALLIUM**: When the alloy is silver free, Gallium is added to compensate for the decreased co-efficient of thermal expansion. The elimination of silver reduces the tendency for green stain at the margin of metal-porcelain interface.

PROPERTIES

PHYSICAL PROPERTIES:

- **DENSITY** :More number of cast restoration per unit weight can be made from an alloy having a lower density,than one having higher higher density.

TYPE 3 - 15.5gms/cm3

TYPE 4 -15.2gms/cm3

Alloys having higher density cast better than alloys with lower density.

- **MELTING RANGE** :The melting range sets the basis for casting temperature.

TYPE 3 - 932 to 960 ºC

TYPE 4 - 921 to 943 ºC

MECHANICAL PROPERTIES:

- **YIELD STRENGTH**: The Yield Stregnth,Proportional limit and the Elastic limit are essentially the same property.

  This property indicates the capacity of the alloy to withstand mechanical stresses without permanent deformation.

  Yield Strength increases from Type 1 to Type 4.

  TYPE 3 - 207 Mpa

  TYPE 4 - 275Mpa

- **HARDNESS**: This is correlated to Yield Strength. It indicates the suitability of the alloy for clinical use.

  TYPE 3 - 121VHN

  TYPE 4 - 149VHN

- **ELONGATION**:It indicates the ductility of the alloy.Alloys with low elongation are very brittle.

  TYPE 3 - 30 TO 40%

  TYPE 4 - 30 TO 35%

- **MODULOUS OF ELASTICITY**: Gold Alloys are more flexible than base metal alloys.

TARNISH AND CORROSION RESISTANCE

Gold alloys are resistance to tarnish and corrosion in the oral cavity.This is due to their high noble metal content.

WROUGHT BASE METAL ALLOYS:

- When a casting is plastically deformed in any manner, it is called wrought metal.
- Wrought base metal alloys are used in dentistry, mainly as wires for orthodontics and as clasp arms for removable partial dentures.

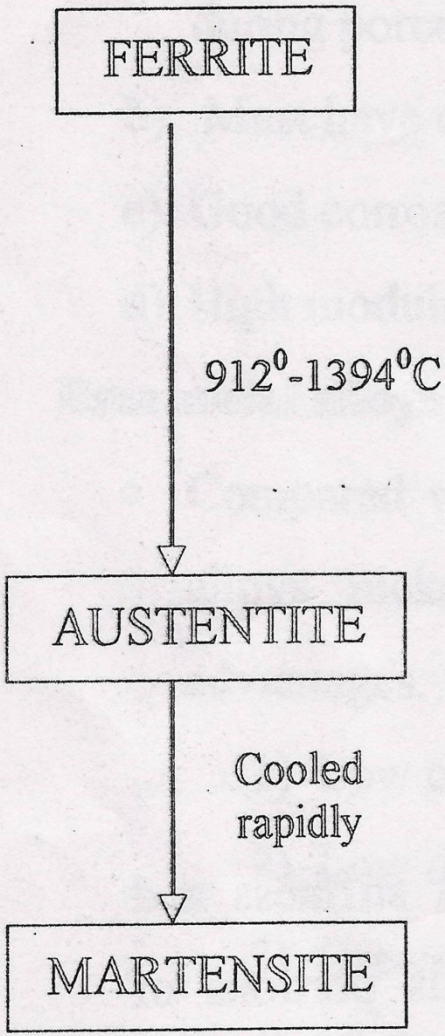
The alloys include:

- Stainless steel : iron-chromium-nickel alloy
- Co-Cr-Ni
- Ni-Ti
- β- Titanium alloys.

CARBON STEELS:

Steels are iron based alloys that usually contain *less than 1.2% carbon*.

The different classes of steels are based on three possible lattice arrangements of iron.



- Pure iron at room temperature
- Body centered cubic structure.
- Stable at high temperatures (912^{0}C)
- Carbon has less solubility due to small spaces in between.

- Face centered cubic structure.
- Large spaces are seen
- Carbon solubility is 2.1 Wt %

- Body centered tetragonal structure.
- Lattice is highly distorted and strained resulting in an extremely hard, strong, brittle alloy.

When 12-30% Cr is added to steel, the alloy is called as Stainless steel

STAINLES STEEL

Chromium containing steels

When 12-30% Cr is added to steel; the alloy is called stainless steel.

Type of space lattice	Chromium	Nickel	Carbon
Ferrite (BCC)	11.5-27	0	0.20 (max)
Austentite (FCC)	16.0-26	7-22	0.25 (max)
Mastensitic (BUC)	11.5-17	0-2.5	0.15-1.20

Martensitic stainless steel:

- ✓ Have high strength and hardness, so used for surgical and cutting instruments.
- ✓ Poor corrosion resistance.

Austenitic stainless steel:

- Most corrosion resistant of all.
- AISI 302 is basic type, containing 18% or 8% Ni and 0.15% carbon.
- Type 304 has 0.08% of carbon.
- Both are designated as 18-8 stainless steel
- Type 316L (0.03% carbon) is ordinarily employed for implants.

COBALT-CHROMIUM-NICKEl ALLOYS:

Co-Cr-Ni alloys are used successfully in orthodontic appliances.

These alloys were originally developed for use as watch springs (Elgiloy).

COMPOSITION:

A representative composition by mass is Co-40%, Cr-20%, Ni-15%.

NICKEL-TITANIUM ALLOYS

- Called as NITINOL
- It has a large working range because of low stiffness in combination with moderately high strength.