

Physical Properties

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Chapter Content

1. Mass related Properties.

- Density

2. Thermal Properties.

- Thermal conductivity.

- Specific heat.

- Thermal diffusivity.

- Coefficient of thermal

expansion and contraction.

- Melting and Freezing point.

- Heat of Fusion.

3. Rheological Properties.

4. Optical Properties.

Mass Related Properties

Density

- It is the mass per unit volume
- Unit: gm/cc **OR** gm/cm³

Mass Related Properties

Importance in Dentistry:

1. Retention of upper denture:

Denture with **lighter weight** will help in retention.

- Nonmetallic denture base is lighter than metallic.
- Base metal alloys is lighter than the gold alloys.

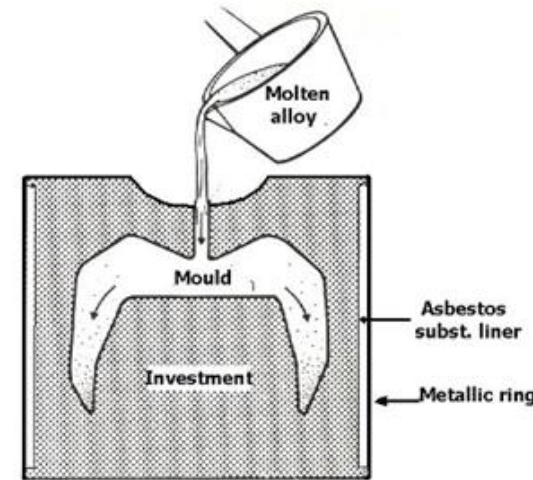


Mass Related Properties

Importance in Dentistry:

2. During Casting:

Lighter alloys require more casting force to allow rapid filling of the mold

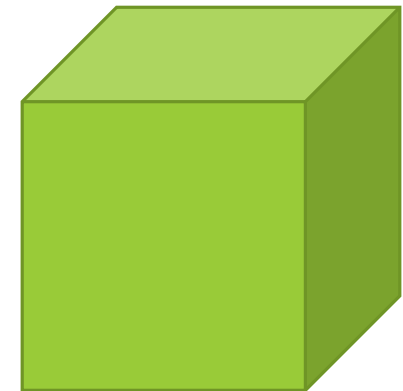
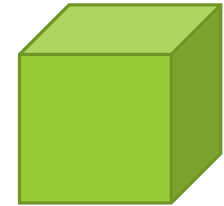


Thermal Properties

Thermal Conductivity

Definition:

it is the quantity of heat in calories per **second** passing through a body of 1 cm **thick** with a **cross section** of 1 cm^2 when **temperature** difference is 1° C .



Thermal Properties

Thermal Conductivity

Unit: Cal/Sec/cm² (°C/cm).

Metals are better conductors than non-metals



Thermal Properties



Importance in Dentistry:

1. Metallic denture base

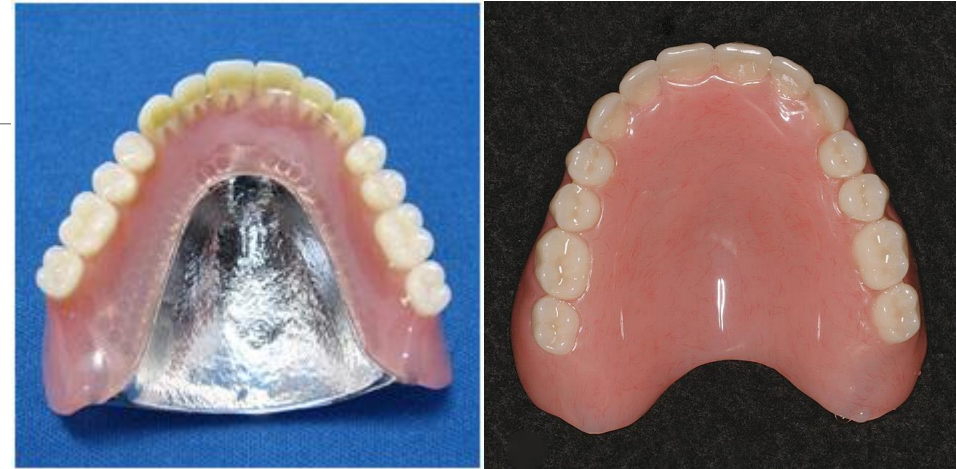
It is preferred than non-metallic denture base.



Thermal Properties

Importance in Dentistry:

1. Metallic denture base



It is preferred than non-metallic denture base, as they provide physiological stimulation (VC and VD) to oral tissue to maintain them in good health (**thermal conductivity is an advantage**).

Thermal Properties

Importance in Dentistry:

2. Metallic restoration in deep cavities should be preceded by a protective base to protect the dental pulp from **thermal shock** (thermal conductivity is a disadvantage).



Thermal Properties

2. Specific heat

Definition:

It is the quantity of heat needed to raise the temperature of a 1 gm of the material 1° C.

Thermal Properties

2. Specific heat

Clinical Importance:

Prolonged heating of gold during casting is unnecessary because gold has low specific heat



Thermal Properties

3. Thermal Diffusivity:

Definition:

It is the **rate** at which a body with non-uniform temperature approaches thermal equilibrium.

Unit: mm^2/Sec

Thermal Properties

3. Thermal Diffusivity:

Equation:

$$\frac{\text{Thermal conductivity}}{\text{Specific heat} \times \text{Density}}$$



Thermal Properties

3. Thermal Diffusivity:

Importance in Dentistry:

- a) Low specific heat combined with high thermal conductivity of dental amalgam → create thermal shock

Thermal Properties

3. Thermal Diffusivity:

Importance in Dentistry:

- b) The thickness of remaining dentine is very important to prevent thermal pulp shock → preserve the sound tooth structure.

Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

Definition:

It is the change in length per unit length of the material for 1°C change in temperature.

It is called **linear** thermal coefficient of expansion and contraction (α).

Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

Equation: $\alpha = \frac{L_f - L_0}{L_0 (C_f^0 - C_0^0)}$

Unit: /°C

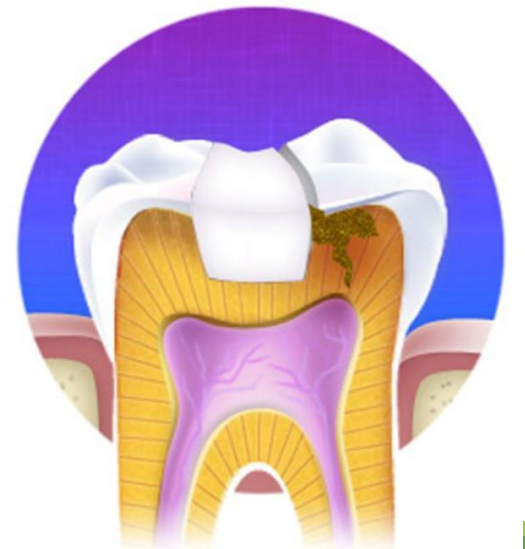
The value is small so it is expressed as part per million (10^{-6})

Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

Importance in Dentistry:

- a) The high α difference between tooth and restoration leads to marginal leakage (at tooth-restoration interface) which leads to:
- 1) Hypersensitivity
 - 2) Recurrent caries
 - 3) Marginal discoloration



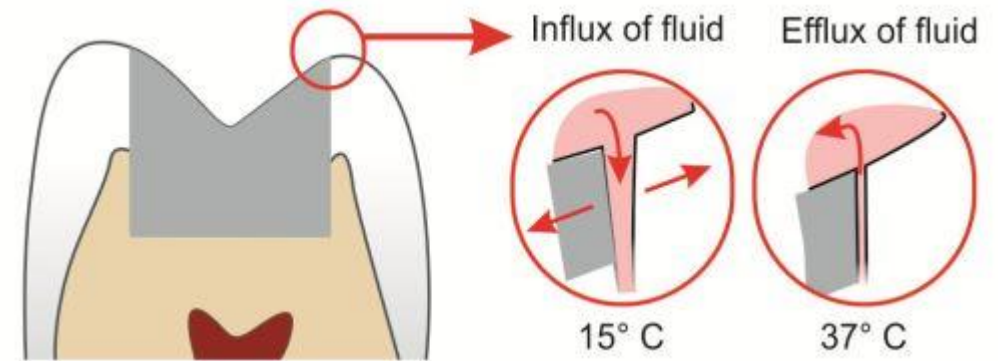
Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

Importance in Dentistry:

Marginal percolation

(pumping in and out of food and saliva between tooth and restoration due to high α difference.

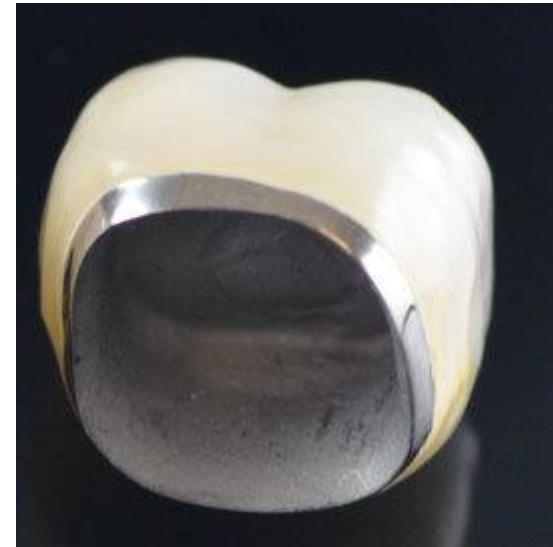


Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

Importance in Dentistry:

- b) In porcelain fused to metal crown, slight difference in α between metal and porcelain is important to allow strong **compressive bond**.



Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

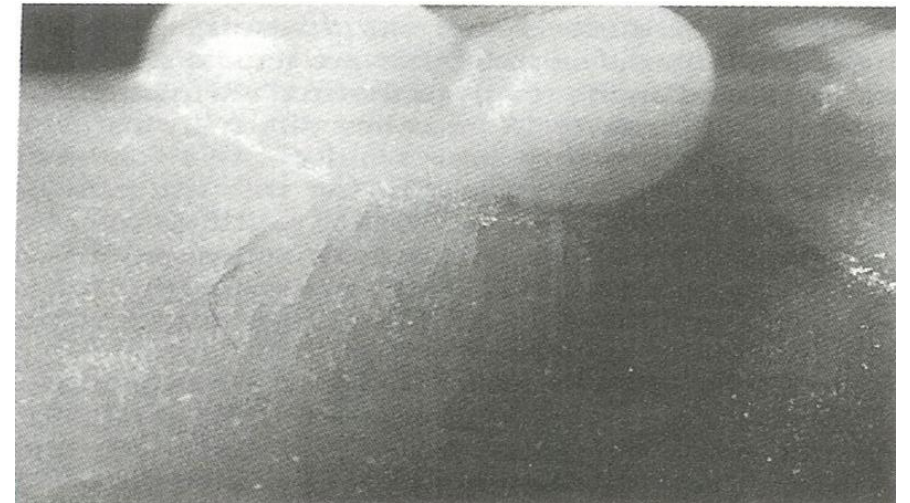
Importance in Dentistry:

- c) The high α difference between artificial teeth and acrylic denture base should be avoided to prevent **crazing** of denture base.

Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

Crazing



Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

Importance in Dentistry:

- d) The high α of wax used for wax pattern construction may lead to its distortion.

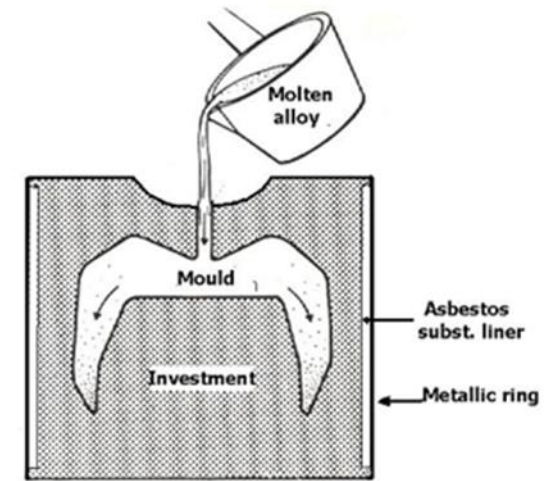


Thermal Properties

4. Coefficient of Thermal Expansion and Contraction:

Importance in Dentistry:

- e) Thermal expansion of investment material is important to compensate the thermal shrinkage of molten metal.



Thermal Properties

4. Melting and Freezing Temperature:

Definition:

It is the temperature at which a material melts or freezes.

Thermal Properties

4. Melting and Freezing Temperature:

Importance in Dentistry:

1. Determine the melting machine for melting dental casting alloys.



Thermal Properties

4. Melting and Freezing Temperature:

Importance in Dentistry:

2. Determine the type of investment material.



Thermal Properties

4. Melting and Freezing Temperature:

Importance in Dentistry:

3. Avoid over heating of materials to avoid evaporation of specific ingredients from it.

Thermal Properties

4. Melting and Freezing Temperature:

Importance in Dentistry:

4. Waxes used in molten state inside the oral cavity should have low softening point to avoid burning of living tissues.

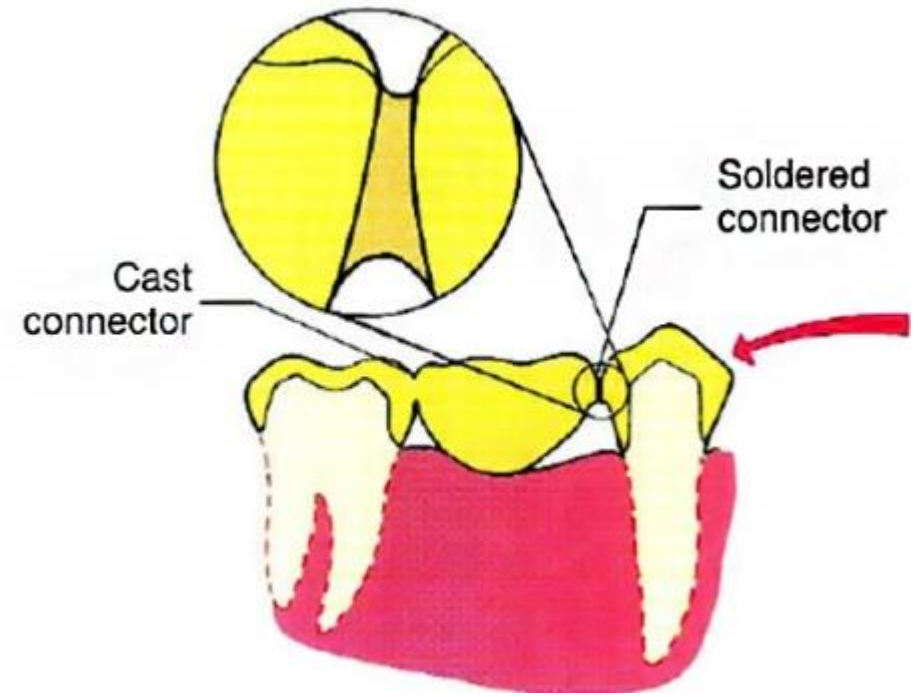


Thermal Properties

4. Melting and Freezing Temperature:

Importance in Dentistry:

5. The solder should melt at temperature lower than soldered metals by 50-100° C to avoid distortion of soldered structures.

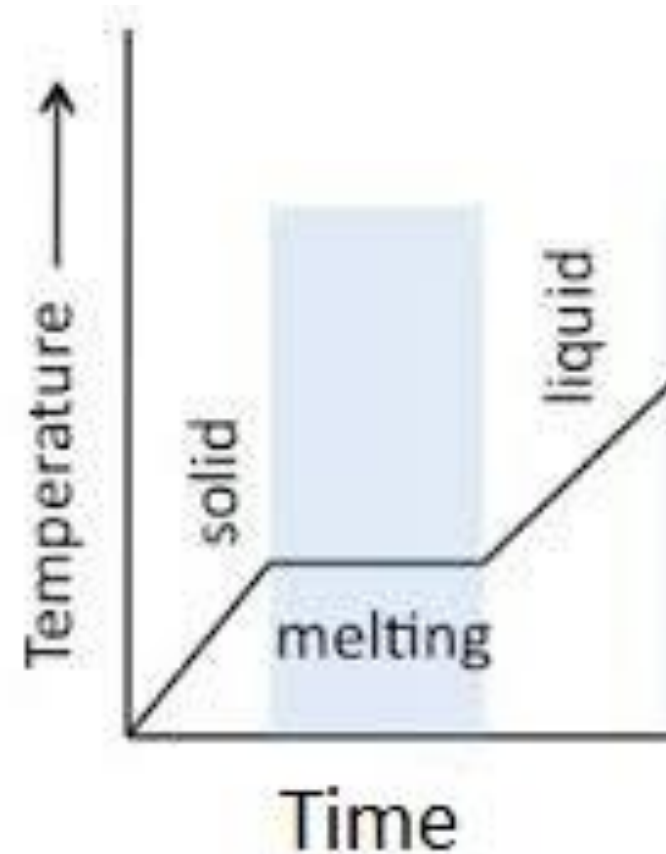


Thermal Properties

5. Heat of Fusion:

Definition:

It is the amount of heat in calories required to convert 1 gm of a material from solid state to the liquid state **at melting temperature.**

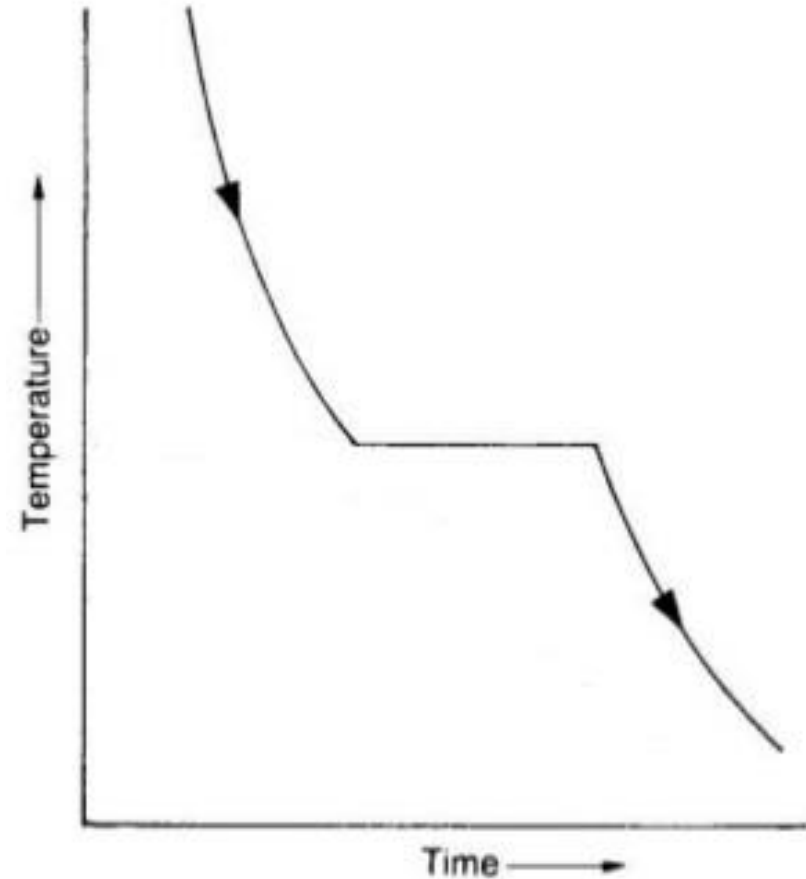


Thermal Properties

5. Latent Heat of Fusion:

Definition:

It is the amount of heat **liberated** during converting 1 gm of the material from liquid to solid state **at freezing temperature**



Rheological Properties

It is the study of the flow of the material.

1. Fluidity: it is the tendency of the fluids to flow.
2. Viscosity: it is the resistance of fluids to flow.
3. Viscoelasticity: it the deformation of solids.

Rheological Properties



Rheological Properties

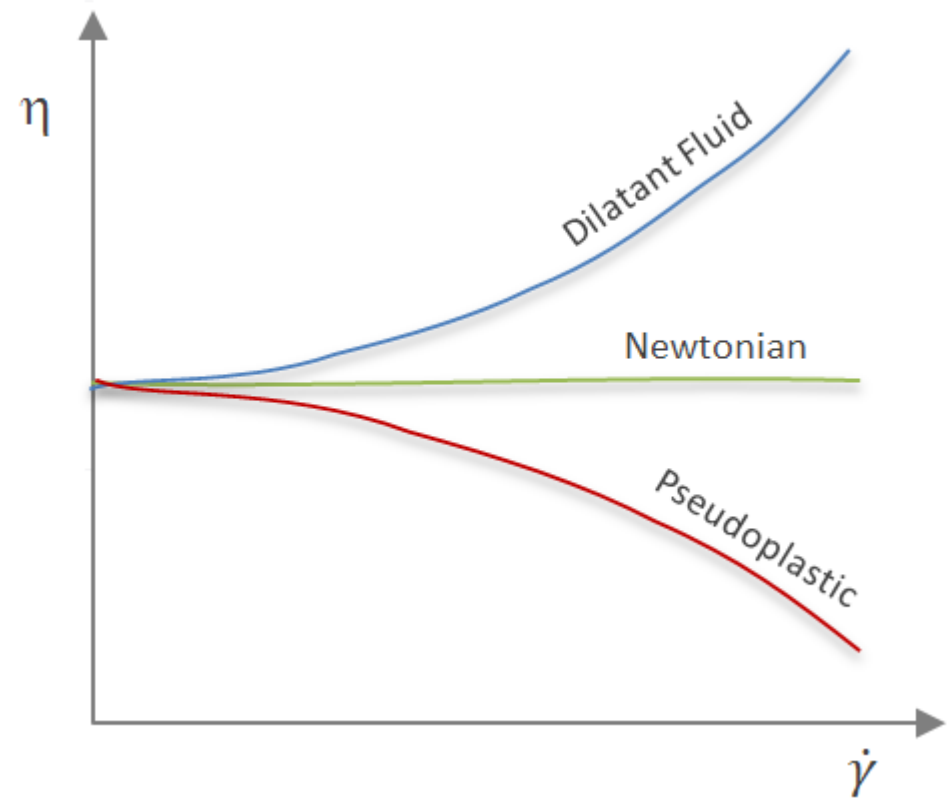
Materials can be classified as:

- 1. Newtonian:** The viscosity is constant with application of Shear stresses.
- 2. Dilatant:** The Viscosity increased with increasing shear stresses.
- 3. Pseudo-plastic:** The viscosity decreased with increasing shear stresses.

Rheological Properties

Materials can be classified as:

1. Newtonian.
2. Dilatant.
3. Pseudo-plastic.



Rheological Properties



DR AHMED MAGDY

Rheological Properties

Importance in Dentistry:

Many impression materials and cements are subjected to shear stresses during their extrusion just before clinical use to increase their flow.



Optical Properties

Light

Definition:

It is an electromagnetic radiation that can be detected by human eye.

Optical Properties

Light at interface:

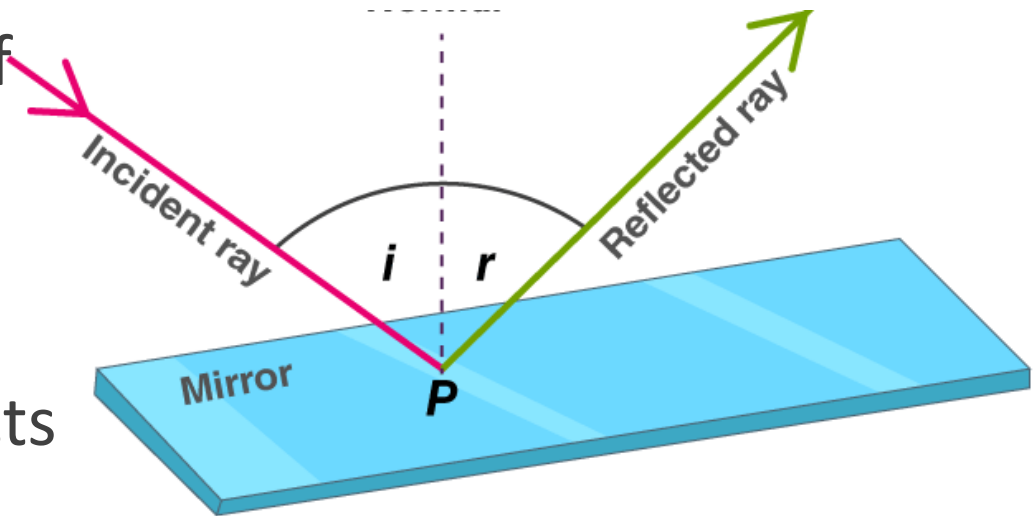
When incident light travelling form one medium to another, one of the following results:

1. Reflection
2. Refraction
3. Scattering
4. transmission

Optical Properties

1. Reflection:

- If light falls on smooth surface, it reflects regularly, (where the angle of incidence = angle of reflection) and called **specular reflection** and the surface appears shiny.
- If light falls on rough surface, it reflects in all directions and called **diffuse reflection**. The surface appears dull.



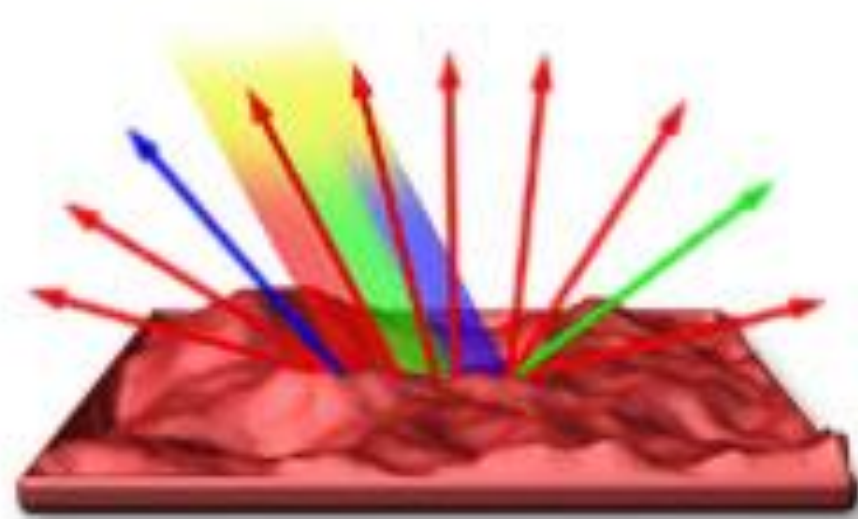
Optical Properties

1. Reflection:

Specular and Diffuse Reflection



**Specular
Reflection**



**Diffuse
Reflection**

Optical Properties

1. Reflection:

Importance in Dentistry:

The surface of aesthetic restoration should be smooth to produce specular reflection so producing shiny surface.



Optical Properties

2. Refraction:

Definition:

It is the change of light direction on entering second medium.

It results from difference in refractive indices of 2 media.

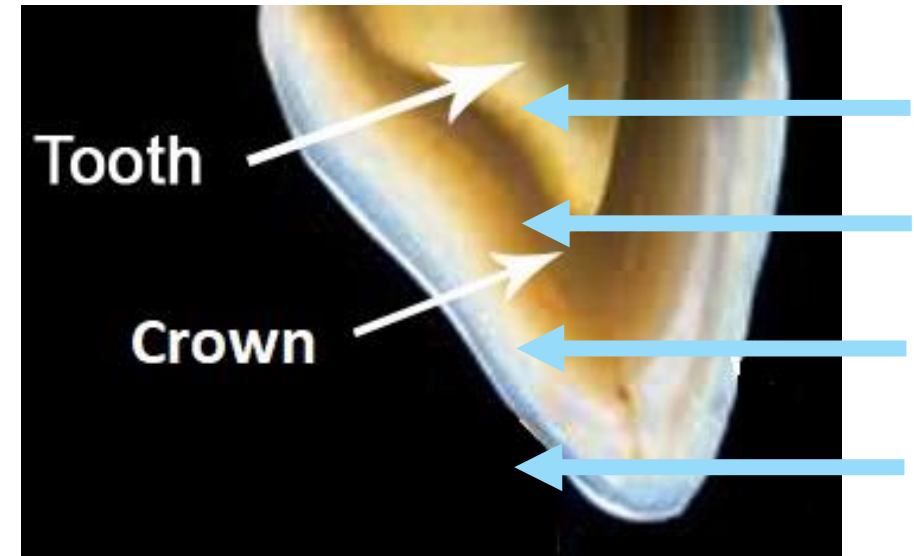


Optical Properties

2. Refraction:

Importance in Dentistry:

The refractive indices of aesthetic restorative material (composite resin, porcelain) should be matched with tooth structure.



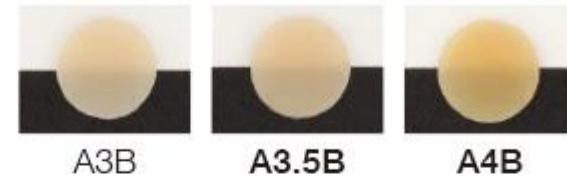
Optical Properties

3. Scattering:

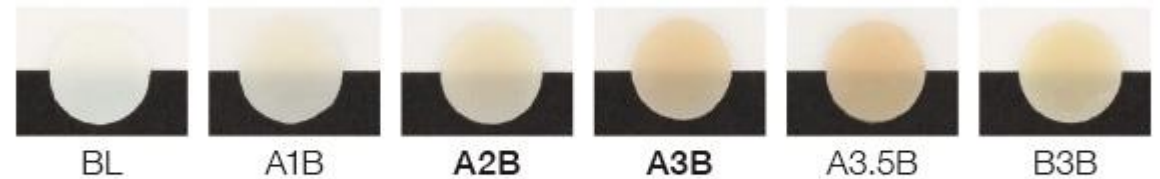
Importance in Dentistry:

- a) Opacifiers are added to esthetic restorative materials to obtain different shades.

Cervical area



Body area



Incisal area



Optical Properties

3. Scattering:

- b) Incorporation of air bubbles during mixing of restoration will give more opaque restoration.



Optical Properties

4. Transmission:

Properties of materials in Relation to Light Transmission:

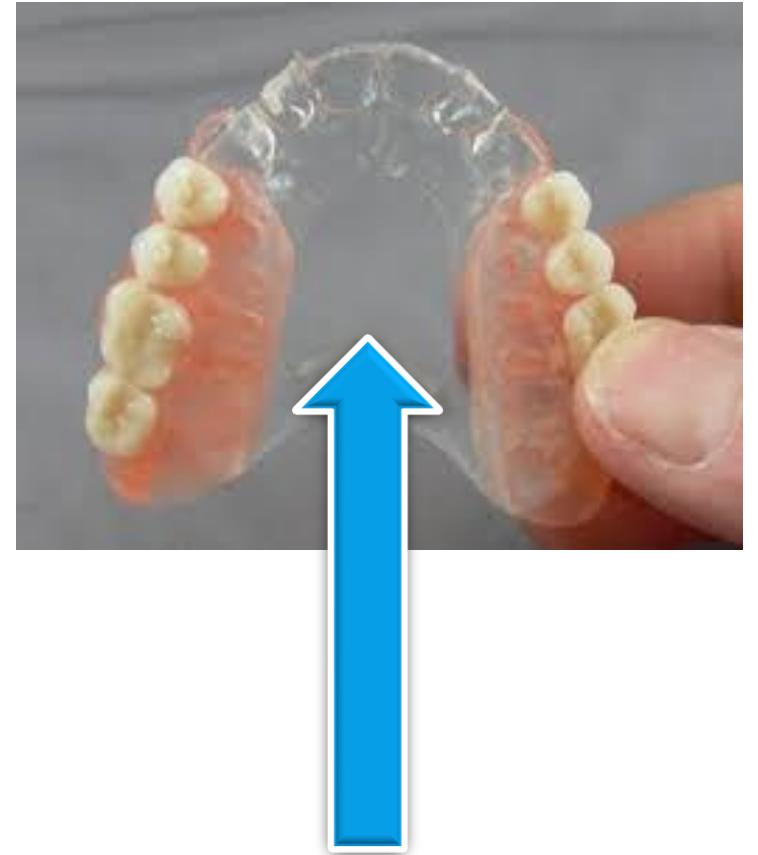
- a) Transparency
- b) Translucency
- c) Opacity

Optical Properties

4. Transmission:

a) **Transparency:**

- Most of light passed through the material,
- Object can be seen clearly through it.
- e.g: glass & acrylic resin.



Optical Properties

4. Transmission:

b) **Translucent:**

- Some of light passed and the rest scattered or reflected,
- Object can't be seen clearly.
- e.g: tooth enamel, porcelain, composite resin & pigmented acrylic resin.

Optical Properties

4. Transmission:

b) Translucent:



Optical Properties

4. Transmission:

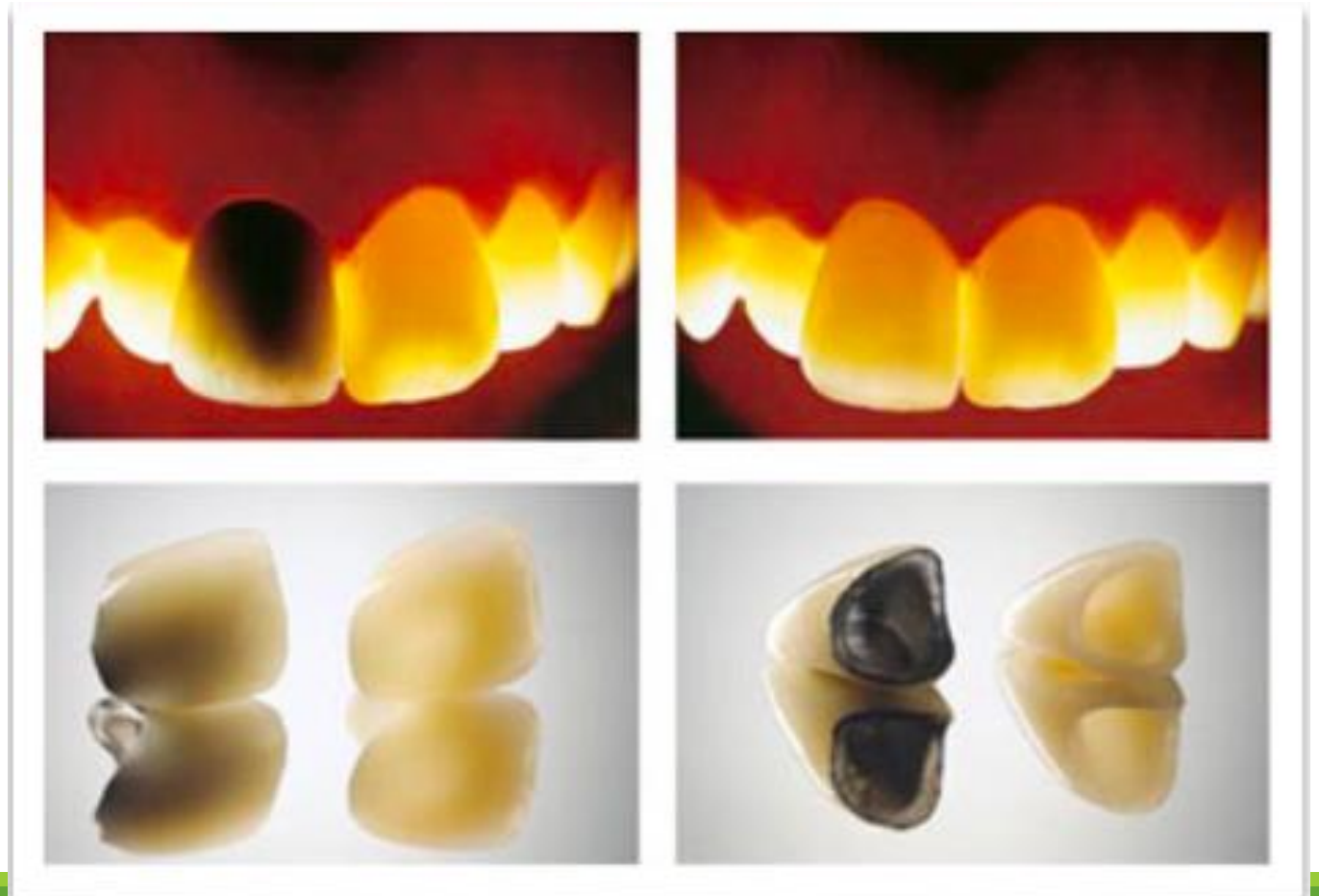
c) **Opacity:**

- All of light is absorbed, the material prevents light passage through it.
- The objects can't be seen through it.
- e.g: Metals, alloys, and gypsum products

Optical Properties

4. Transmission:

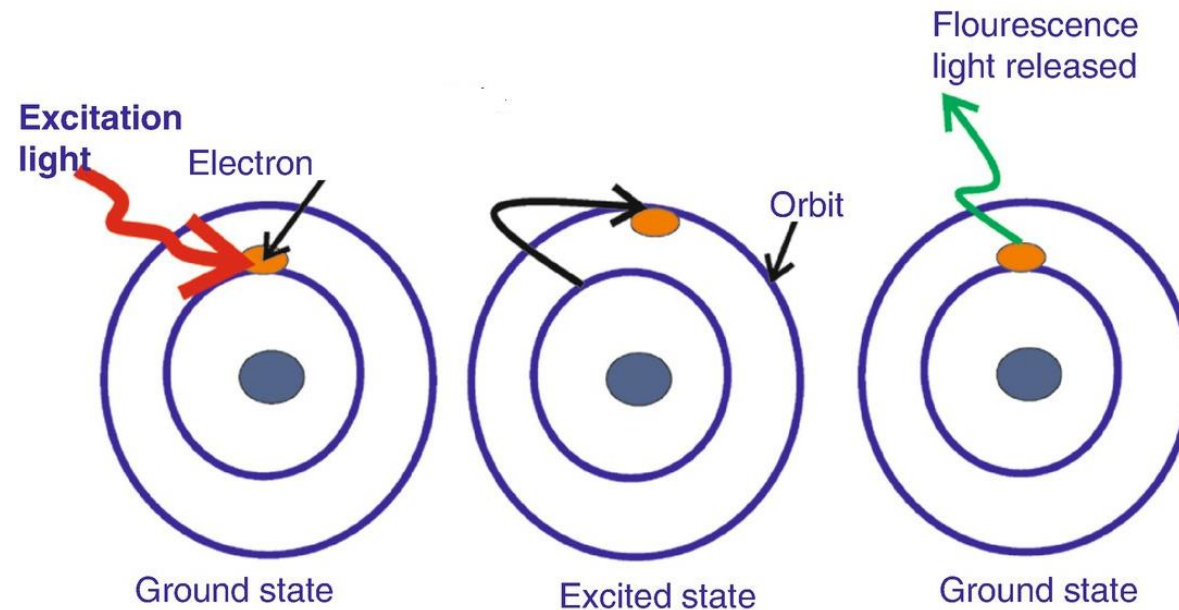
c) Opacity:



Optical Properties

5. Fluorescence:

The human teeth absorb light and emit it with longer wavelength.



Optical Properties

5. Fluorescence:

Importance in Dentistry:

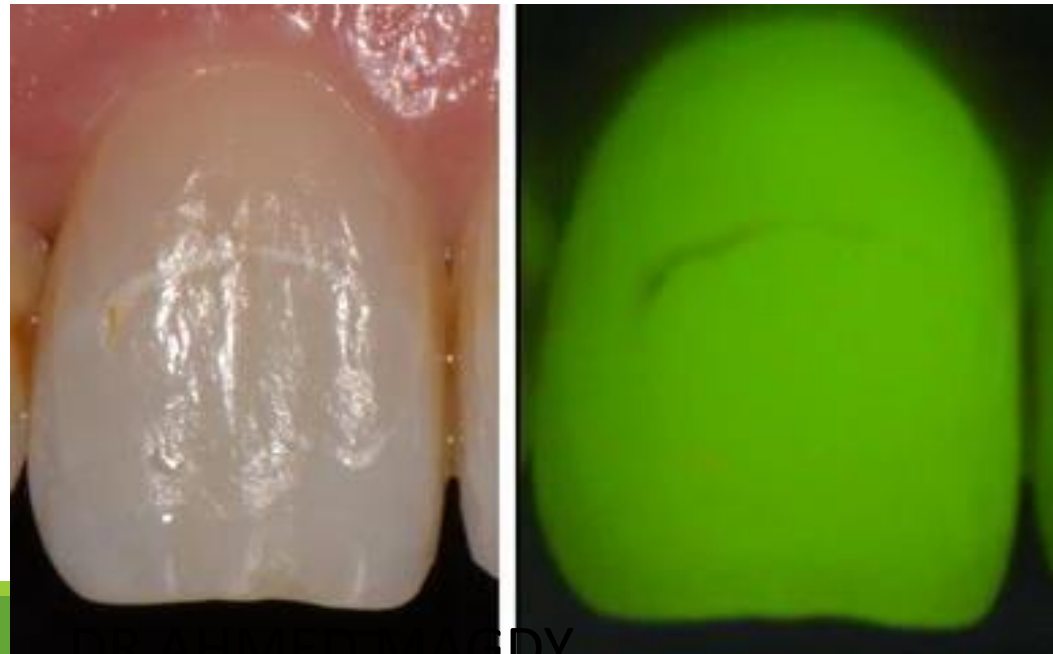
1. Fluorescence gives the tooth brightness and vital appearance.
2. Tooth structure emits fluorescent light when excited by ultraviolet radiation. So aesthetics restorative materials should simulate natural tooth structure.
3. Fluorescence helps in diagnosis of initial caries.

Optical Properties

5. Fluorescence:

Importance in Dentistry:

3. Fluorescence helps in diagnosis of initial caries.



Optical Properties

6. Opalescence:

It is a light scattering effects that is occurs at the tooth surface especially at the incisal edges.



Optical Properties

6. Opalescence:

Importance in Dentistry:

This effect creates bluish-white color when the tooth is seen at different angles.

Optical Properties

Color

Definition:

It is a physiological response to a physical stimulus.

Optical Properties

Color Description:

Color can be described and systemically arranged in the three dimensions.

Munsell color system described the color by three parameters:

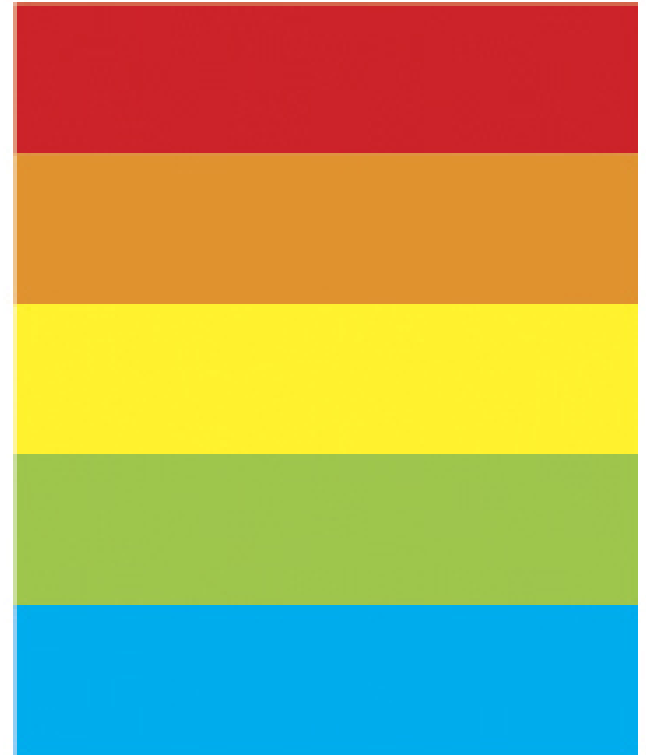
- a) Hue
- b) Chroma
- c) Value

Optical Properties

a) Hue

It is the dominant wave length.

It represents the color of material
(red, yellow, blue, ...)

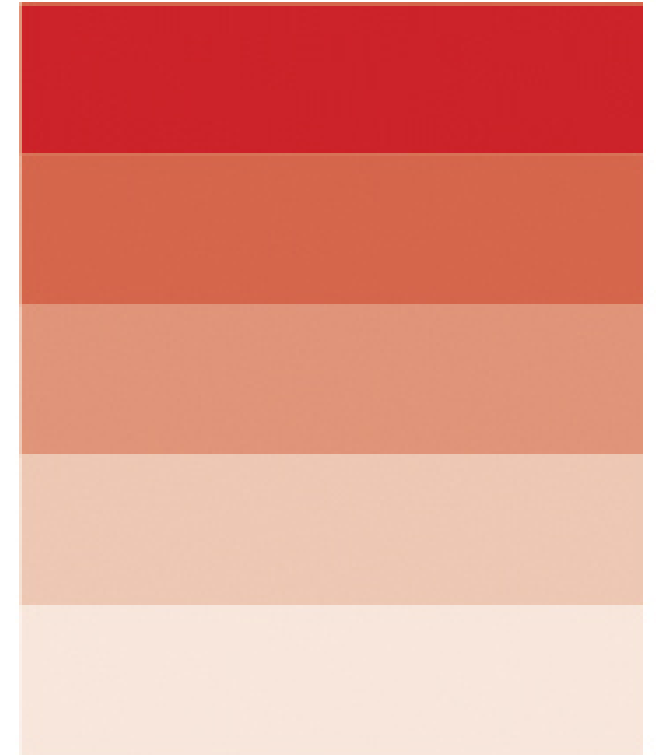


Optical Properties

b) Chroma

It represents the strength of color or degree of saturation or measurement of color intensity.

Glass of water contains 10 ink drops have more chroma than a glass contains just 1 drop.



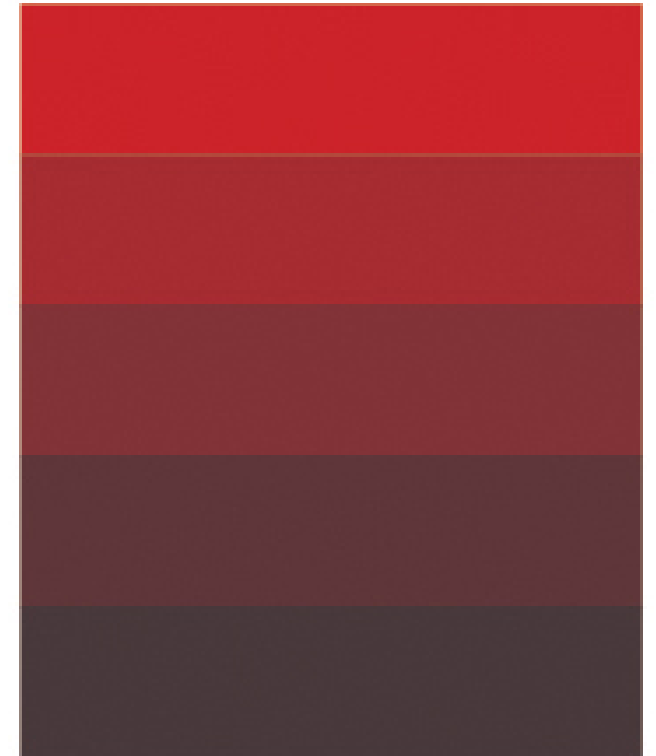
Optical Properties

c) Value:

It represents the lightness or darkness of color.

The lightest materials have a value = 10, while the darkest materials have value = 0

It is the most important color parameter as it represents vitality of tooth (non-vital tooth has low value and appears gray).



Optical Properties

Color Mixing:

1. Additive color mixing
2. Subtractive color mixing



Optical Properties

Additive color mixing	Subtractive color mixing
Occurs due to light mixing	Occurs due to pigments mixing
The eye is stimulated directly by a visible light	The eye is stimulated indirectly by reflection and absorption.

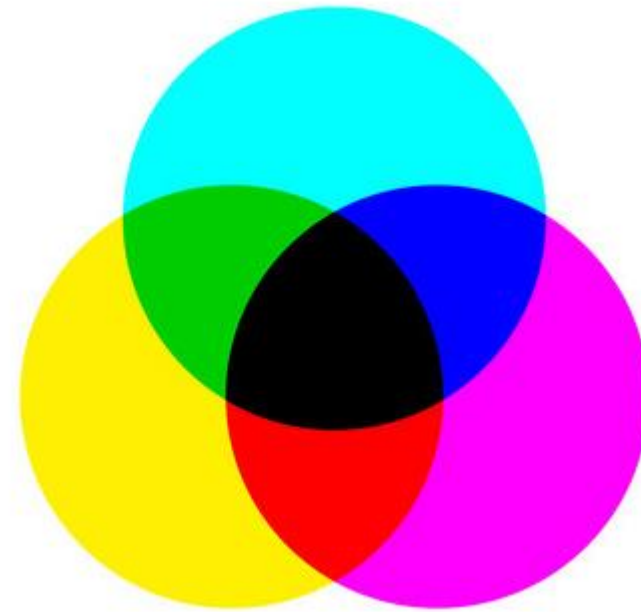
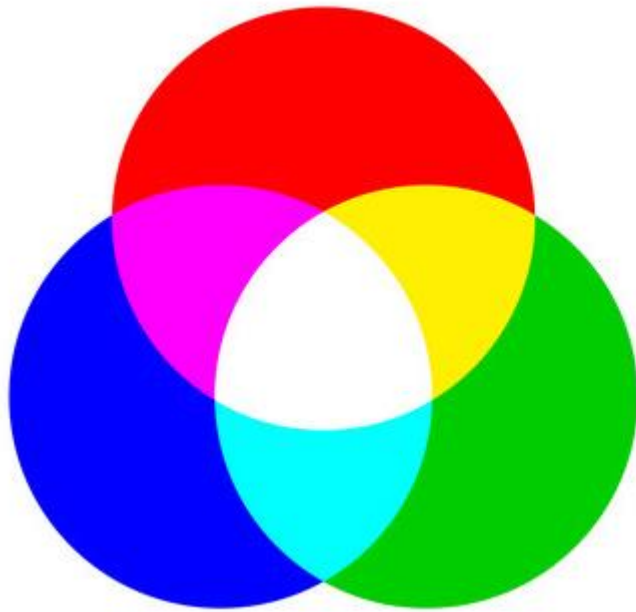
Optical Properties

Additive color mixing	Subtractive color mixing
<p>Primary colors are red, blue and green</p>	<p>Primary colors are cyan, magenta and yellow</p>
<p>Mixing for all primary colors leads to white color</p>	<p>Mixing for all primary colors leads to black color</p>

Optical Properties

Additive color mixing

Subtractive color mixing



Optical Properties

Additive color mixing	Subtractive color mixing
Primary colors are red, blue and green	Primary colors are cyan, magenta and yellow
Secondary colors are cyan, magenta and yellow	Secondary colors are red, blue and green

Optical Properties

Primary colors:

The colors that cannot be produced by color mixing.

Secondary colors:

Mixing of two primary colors.

Complementary colors:

Mixing of them results in white (additive) or black (subtractive)

Optical Properties

Factors Affecting Color Appearance and Selection:

1. Light Source:

Different light sources have different color content

Metamerism:

The change of color matching of two objects under different light sources.

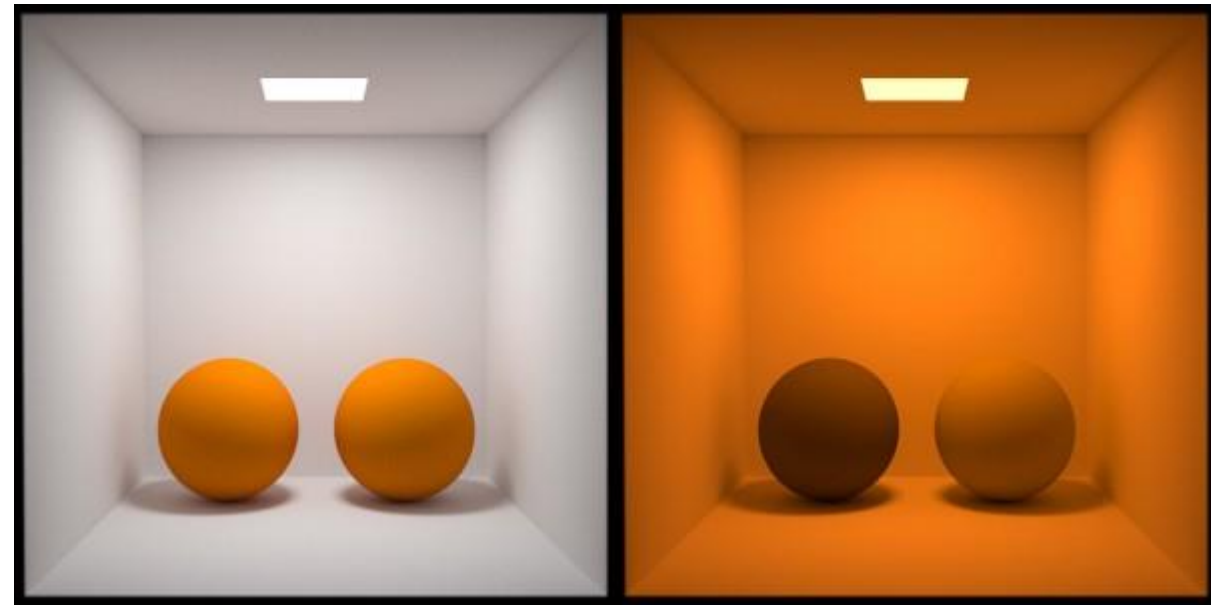
Optical Properties

Factors Affecting Color Appearance and Selection:

1. Light Source:

Clinical Importance:

Selection of tooth color should be done under day light, as it contains almost all visible wavelengths.



Optical Properties

Factors Affecting Color Appearance and Selection:

2. Surroundings:

Color of surroundings (wall, lips, patient's clothes, ..) modify the type of light reaching the object.



Optical Properties

Factors Affecting Color Appearance and Selection:

3. Object:

a) Translucency:

It controls the lightness or darkness of color.

High translucency gives a lighter color appearance (higher value) i.e. more vital tooth appearance.

Optical Properties

Factors Affecting Color Appearance and Selection:

3. Object:

b) Surface texture (surface finish):

Smooth surface appears brighter than rough surface.

Optical Properties

Factors Affecting Color Appearance and Selection:

3. Object:

c) Presence of scattering centers:

Increase opacity and lower the value (more dark).

Optical Properties

Factors Affecting Color Appearance and Selection:

3. Object:

d) Fluorescence:

It makes the human teeth bright and vital, as it increases the brightness.

Optical Properties

Factors Affecting Color Appearance and Selection:

3. Object:

e) Thickness:

Increase in thickness increase opacity, and lower the value.

Optical Properties

Factors Affecting Color Appearance and Selection:

3. Object:

f) Metamerism:

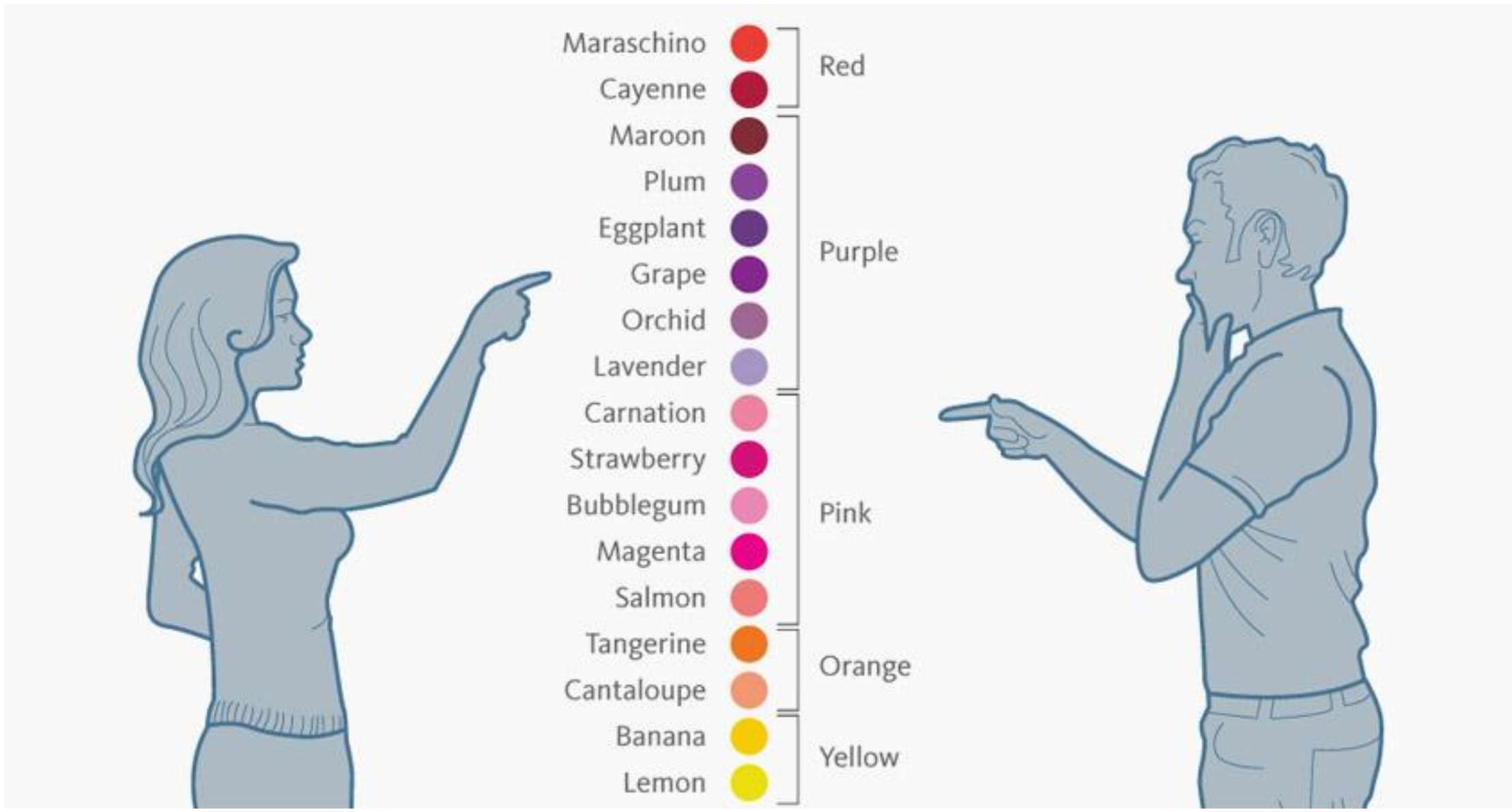
Optical Properties

Factors Affecting Color Appearance and Selection:

4. Observer:

a) Color Response:

Eye responds differently from one person to another due to difference in age, sex, memories, cultural and sociological background



Optical Properties

Factors Affecting Color Appearance and Selection:

4. Observer:

b) Color Blindness:

Some people can't distinguish between certain colors.

Optical Properties

Factors Affecting Color Appearance and Selection:

4. Observer:

c) Color Fatigue:

Constant stimulation of one color decreases the response of the eye to that color.

Optical Properties

Factors Affecting Color Appearance and Selection:

4. Observer:

c) Color Fatigue:

To avoid color fatigue:

- i. Tooth shade should be recorded before tooth preparation to avoid prolonged staring at tooth.
- ii. If happened, looking to the complementary color (blue).

Water Sorption

Definition:

It is the amount of water adsorbed on the surface and absorbed into the body of the material.



Water Sorption

Clinical importance:

1. Water sorption of acrylic resin denture base will compensate cooling shrinkage.
2. Hydrocolloids impression materials should not be immersed into water to avoid dimensional changes.



Thank You



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