MAIN AND ADDITIONAL MATERIALS IN PROSTHETIC DENTISTRY

CLASSIFICATION

- **Materials are divided into**
- Main materials
- Additional materials
- Clinical materials

MAIN MATERIALS

- Alloys
- Polymers
- Ceramic

ADDITIONAL MATERIALS

- Wax
- Plaster
- Impression materials
- Whitening

CLINICAL MATERIALS

- Wax
- Composite
- Ormocers

DEFINITION

- **METALS are substances with high electrical conductivity and thermal conductivity, forgeability, plasticity and metallic luster.**

- **These characteristics of the metal due to freely moving electrons in the crystal lattice.**

THE CRYSTALLINE STRUCTURE OF METALS

- All substances in the solid state are crystalline or amorphous structure.
- In crystalline matter atoms are geometrically correct and on certain distance from each other, amorphous, randomly.
- Any substance can be in three aggregation States — solid, liquid and gaseous.

DISTRIBUTION OF ATOMS IN A CRYSTAL IS VERY CONVENIENT TO PORTRAY AS A SPATIAL SCHEMAS — ELEMENTARY CRYSTALLINE CELLS.

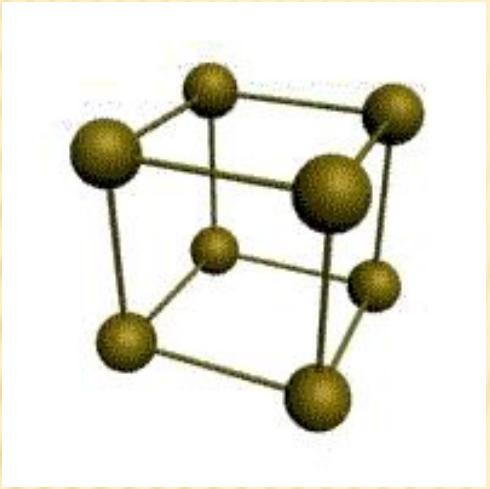
- The crystalline lattice of metals. During the transition from liquid to solid is formed crystal lattice, there are crystals. This peculiar process is called crystallization.

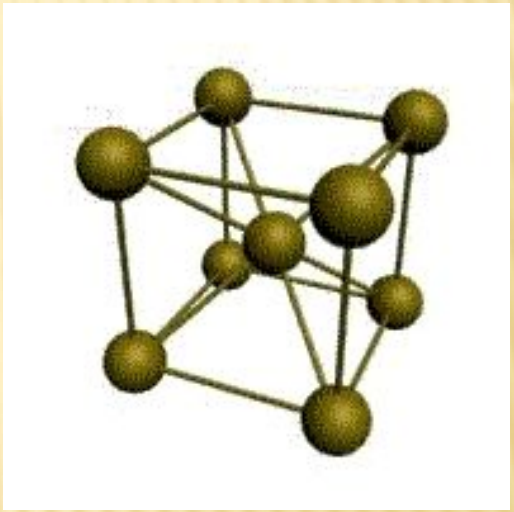
Back in 1878, D.K. Chernov, studying the structure of cast steel, pointed out that the crystallization process consists of two basic stages. The first is the origination of the smallest particles of crystals, which he called "conceived by Kami, and now they are called" embryos of crystallization. The second stage is the growth of crystals of these centers. The minimum size is called embryo growth capable of critical facilities.

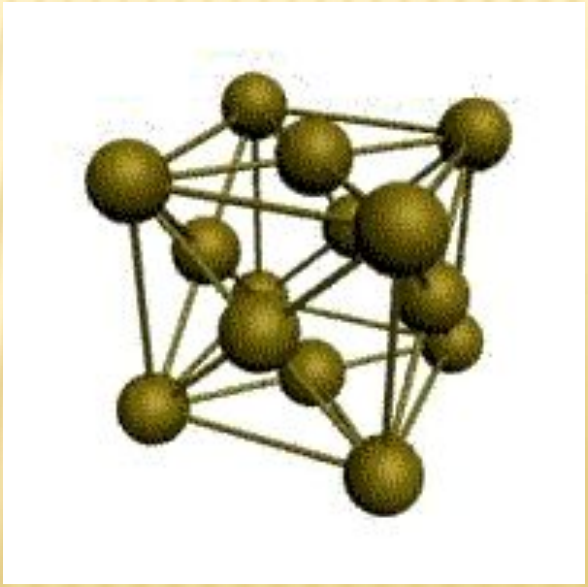
- The simplest type of crystalline cell is cubic lattice. "Atoms packed sufficiently tightly. Some metals have tetragonal lattice.

- Each metal has a certain crystalline lattice, which when changing external conditions (heat treatment, casting, etc.) could change is phenomenon called polymorphism.

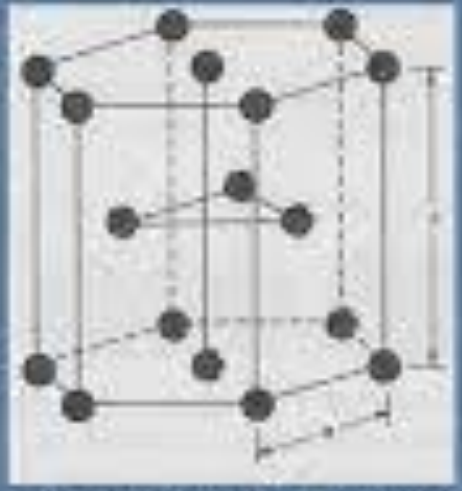
SPACE-CENTERED CUBIC LATTICE







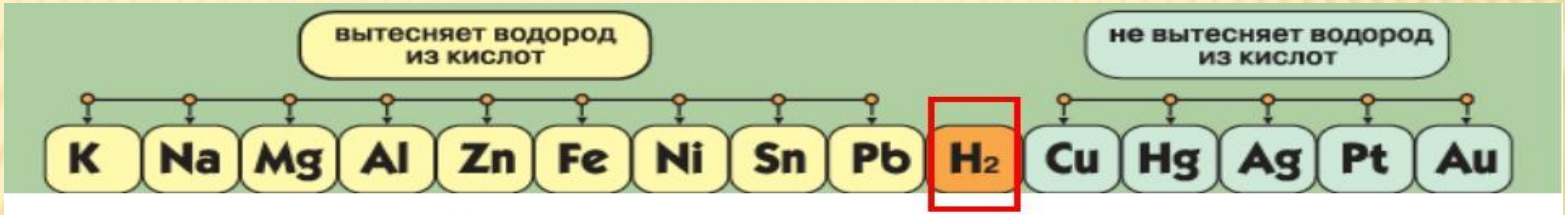
Кристаллическое строение металлов



- Гексагональная плотноупакованная решетка (ГПУ)

- All metals are consistently in a series of descending chemical activity.
- This series was called "Beketov several" in honor of the scientist, incorporating the phenomenon of displacement of some other metals.

THIS SERIES IS AS FOLLOWS:



Вытеснительный ряд металлов

Русский химик Н. Н. Бекетов исследовал металлы и расположил их в вытеснительный ряд (ряд активности) в порядке уменьшения реакционной активности.
Металлы, стоящие слева от водорода, способны вытеснять его из кислот. А металлы, стоящие справа от водорода, не могут вытеснять его из кислот.

Николай Николаевич Бекетов
1827—1911

- In the manufacture of dental prostheses and appliances of various designs with the use of heterogeneous metals must take into account the chemical activity of these metals, as well as metals, already present in the oral cavity.
- Otherwise, you may encounter the redox reactions, contributing to a decrease in the strength of structures.


3
24stoma.ru

Metals have a high ability to reflect its surface light radiation, causing the metallic luster.

Metals conduct electricity well, warmth, under the influence of the external force.

- This allows the manufacture of metal products of different shapes and sizes, including dentures.

CLASSIFICATION OF METALS

1. **On the situation of the periodic system of elements**
2. **By density**

- lights –< 5 гсм
- hard > 5 гмс

CLASSIFICATION OF METALS

1. **In industry**
2. Black
3. Colored
4. Rare

5. 2. **On interaction of metals with oxygen**
6. - noble
7. - based

INTERNATIONAL STANDARDS (ISO, 1989) ALL ALLOYS

METALS ARE DIVIDED INTO GROUPS:

1-PRECIOUS METAL ALLOYS BASED ON GOLD.

2-NOBLE METALS AND ALLOYS THAT CONTAIN 25-50% OF GOLD OR PLATINUM OR OTHER PRECIOUS METALS.

3-PRECIOUS METAL-FREE ALLOYS.

4-ALLOYS FOR METAL-CERAMIC CONSTRUCTIONS:

A) WITH HIGH CONTENT OF GOLD (75%);

B) WITH HIGH CONTENT OF PRECIOUS METALS (GOLD AND PLATINUM OR GOLD AND PALLADIUM-75%);

C) BASED ON PALLADIUM (MORE 50%);

D) ON THE BASIS OF BASE METALS: COBALT (25% CHROMIUM, MOLYBDENUM 2%); NICKEL (11% CHROMIUM, MOLYBDENUM, 2%)

ALLOYS BASED ON PRECIOUS METAL SUBDIVIDED:

- Gold;
- Gold-Palladium;
- silver-palladium.

PRECIOUS METAL-FREE ALLOYS INCLUDE:

- chromium-nickel steels (stainless) steel;
- Cobalt and nickel alloy;
- Nickel chrome alloy;
- titanium alloys;
- auxiliary alloys of aluminum and bronze for temporary use.
- lead-based alloy and Tin, which differs are easy to melt.

ON OTHER GROUNDS:

- by destination (for removable, metal prostheses metal polymer);
- on the number of components of the alloy;
- on the physical nature of the components of the alloy; melting temperature;
- processing technology

REQUIREMENTS FOR METAL ALLOYS USED IN PROSTHODONTICS STOMATOLOGY CLINIC:

- biological indifference and corrosion resistance to the influence of acids and alkalis at low concentrations;
- high mechanical properties (flexibility, elasticity, hardness, high resistance to wear, etc.);
- the presence of certain physical set (low melting temperature, minimal shrinkage, low density, etc.) and technological (forgeability rating, yield when casting etc.) properties resulting from a particular destination.

GOLD-BASED ALLOYS

- These alloys are generally yellow in color.
- **Type 1** gold alloys are soft and designed for inlays supported by teeth and not subjected to significant mastication forces.
- **Type 2** alloys are widely used for inlays because of their superior mechanical properties, but they have less ductility than type 1 alloys.
- **Type 3** alloys are used for constructing crowns and onlays for high-stress areas. Increasing the Pt or Pd content raises the melting temperature, which is beneficial when components are to be joined by **soldering** (or brazing).
- **Type 4** gold alloys are used in high-stress areas such as bridges and partial denture frameworks.

Metal (Symbol)	Function	Melting Point (°C)	Color
Palladium (Pd)	Reduces corrosion and tarnish Improves mechanical properties	1554	White
Platinum (Pt)	Raises melting temperature Improves hardness and elasticity	1772	Blue-white
Copper (Cu)	Hardens and strengthens the alloy Allows heat-treatment properties	1083.4	Reddish
Silver (Ag)	Hardens gold alloy Counters copper's redness	961.9	Silver
Zinc (Zn)	Acts as oxygen scavenger during casting process	419.6	Blue-white
Indium (In)	Used as a replacement for zinc	156.6	Gray-white
Nickel (Ni)	Seldom used. Increases hardness and strength	1453	White
Tin (Sn)	Acts with palladium and platinum to harden the alloy	232	White
Gallium (Ga)	Forms oxides for bonding ceramic to metal	29.8	Gray-white
Iridium (Ir)	Improves yield strength by creating smaller grains	2410	Silver-white
Ruthenium (Ru)	Improves yield strength by creating smaller grains	2310	White

NICKEL - CHROMIUM AND COBALT - CHROMIUM ALLOYS:

Also known as base metal alloys , extensively used

The Ni-Cr alloys can be divided into those with and without beryllium, which improves castability and promotes the formation of a stable metal oxide for porcelain bonding.

Advantages :low cost

strong and hard

Disadvantage : difficult to work (cutting , grinding , polishing)

TITANIUM AND TITANIUM ALLOYS :

can be used for metal and metal ceramic restorations as well as partial dentures .

SILVER – PALLADIUM ALLOYS:

- Offered as an economical alternative to the more expensive gold-platinum-silver and gold-palladium-silver (gold based) alloy systems.
- Palladium – cheaper
  tarnish resistance

Ag – Pd (non copper) : Ag 70 – 72 %
Pd 25 %

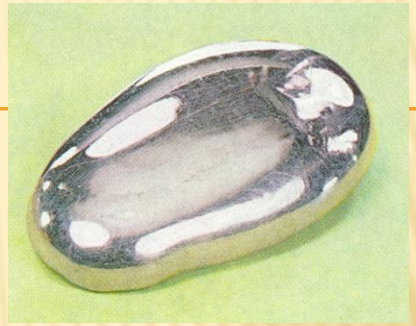
Ag – Pd – Cu : Ag 60%
Pd 25 %
Cu 15%

- The major limitation of Ag-Pd alloys in general and in the Ag-Pd-Cu alloys in particular is their greater potential for tarnish and corrosion.
- Silver, copper, and/or gold can be added to increase the ductility and improve the castability of the alloy for dental applications

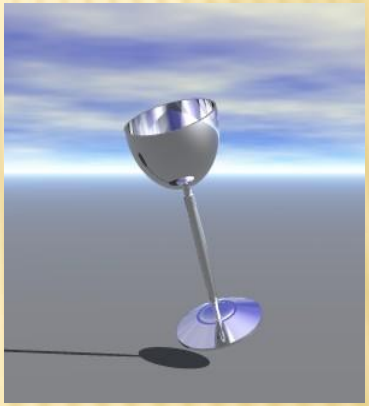
GOLD

- Pure gold --soft, malleable, ductile, rich yellow color, strong metallic luster.
- Lowest in strength and surface hardness.
- Highest ductility, malleability and high density
- High level of corrosion and tarnish resistance
- High melting point, low C.O.T.E value and very good conductivity
- Improves workability, burnish ability, raises the density .
- Alloyed with copper, silver, platinum, and other metals to develop the hardness, durability, and elasticity

SILVER

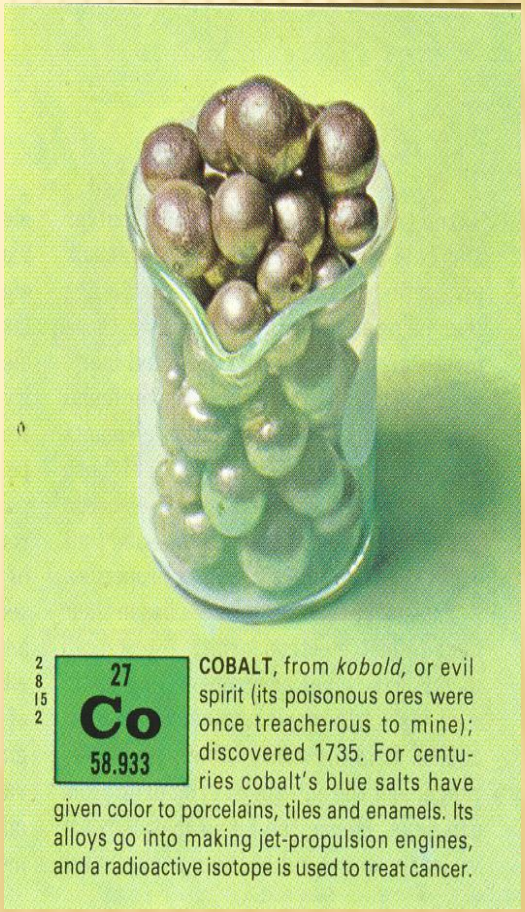


- **Lowers the melting range**
- **Low corrosion resistance**
- In gold-based alloys, silver is effective in neutralizing the reddish color of copper.
- Silver also hardens the gold-based alloys via a solid-solution hardening mechanism.
- **Increases CTE in gold- and palladium-based alloys**
- Foods containing sulfur compounds cause severe tarnish on silver, and for this reason silver is not considered a noble metal in dentistry.
- Pure silver is not used in dental restorations because of the black sulfide that forms on the metal in the mouth.



Cobalt

- INCREASES hardness, strength and elastic modulus.
- high melting point of 1495°C
- boiling point of 2900 °C
- density of 8.85 gm/cm3 and
- CTE $13.8\times10^{-6}/^{o}C$

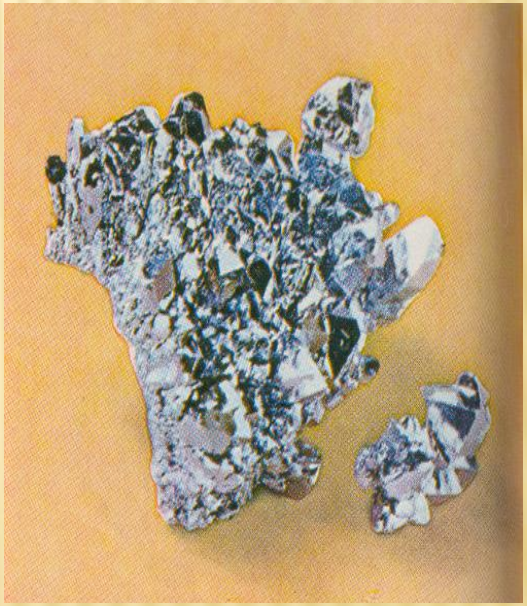


NICKEL

- Chosen base for porcelain alloys because its COTE approximates that of gold
- provides resistance to corrosion.
- sensitizer and a known carcinogen.----contact dermatitis
- melting point of 1453°C
- boiling point of 2730 °C
- density of 8.9 gm/cm^3
- CTE 13.3×10^{-6}/°C

CHROMIUM

- **passivating effect**
- Chromium content is directly proportional to tarnish and corrosion resistance.
- **solid solution hardening.**
- It has melting point of 1875°C
- boiling point of 2665 °C
- density of 7.19 gm/cm^3
- CTE 6.2×10^{-6}/ °C



COPPER

- principal hardener.
- reduces the melting point and density of gold.
- gives the alloy a reddish colour.
- 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%.
- It has melting point of 1083°C ,

- For metal ceramic prostheses, the alloys must have closely matching thermal expansion coefficients to be compatible with given porcelains, and they must tolerate high processing temperatures without deforming via a creep process.
- They must flow well and duplicate fine details during casting.
- They must have minimal shrinkage on cooling after casting.
- They must be easy to solder.
- To achieve a sound chemical bond to ceramic veneering materials, the alloy must be able to form a thin adherent oxide, preferably one that is light in color so that it does not interfere with the esthetic potential of the ceramic.

METAL ALLOYS THAT PRODUCE FOR ORTHOPEDIC DENTISTRY DIVIDE

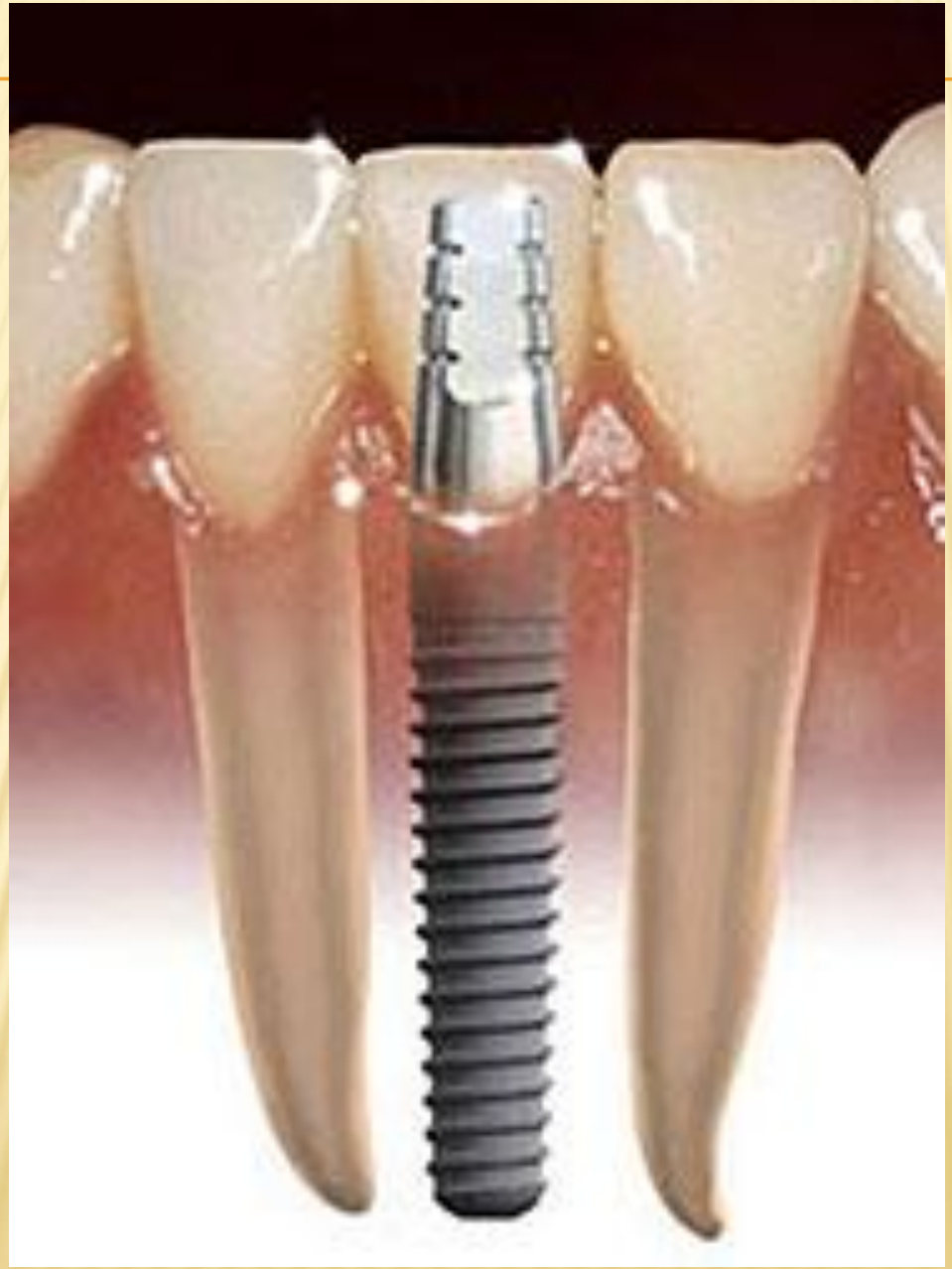
- alloys for cast dentures- Bûgodent;
- alloys for prostheses- Kh-dent;
- Nickel chrome alloys for prostheses-PC-dent;
- Ferrum nickel chrome alloys for dental prostheses- Dentan.

EMPLOYEES OF THE DEPARTMENT OF ORTHOPEDIC DENTISTRY ALLOYS HAVE BEEN DEVELOPED

- Stomet – 1 kz
- Stomet – 2 kz

TITANIUM ALLOYS.

- absolute inertness to the tissues of the oral cavity, which eliminates the possibility of allergic reaction on nickel and chromium, which are part of the metal bases of the other alloys;
- the complete absence of toxicity, allergic effects inherent in plastic bases;
- a small thickness and weight with sufficient hardness basis due to the high specific strength of titanium;
- Creating of implants



BLE DENTUR

ADDITIONAL REQIREMENTS FOR PARTIAL DENTURE ALLOYS

- ✔ Light in weight, lighter weight aids in retention in the mouth
- ✔ High stiffness, making the casting more thinner, especially in the palate region, more comfortable to the patient, stiffness prevents bending under occlusal forces
- ✔ Have good fatigue resistance for clasps,- clasps have to flex when inserted or removed from the mouth, if do not have good fatigue resistance break repeated insertion and removal
- ✔ Should be economical, cost should be low
- ✔ Not react to denture cleansers

TYPES alloys used for removable dentures

- ✔ Cobalt chromium alloys
- ✔ Nickel chromium alloys
- ✔ Aluminum and its alloys
- ✔ Type 4 noble alloys
- ✔ Titanium

COBALT-CHROMIUM ALLOYS

Posses high strength, excellent corrosion resistan

COMPOSITION:

Cobalt : 35 to 65%

Chromium : 23 to 30%

Nickel : 0 to 20%

Molybdenum: 0 to 7%

Iron : 0 to 5%

Carbon : up to 0.4%

Tungsten, manganese, silicon and platinum in traces

COMPARISON OF TITANIUM AND COBALT-CHROMIUM REMOVABLE PARTIAL DENTURE CLASPS.

The Journal of Prosthetic Dentistry. 1997;78(2):187-193.

- This study assessed the characteristics of cast clasps made of titanium and titanium alloys to determine whether these materials are suitable alternatives for removable partial denture applications.
- Removable partial denture clasps at two undercut depths were fabricated from commercially pure titanium, titanium alloy (Ti-6A1-4V), and cobalt-chromium.
- Results showed that for the 0.75 mm undercut specimens, there was less loss of retention for clasps made from pure titanium and titanium alloy than for cobalt-chromium clasps.
- Porosity was more apparent in the pure titanium and titanium alloy clasps than in those made from cobalt-chromium.

CROSS REFERENCES

- 1. Taira Y, Nakashima J, Sawase T, Sakihara M. Wear of tooth enamel against silver–palladium–gold alloy and two other restorative materials in vitro. Journal of Prosthodontic Research. 2015;59(3):210-212.
- 2. Bridgemana J, Marker V, Hummel S, Benson B, Pace L. Comparison of titanium and cobalt-chromium removable partial denture clasps. The Journal of Prosthetic Dentistry. 1997;78(2):187-193.
- 3. Jorge J, Barão V, Delben J, Faverani L, Queiroz T, Assunção W. Titanium in Dentistry: Historical Development, State of the Art and Future Perspectives. The Journal of Indian Prosthodontic Society. 2012;13(2):71-77.
- 4. Ucar Y, Brantley W, Johnston W, Iijima M, Han D, Dasgupta T. Microstructure, elemental composition, hardness and crystal structure study of the interface between a noble implant component and cast noble alloys. The Journal of Prosthetic Dentistry. 2011;106(3):170-178.

thank you