Ashur University College
Dental material
2nd year Prosthodontics
Technology dept.
Lect 3&4

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PROPERTIES OF DENTAL MATERIALS

A. Physical Properties
B. Thermal Properties
C. Electrical Properties
D. Optical Properties
E. Biological properties
F. Mechanical Properties

1. Density

It is the mass per unit volume of the material.(The amount of mass of a material in a given volume).

Units are gm/cm3 or pound/in3. Density: Mass/Volume

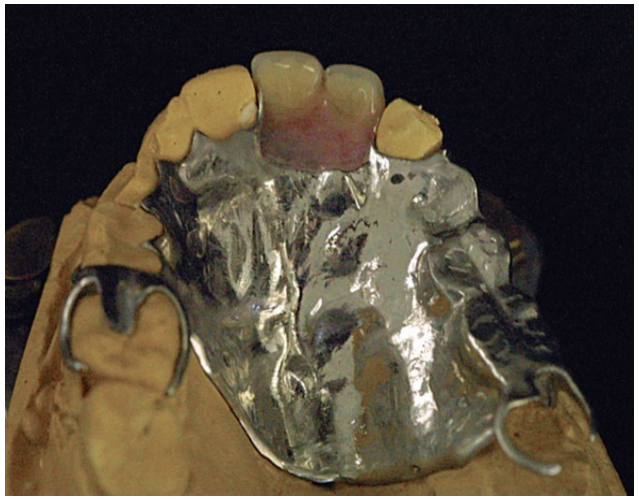
Clinical importance in Dentistry:

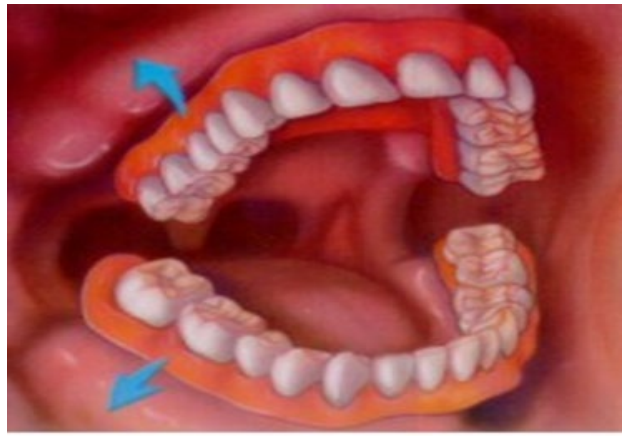
1.upper denture must be made up of the materials that are of low density to help its retention.

2. Sometimes tin or lead is used inside the full lower denture to make it heavy to control its mobility.

The density of gold:14 gm/cm^3. Acrylic :1.2 gm/cm^3. Chromium / cobalt: 8.3 gm/cm^3. Water: 1gm/cm^3.







Complete Denture

2. **Rheological properties(Viscosity)**

Rheology is the study of the flow of materials. For liquids, flow is measured by the viscosity, whereas for solids one considers creep and viscoelasticity.

The units of viscosity are poise P. (1P = 0.1 Pa.s = 0.1 NS/m2), or is also reported in centipoises CP

(100 CP = 1P

Water at 20°C has a viscosity of 0.01 P, or 1 centipoise (cP). Impression materials have viscosities between

100,000 and 1,000,000 cP.

A liquid that becomes less viscosity and more fluid under repeated applications of pressure is referred to as thyrotrophic. Eg. Dental prophylaxis pastes, plaster of Paris



Creep and Flow

- **Creep** is defined as the time-dependent plastic strain of a material under a static load or constant stress.
- The term **creep** implies a relatively small deformation produced by a relatively large stress over a





Creep and Flow contd…

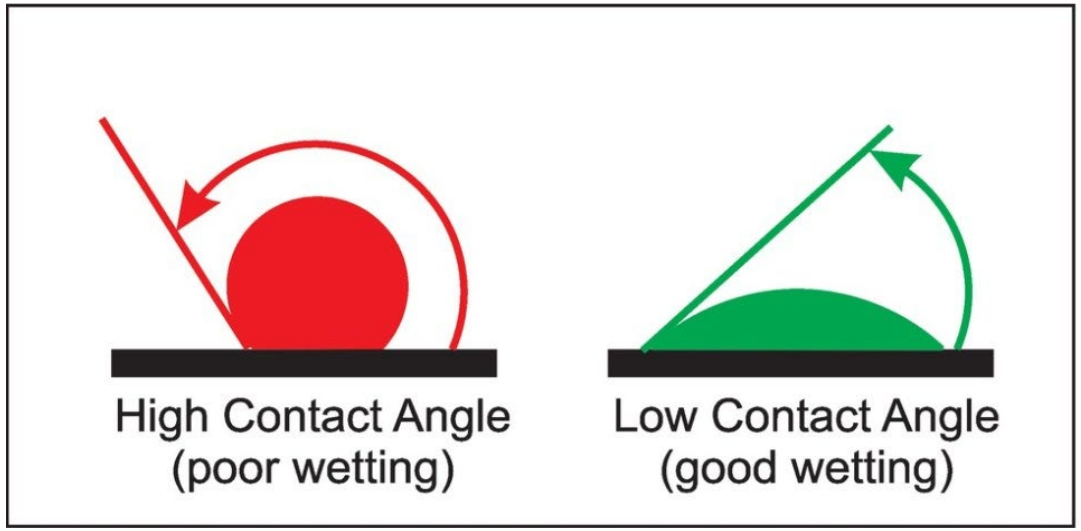
- **Flow** implies a greater deformation produced more rapidly with a smaller applied stress.
- The term **flow** is generally been used in dentistry to describe the rheology of amorphous materials such as waxes.

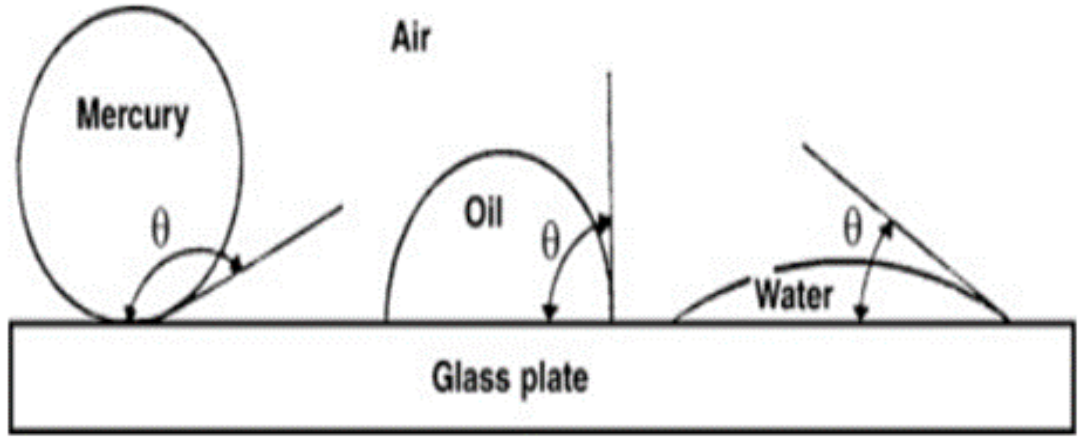


3-Wettability

Wettability is the measure of the affinity of a liquid for a solid as indicated by spreading of a drop. It observed by shape of the drop of liquid on the solid surface.

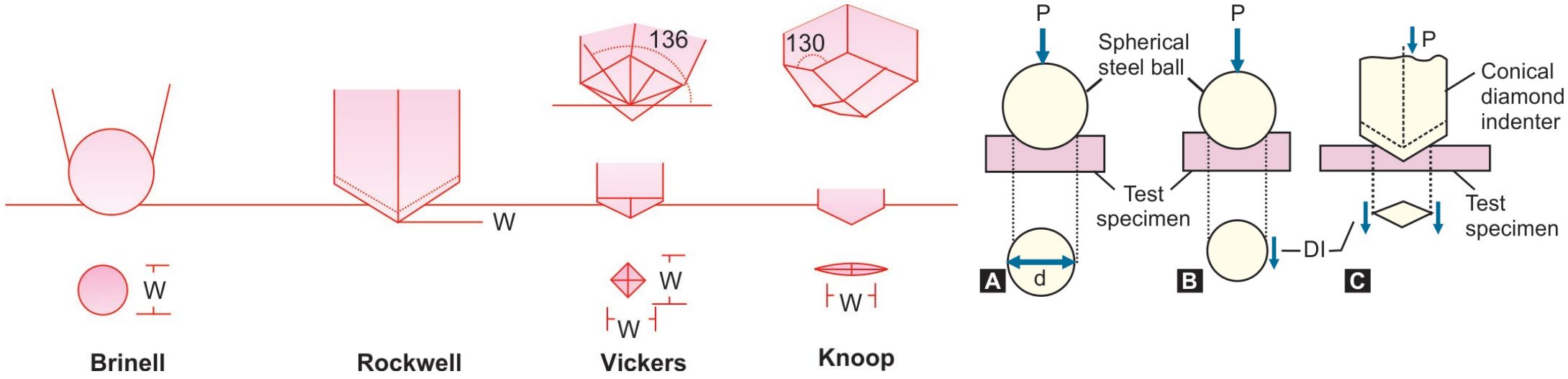
A high-contact angle, such as that of a drop of water on most plastics, indicates poor wetting. Another example of wetting in dentistry occurs when a gypsum product (plaster) is poured into an impression. If the mixed material wets the surface of the impression material, the fine details of the impression will be reproduced in the cast. If poor wetting occurs, bubbles will likely result in insufficient detail and an unusable cast.





4. Hardness

Hardness is the resistance of a material to indentation. It is measured by scientific instruments that press a characteristically shaped tips made of steel or diamond. Hardness is calculated based on the size of the indentation, the load on the tip, and the shape of the tip. Some of the most common methods of testing the hardness of restorative materials are: Brinell ,Knoop ,Vickers ,Rockwell , Barcol and Shore A hardness tests. The Knoop hardness number (KHN) of enamel is 350, whereas the KHN of dentin is 70. Some dental materials are harder than enamel. Porcelain has a KHN of 400 to 500



5. Abrasion Resistance

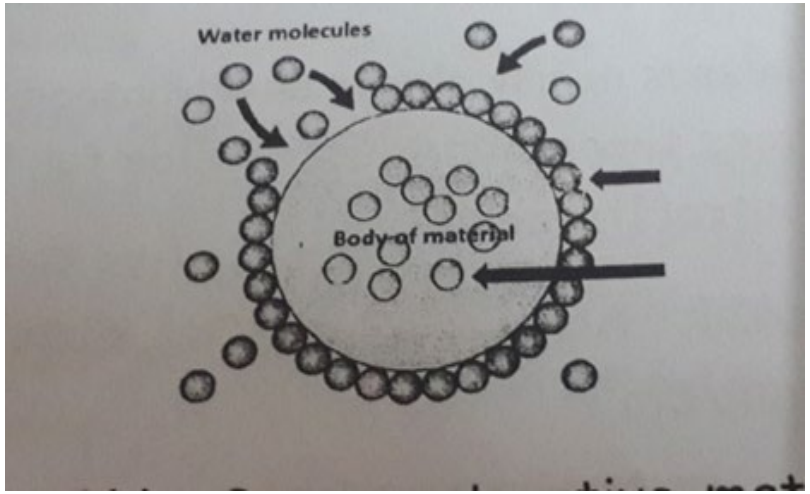
Abrasion resistance – is the ability of a material to withstand mechanical action that tends progressively to remove material from its surface . Harder materials tend to be more resistant to abrasion than softer materials. In dentistry, we are interested in the abrasion resistance (wear resistance) of dental restorations to food, opposing teeth, and other dental materials such as ceramic crowns or porcelain denture teeth.

6-Solubility: Restorative materials should not dissolve in the mouth, and if it dissolves, it should not release toxic substances. It's measured in Mg/mm^2. Solubility of composite: 0.01Mg/mm^2. The solubility of resin cement maximum:7.5 Mg/mm^2.



7. Water sorption

Some materials will absorb water or other fluids. If it is too much or continued for a long time, this will result in serious dimensional changes and the material would also be unhygienic. On the other, some materials like acrylic will absorb water for a day and stops after that, so it is acceptable. Water absorption of composites 40Mg/mm^2.



8. Adhesion and cohesion: Adhesion is the force that causes two or more different substances to attach when they are brought in contact with one another. When the molecules of the same substances hold together, the forces are said to be cohesion.



9. Dimensional stability:

Many material change shapes when they set or harden. Impression materials should not change dimensions when set. Also, dental materials should have no dimensional changes after setting.

A restoration may expand or contract more than natural teeth with changes in temperature. This leads to leakage at the margins called percolation.



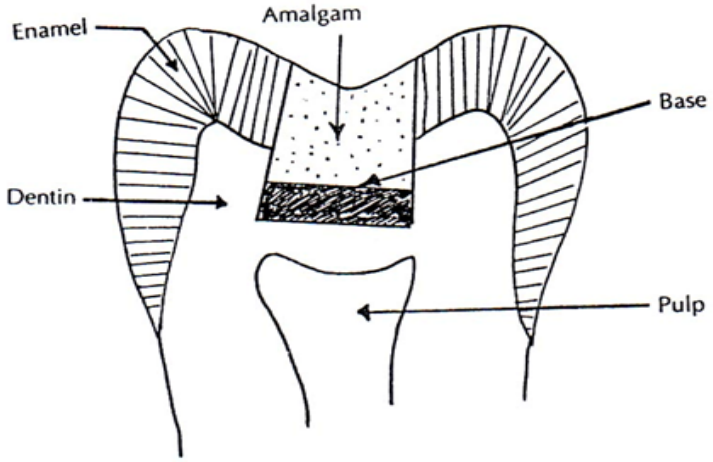


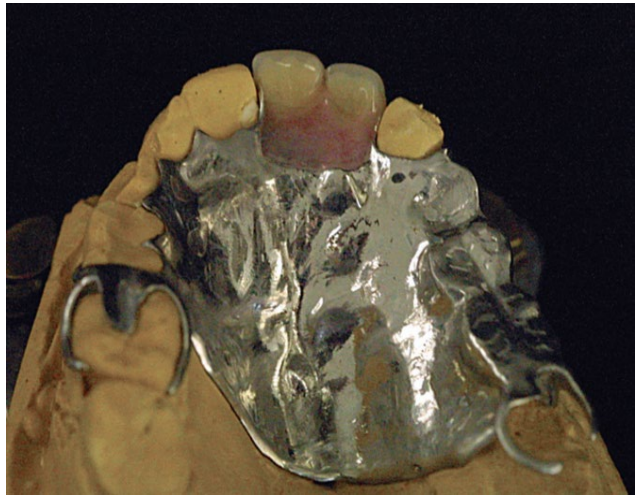
B. Thermal Properties

1. Thermal Conductivity: The thermal conductivity (K) of a substance is the quantity of heat in calories or joules per second passing through a body of 1 cm thick with a cross-section of 1 cm2 when the temperature difference is 1°C.

Units: **Cal/sec/cm2 or °C/cm.**

Metal filling material like amalgam sometimes causes pulp pain by transmitting cold more than natural tooth especially in deep cavities. Thus, they require a heat-insulating layer between the filling and the pulp, here it is a desirable property. On the other hand, the thermal conductivity of metallic denture base material is an advantage as it gives feeling closer to the normal condition and the patient will feel normal also it will protect him from drinking very hot drinks which may burn his mouth.





2. Thermal diffusivity is the measure of the speed with which a temperature change will spread through an object when one surface is heated.

It is a measure of the rate at which a body with a non-uniform temperature reaches a state of thermal equilibrium.

h = K/Cp.

Where h = thermal diffusivity

K = thermal conductivity

Cp = temperature dependent specific

heat capacity. = temperature dependent density

Units: **m2/sec or cm2/sec or mm2/sec.**

3. linear coefficient of thermal expansion and contraction

As the temperature rises a solid material will expand and on cooling it will contract, this is measured by the linear coefficient of thermal expansion and contraction which is the change in length per unit length for I C° temperature change.

α = final length-original length/ original length *temp change (Cm/Cm.C°).

Hard Tooth structure has the smallest coefficient, metals are intermediate, and polymers have the largest.

Tooth: 11*10-6 Cm/Cm.C°.

$$\alpha = \frac{(\text{L final- L original})}{\text{L original - (°C final}^{-}\ \text{°C original)}}$$

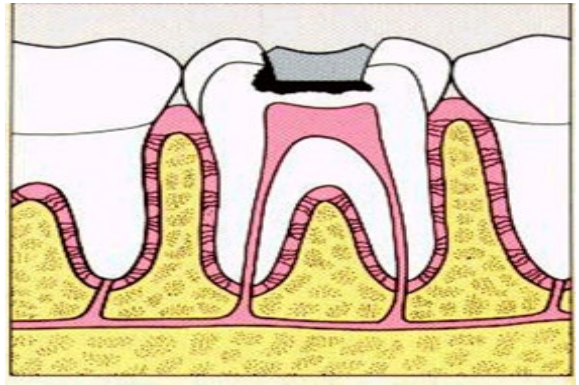
Clinical importance of linear coefficient of thermal expansion in Dentistry:

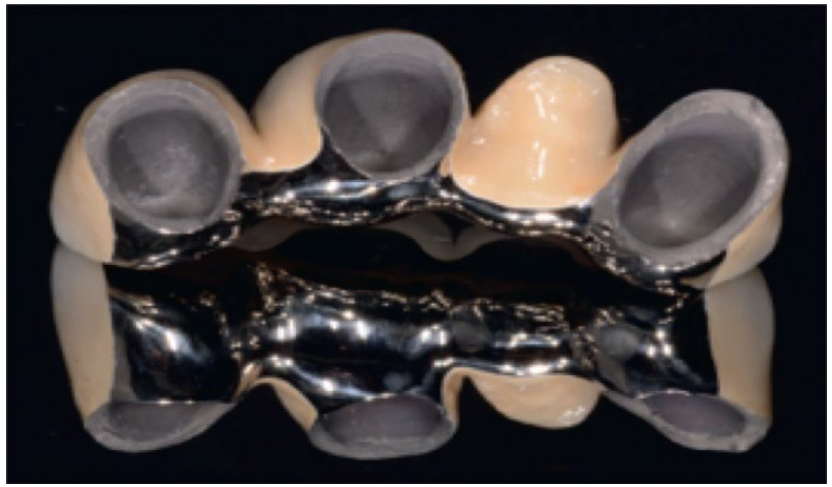
Close matching or the same of the coefficient of thermal expansion (α) is important between

1- The tooth and the restorative materials to prevent marginal leakage.

2-Porcelain and metal in ceramometallic restorations (crowns and bridges) to provide metal ceramic bonding.

3-Artificial tooth and denture base to avoid crazing







C. Electrical Properties

1) Electrical Conductivity and Resistivity

It is the ability of a material to conduct the electrical current. Metals are good electrical conductors. Polymers and ceramics are poor conductors and are termed insulators. It is important to consider during electrosurgery or electrical pulp testing.

2. Galvanism

Metals can ionize by losing electrons. If there is a high difference in the electrode potentials of two metals in contact with the same solution like gold and aluminum, an electrolytic cell may develop and the patient may feel discomfort.

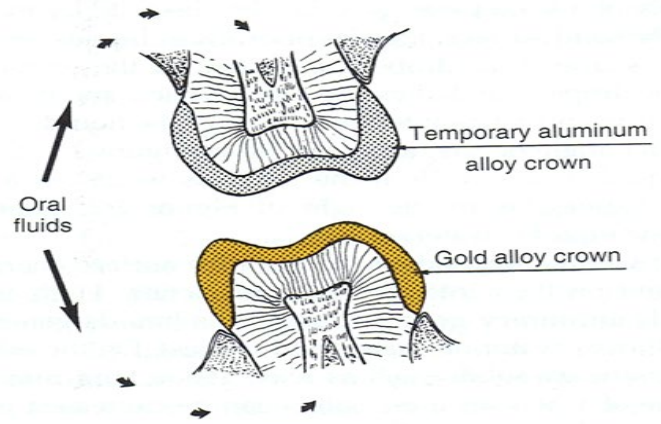


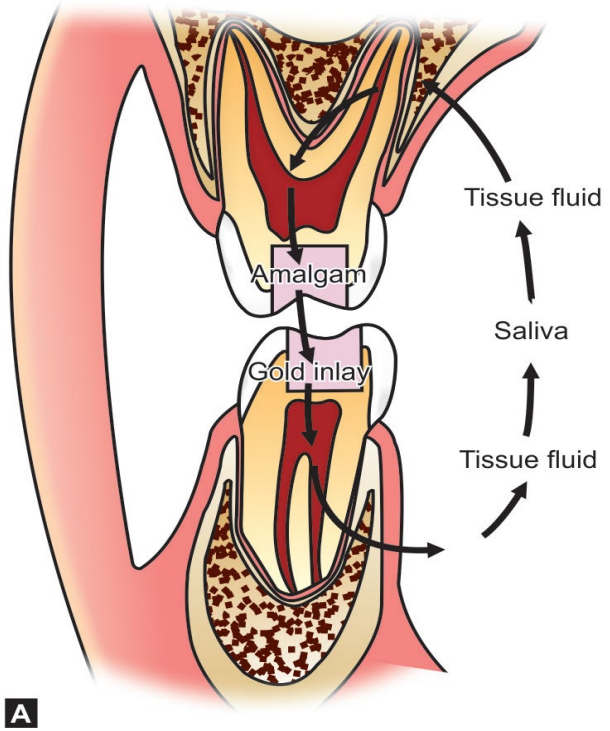
FIGURE 2–1 Diagrammatic sketch of opposing teeth with a gold crown and a temporary aluminum alloy crown indicating how galvanism can occur.

3. Electrochemical Corrosion

It is also referred to as **wet corrosion**, since it requires the presence of water or some other fluid electrolyte.

Metals undergo chemical or electrochemical reactions with the environment resulting in dissolution or formation of chemical compounds.

In most cases corrosion is undesirable. However, in dental practice, a limited amount of corrosion around the margins of dental amalgam restorations may be beneficial, since the corrosion products tend to **seal the marginal gap** and inhibit the ingress of oral fluids and bacteria.



Tarnish and Corrosion

- **TARNISH:**
  - Tarnish is a surface discoloration of the metal or even a slight loss of the lustre.
  - This surface discoloration is due to either, the formation of hard and soft deposits on the surface, or the formation of thin films of oxides, sulphides or chlorides.
  - Tarnish is often the first step of corrosion



Tarnish and Corrosion contd…

- **CORROSION:**

  Corrosion is not only a surface discoloration but is a disintegration of a metal by reaction with its environment.

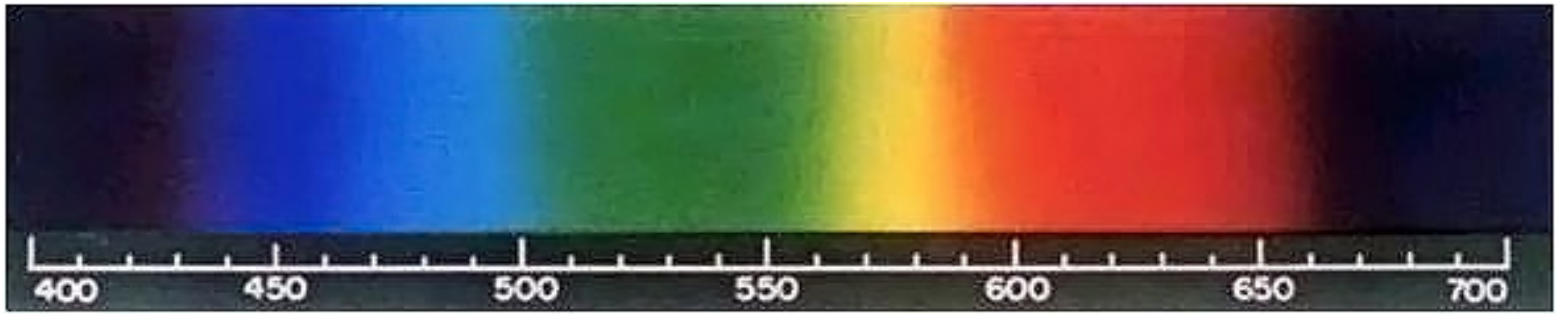


d. Optical Properties

Color: The perception of the color of an object is the result of a physiological response to a physical stimulus. For an object to be visible, it must reflect or transmit light incident on it from an external source.

LIGHT

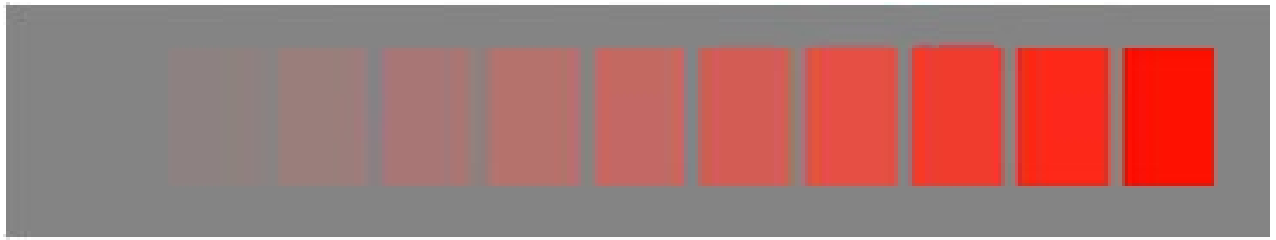
It is an electromagnetic radiation that can be detected by the human eye. It can be seen that the visible electromagnetic radiation is in the range from 400-700 nanometers.



1) Color parameters

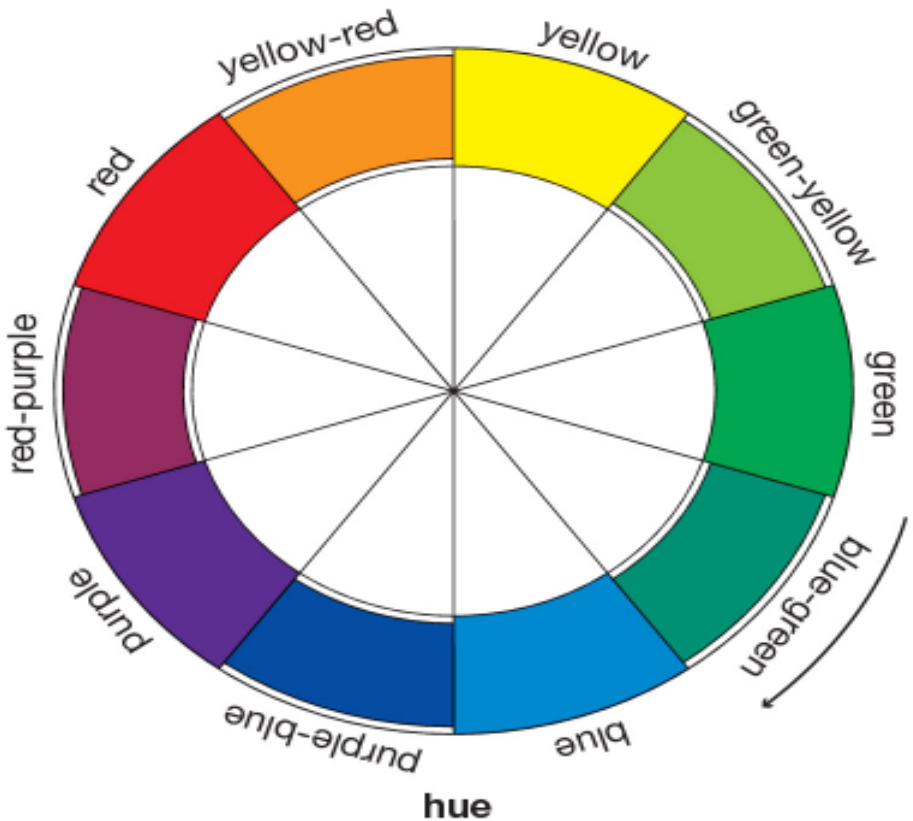
a) **Hue: It is the dominant wavelength. It represents the color of the material, i.e green, red and blue.**

b) Chroma: or excitation purity. It represents the strength of the color or degree of saturation of the color (color intensity).



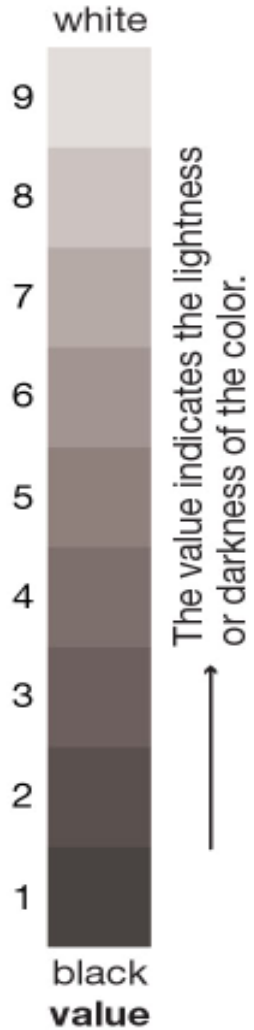
c) Value: or luminous reflectance. It represents the lightness or darkness of color. BLACK = 0 ; WHITE = 10

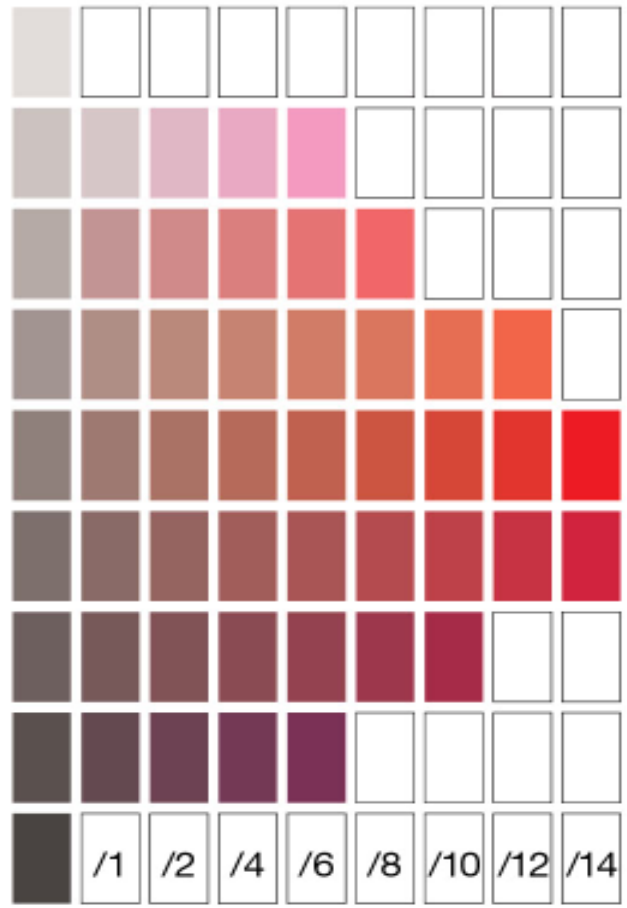
The Munsell system



hue

The hue distinguishes one color from another.





The chroma indicates the strength or weakness of a color.

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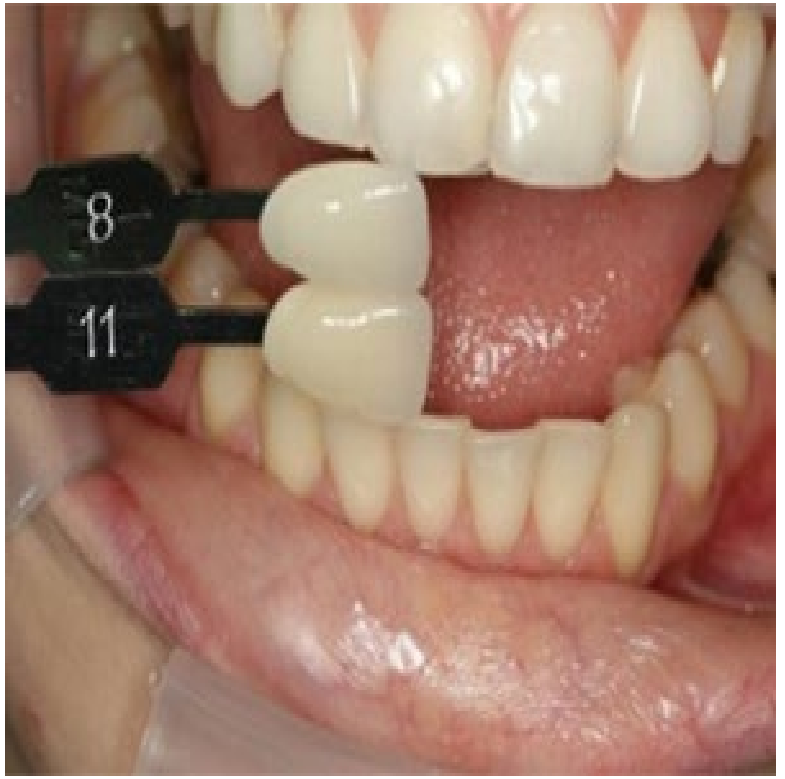
2. COLOR MATCHING

In dental practice, color matching is most often performed with the use of a shade guide, , to select the color of ceramic veneers, inlays, or crowns. Shade guide tabs are used.2



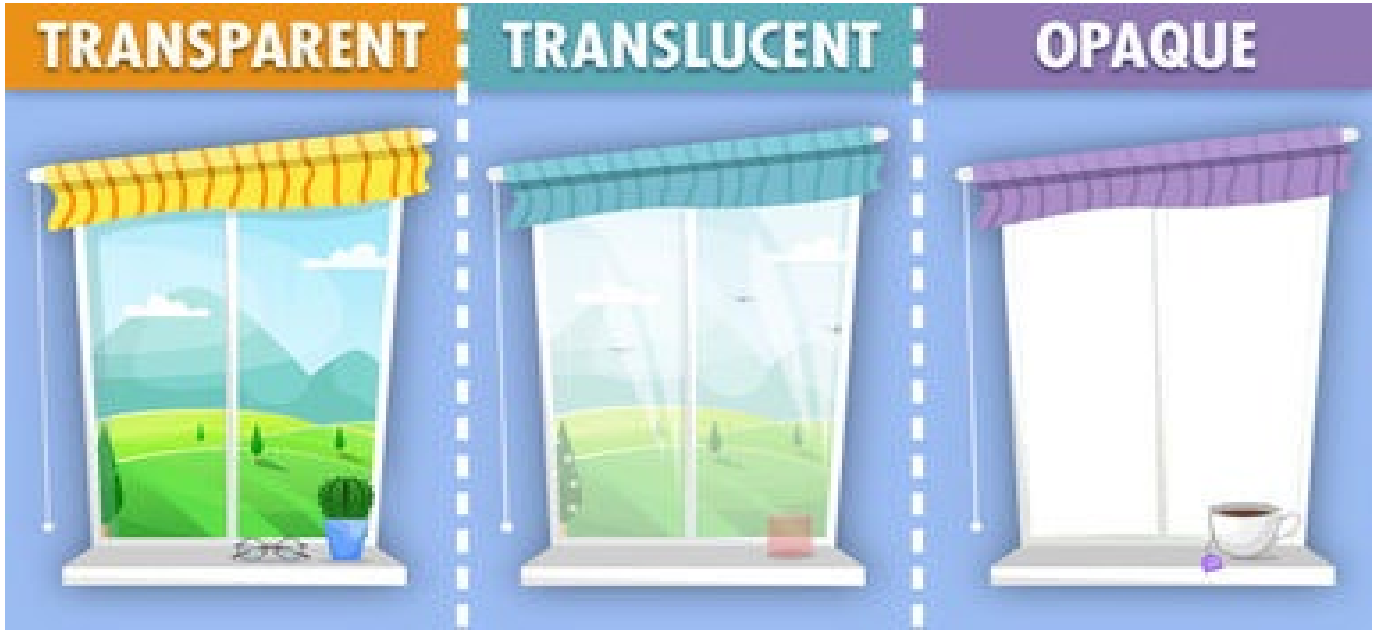


3. Properties of materials in relation to light transmission and absorption

i) Opacity: is a property of the material that prevents the passage of light. Opaque material = absorbs all light = black

ii) Translucency: is a property of the material, which allows the passage of some light but disperses the rest. So objects cannot be clearly seen through them. E.g. Ceramics, resin composites, denture plastics

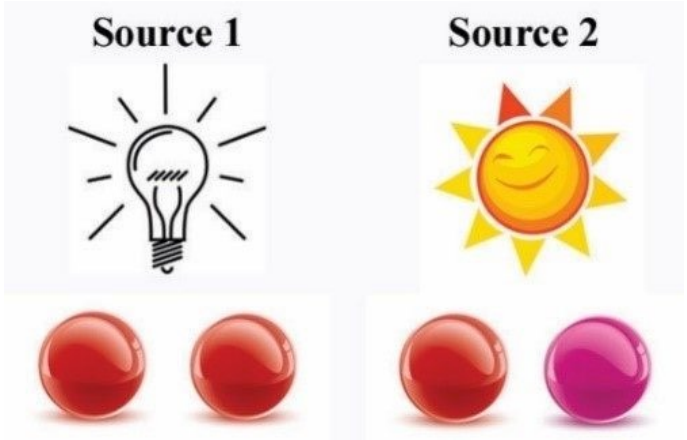
iii) Transparency: is a property of a material, that allows the passage of light in such a manner that little distortion takes place. So that objects can be clearly seen through them. E.g. Glass, pure acrylic resin.



4. Factors affecting color appearance and selection.

i) Surface finish and thickness: This determines the relative amount of light reflected from the surface. Rough surface appears grayer than a smooth surface ; thickness of a restoration can affect its appearance. Opacity increases as the thickness increases.

ii) Metamerism: It is the change of color matching of two objects under different light sources. if possible, color matching should be done under two or more different light sources.





Fluorescence: It is the emission of light by a material when a beam of light is shone on it. It makes the teeth bright and vital, as it increases the brightness. *Anterior teeth restoration*





e. Biological Properties.

It is a primary requirement of any dental material that it should be harmless to the patient and to those involved in its manufacture and handling. Ideally, a material placed into a

patient's mouth should be:

1-Be non-toxic to the body.

2-Be non-irritant to the oral or other tissues.

3-Not produce allergic reactions and, not be mutagenic or carcinogenic.

INFECTION CONTROL

There is increased interest in expanding infection control measures to the dental laboratory. Concern over possible cross contamination to dental office personnel by micro-organisms, including hepatitis-B virus and human immunodeficiency virus (HIV), through dental impressions has promoted the study of the effect of disinfecting techniques on dental materials.

Disinfection of Dental Materials

Impressions are the main source of spread of infection among the dental materials. However disinfecting impression materials is more complex. The disinfectant must not affect its properties and accuracy. If the impression has not been disinfected, we must disinfect the cast.

Materials may be disinfected by:

1. Immersion in a disinfectant

2. Spraying with a disinfectant

3. Incorporating the disinfectant into the material as part of its composition.

Thank you