DENTAL MATERIALS

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DENTAL MATERIALS CURECULUM 2022-2023

No.	Title Of The Lectures
1	Introduction and physical properties of dental material □ Introduction to dental materials □ Physical, chemical and biological properties of dental materials
2	Mechanical properties
3	Gypsum materials □ Definition, requirement, types, □ gypsum bonded investment □ phosphate bonded investment □ ethyl silicate bonded
4	Impression materials □ Definition □ Ideal properties of impression materials □ Classification of impression materials □ Non elastic impression materials □ Impression plaster □ Impression compound □ Zinc oxide - eugenol □ Elastomeric impression material
5	Waxes □ Definition, □ Requirements, □ classification of wax according to origin & melting point, □ classification of wax according to uses, properties of dental waxes.

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6	Polymers ☐ Polymers and polymerization ☐ Definition of polymer, co-polymer, cross-link polymer and Degree of polymerization ☐ Factors which control structure and properties of polymer ☐ Types of polymerization ☐ Heat activated acrylic ☐ Composition ☐ Properties ☐ Chemically activated resin ☐ Composition ☐ Properties ☐ Light activated resin ☐ Composition ☐ Properties ☐ Chemically activated resin compared to heat activated resins ☐ Polymers used in dentistry ☐ Processing errors
7	Investment materials ☐ factors affecting setting time, setting expansion, strength, storage and manipulation of gypsum products, and hygroscopic expansion
8	Cement materials ☐ Classification of dental cements ☐ Definition ☐ Requirements
9	Temporary filling ☐ Definition ☐ indication ☐ Types ☐ Requirements
10	Metal and metal alloy ☐ Metallic denture base materials ☐ Types of metal and metal alloys ☐ Definition of alloy ☐ Requirement of casting alloy ☐ Application of dental alloy ☐ classification of metal ☐ classification of dental alloy ☐ gold foil (advantage, disadvantages) ☐ gold alloys

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11	Filling materials □ Direct filling material □ Definition □ Factors causing lossof tooth substance □ Requirement of an ideal filling material. □ Classification of filling material □ Anterior filling materials Disadvantages Composite filling materials composition and structure Types of composite □ Posterior filling materials Dental amalgam □ Classification of amalgam alloys □ Properties of set amalgam □ Shaping and finishing □ Mercury toxicity
12	Preventive materials
13	Root canal filling materials (obturating materials)
14	Finishing and polishing material
15	Relining material □ Definition □ Types □ Requirements □ Indication □ Soft liners □ Types □ Requirements □ Indication □ Properties
16	Implant materials
17	Maxillofacial materials

- **References**

- Phillips applied dental material
- Restorative dental material
- Dental material their selection and use

الامتحان التقويمي

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This lec……

- ***What is the meaning of Dental Materials.***
- ***Why we should study the Dental Materials.***
- ***What are the general properties of the Dental Materials.***
- ***Who the Dental Materials affect the dental treatment planning.***
- ***What are the hazards from dental materials (as any chemical substances) on living tissues.***

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Dental materials

- It is the science which deals with the materials used in dentistry, their mechanical, physical, chemical and biological properties and their manipulation, as these properties are related to the proper selection and use them to their best advantage by a dentist.
- Besides use in the oral cavity many materials are also used in the laboratory to aid in the fabrication of dental prostheses.

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Dental materials

The objective of dental materials course is to learn the mechanical, physical, chemical and biological properties of some dental materials and their manipulation.

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Most dental treatment may be divided into three phases:

- Prevention
- Restoration
- Rehabilitation

Prevention:

- The preventive phase is probably the most important.
- This includes educating the patient on how to maintain his oral hygiene through ***regular brushing, flossing*** *and* ***periodic checkup at the dental office*** has been shown to be very effective at controlling caries as well as gum (periodontal) problems.
- Fluoride therapy in the control of dental caries has been known to us for a long time.

Restoration:

The next stage is the actual development of dental caries and periodontal disease.

Caries involves the actual demineralization and destruction of tooth structure.

The treatment of caries involves removing the carious tooth structure and restoring the cavity with a suitable filling material.

Some of restorations are processed outside the mouth, in the laboratory; (indirect tech.)

Rehabilitation:

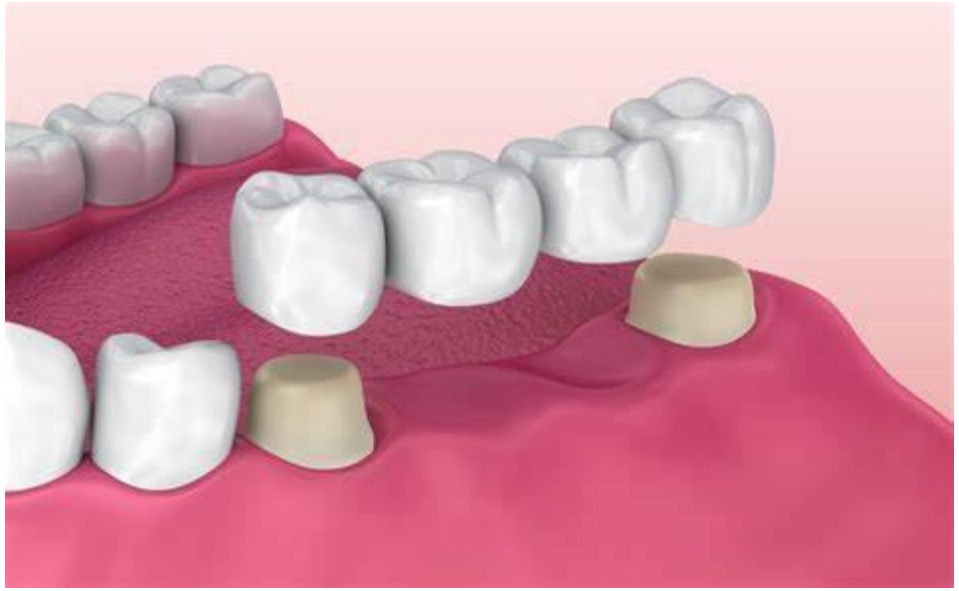
- Unfortunately the reality is that often patients come too late for any kind of conservative treatment.
- Hopeless teeth have to be extracted.
- After extraction the patient often desires that it be replaced with an artificial tooth.

There are many ways of replacing the missing tooth:

1) Implants have become very popular.

There are many ways of replacing the missing tooth:

2 The fixed partial denture (bridge).



There are many ways of replacing the missing tooth:

3 If too many teeth are missing, the removable partial denture which replaces the missing teeth but is not fixed in the mouth.

There are many ways of replacing the missing tooth:

4 The final stage is when all the teeth have to be replaced, the complete denture is usually made of a type of plastic called acrylic or (fixed complete dentures are also available which are supported and retained by implants).

General properties of the dental materials

1) ***Mechanical properties:***
2) ***Physical properties***
3) ***Chemical properties***
4) ***Thermal properties***
5) ***Electrical activity***
6) ***Biological properties***

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Mechanical properties:

- One of the most important properties of dental materials is their ability to withstand the various ***mechanical forces (such as ???)*** applied on the material during its use.

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Mechanical properties:

- **Stress:** When an external force applies on body, tending to produce deformation, a resistance is developed within the body to this external force.
- The internal resistance of the body to the external force is called stress.
- Stress is equal and opposite in direction to the external force applied.
- This external force is also known as load.
- Stress is the force per unit area (N/M^2), (Mpa).

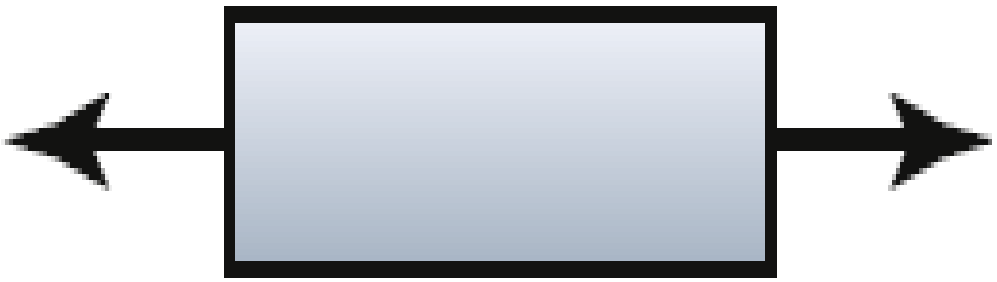
Mechanical properties:

- **Strain:** If the stress (internal resistance) produced is not sufficient to withstand the external force (load), the body undergoes a change in shape (deformation).
- Each type of stress is capable of producing a corresponding deformation in the body.
- Strain is expressed as change in length per unit of original length of the body when a stress is applied.

$$\text{Strain} = \frac{\text{Deformation or change in length}}{\text{Original length}} = \frac{E}{L}$$

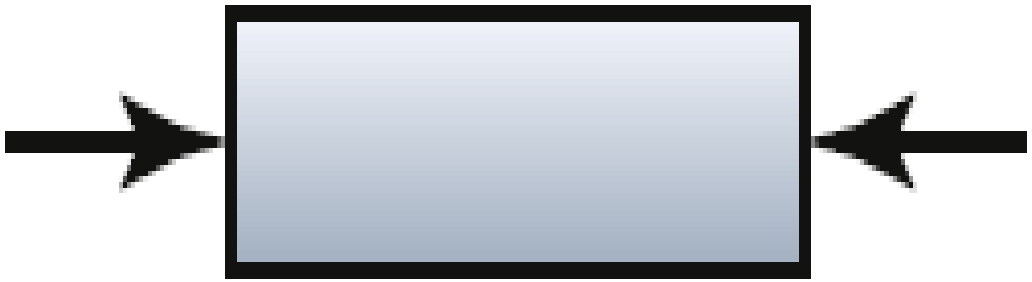
Types of stresses:

- **Tensile Stress:** Results in a body when it is subjected to two sets of forces that are directed away from each other in the same straight line.
- The load tends to stretch or elongate a body.
- It's accomplished by ***tensile strain.***



Types of stresses:

- **Compressive Stress:** Results when the body is subjected to two sets of forces in the same straight line but directed towards each other.
- The load tends to or shortens a body.
- It's accomplished by ***compressive strain***

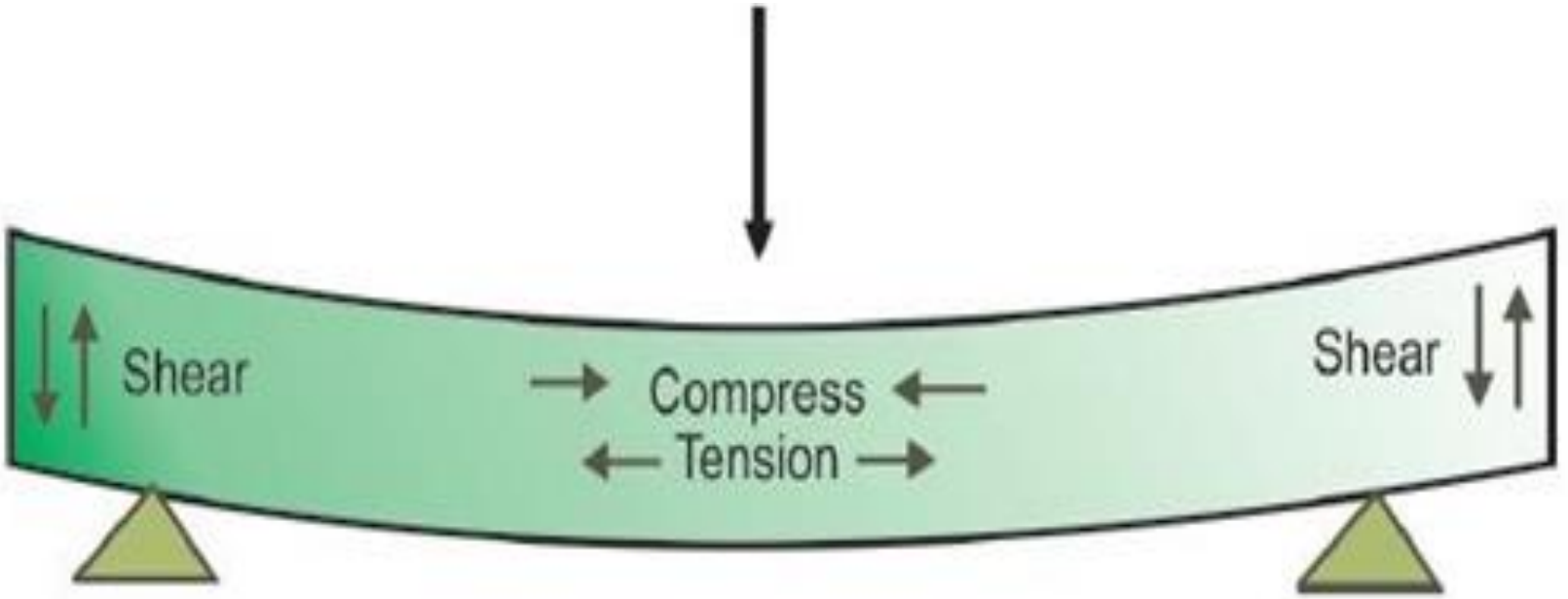


Types of stresses:

- **Shear Stress:** Results when two forces directed parallel to each other.
- The load tends to twist, or slid of one portion of a body over another.
- It's accomplished by ***shear strain.***

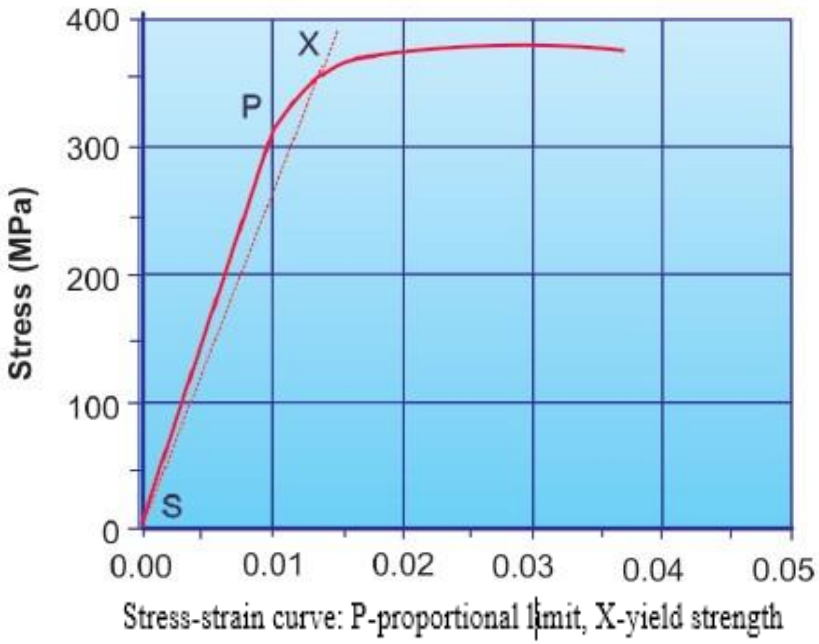
Types of stresses:

- Usually three types of stresses occur at the same time.
- If a piece of metal is being bending, it will exhibit tensile stress on the outer surface, compressive stress on the inner and shear stress in the middle.



Stress-strain curve

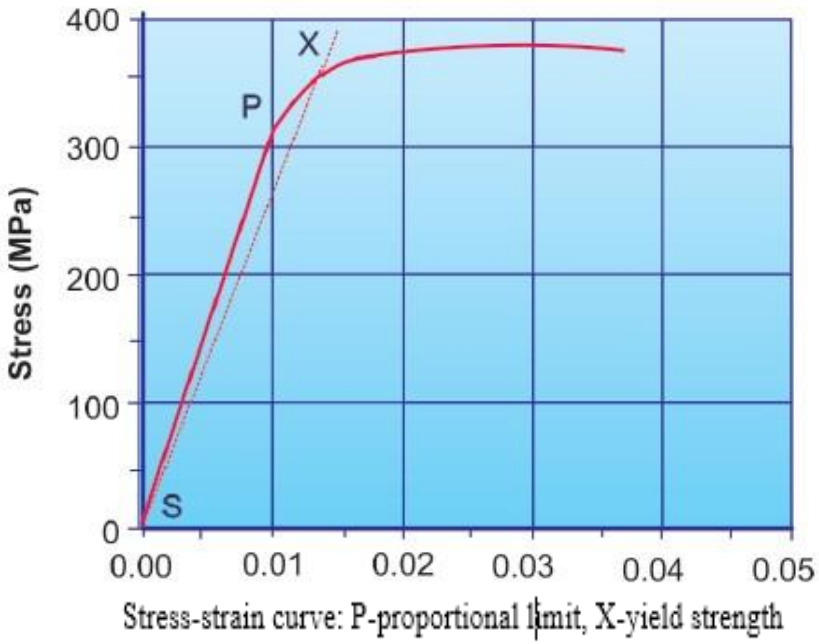
- **Stress-strain curve:** is a straight line up to point ‘P’ after which it curves.
- **Proportional limit ‘P’:** when the stress is applied to a material, the material will tend to deform in shape and dimension in an amount proportional to the magnitude of applied stress.
- The point ‘P’ is the proportional limit, up to point ‘P’ the stress is proportional to strain (Hooke’s Law).



Stress-strain curve: P-proportional limit, X-yield strength

Stress-strain curve

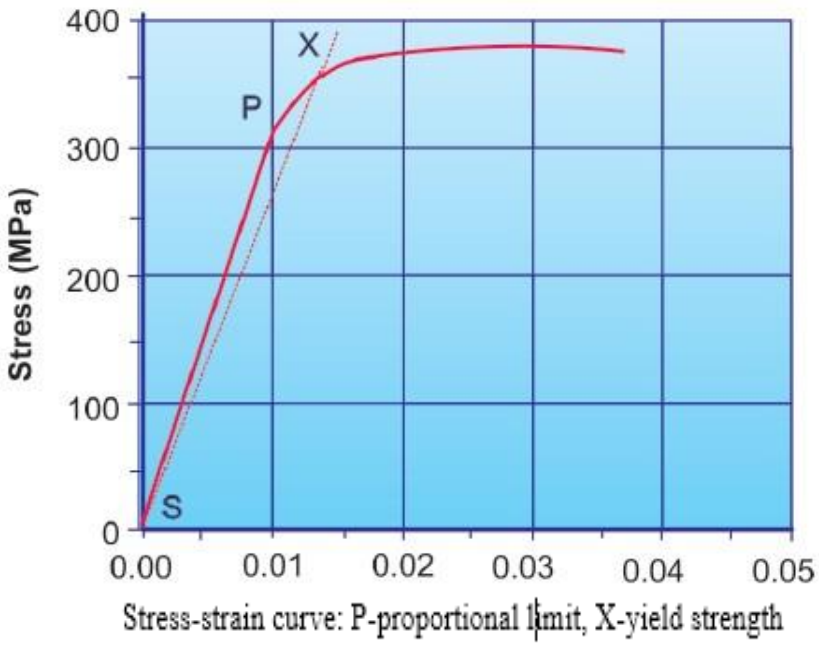
- **Elastic limit:** the maximum stress that a material will withstand without permanent deformation (change in shape), if the load is removed the material will return to its original shape.
- If the stress increased beyond the elastic or proportional limit, the material will deform and if stress is removed, the material will not return to its origin dimension, this is called plastic or permanent deformation.
- If the stress increased more and more, the material will break.



Stress-strain curve: P-proportional limit, X-yield strength

Stress-strain curve

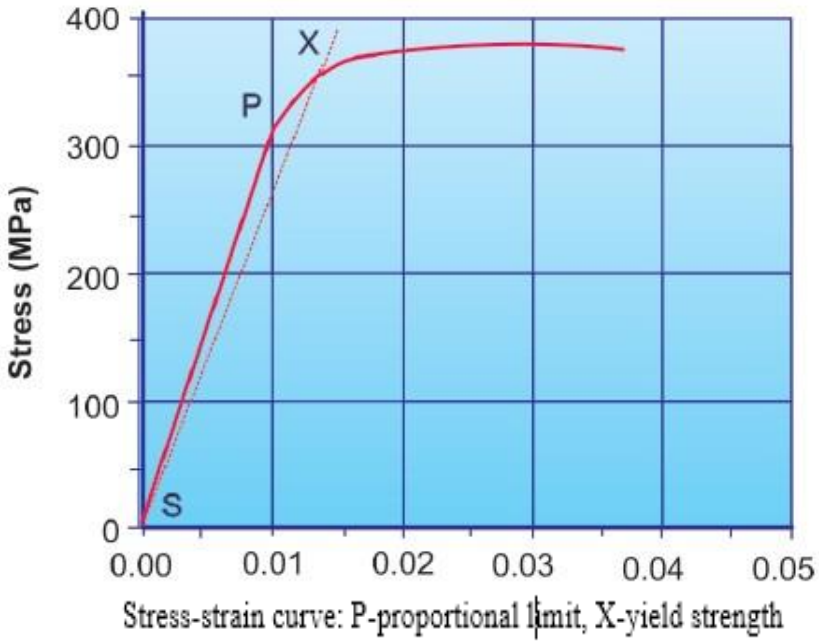
- ***Yield strength:*** it is the stress at which a material exhibits a small amount of deviation beyond proportional limit ‘P’.
- ***Transverse strength or bend strength, or fracture strength:*** is obtained when a load is applied in the middle of a beam supported at each end.



Stress-strain curve: P-proportional limit, X-yield strength

Stress-strain curve

- ***Fatigue strength:*** when the material is subjected to repeated stresses below its proportional limit can produce sudden failure of the structure.
- ***Impact strength:*** It is the ability of material to fracture under an impact force or sudden impact,
- low impact strength means brittle material, like dropping of denture



Stress-strain curve: P-proportional limit, X-yield strength

Malleability

- **I**t is the ability of the material to withstand permanent deformation under compressive force without fracture.
- It is the ability of the material to be drawn into a sheet.

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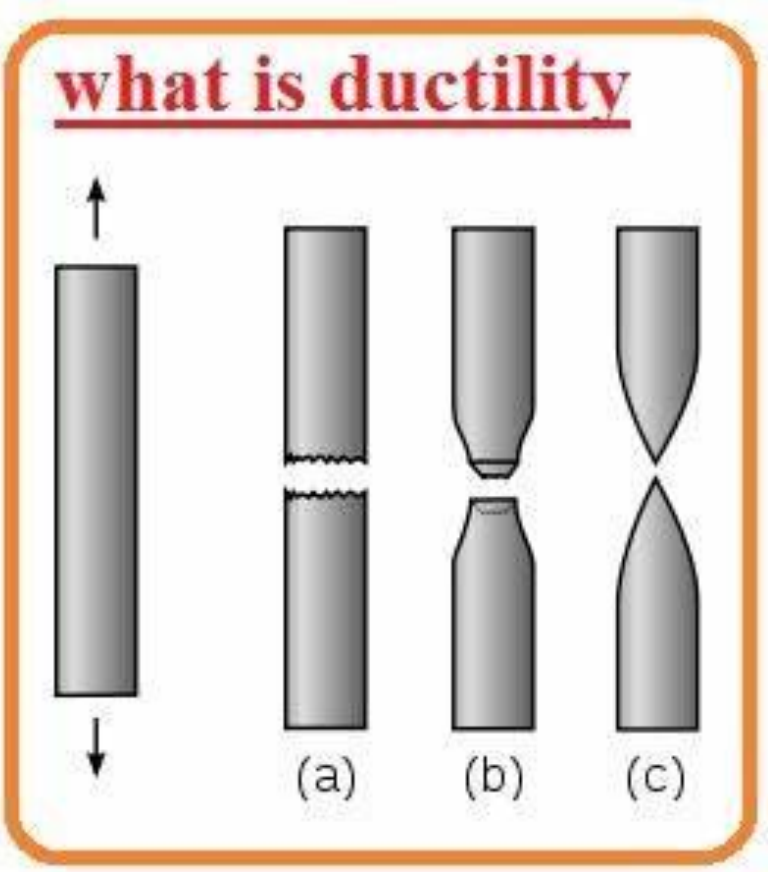
Ductility

- It is the ability of the material to withstand permanent deformation under tensile force without fracture.
- It is the ability of the material to be drawn into a fine wire.



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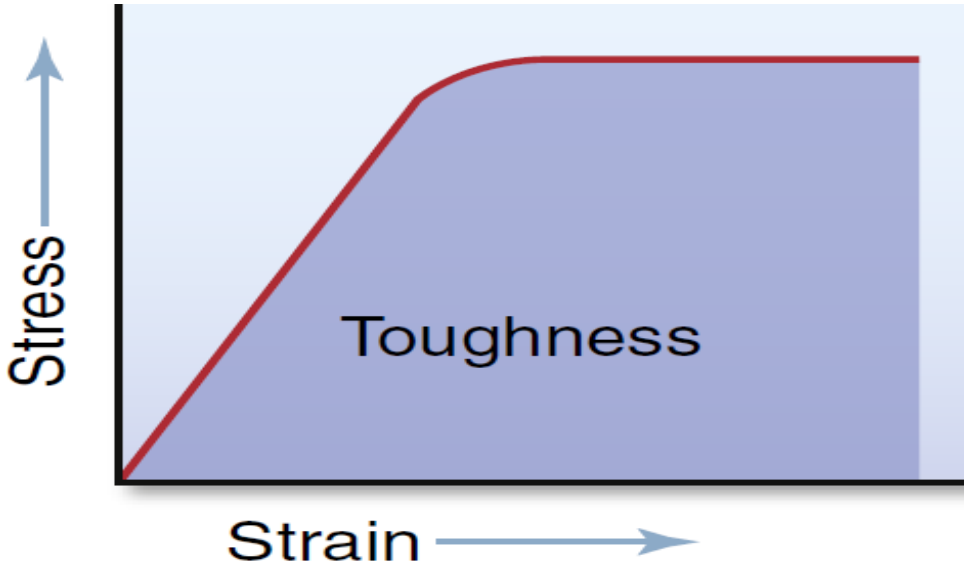
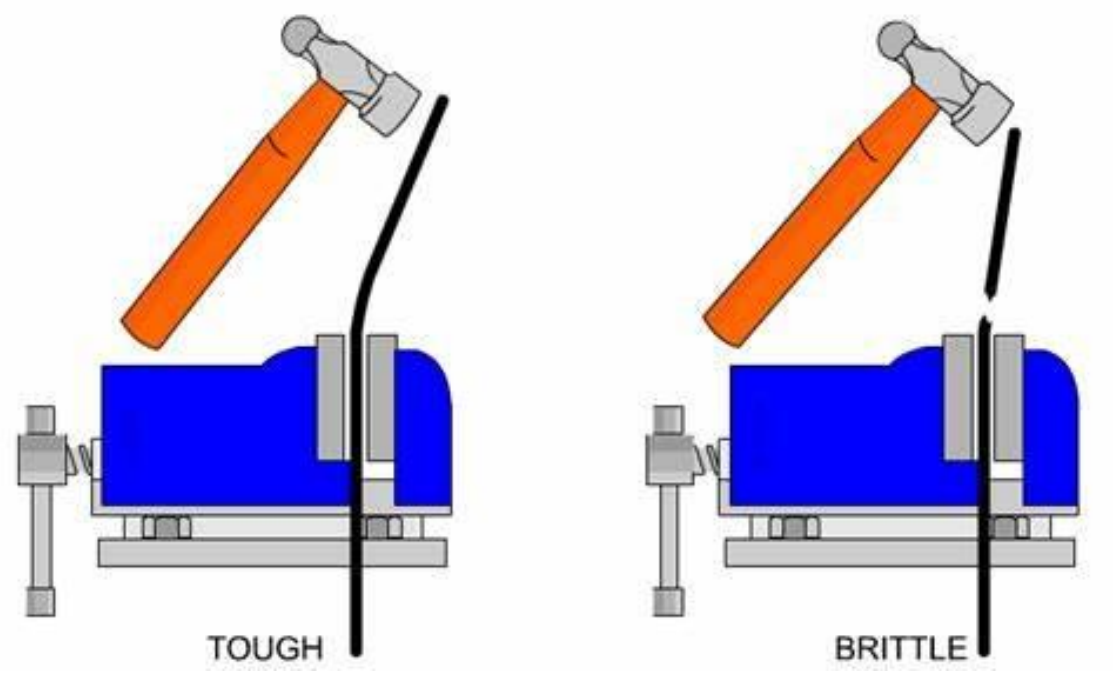
Toughness

- It is the energy required to fracture a material , which describes as how difficult the material would be to break.
- It is a total area under the stress-strain curve.



Brittleness

- It is the opposite of toughness, a brittle material fractures at or near its proportional limit.
- Many dental materials are brittle, e.g., porcelain, cements, dental stone.

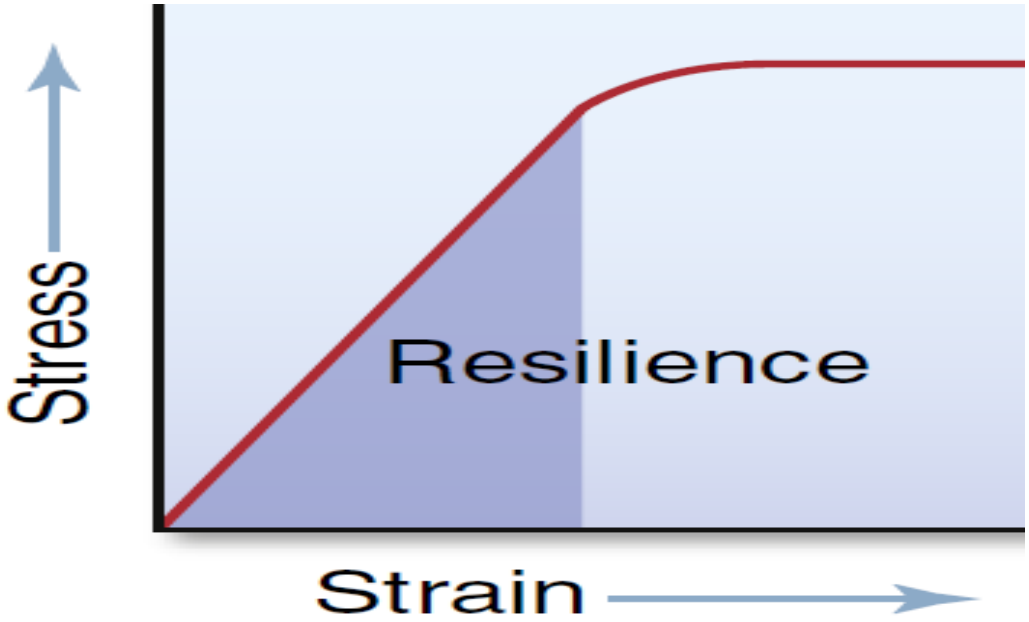


Flexibility

- **I**t is the greatest strain produced in the material when it is stressed to its proportional limit,
- ex: it is useful to know the flexibility of elastic impression materials to determine how easily they may be withdrawn over undercuts in the mouth.

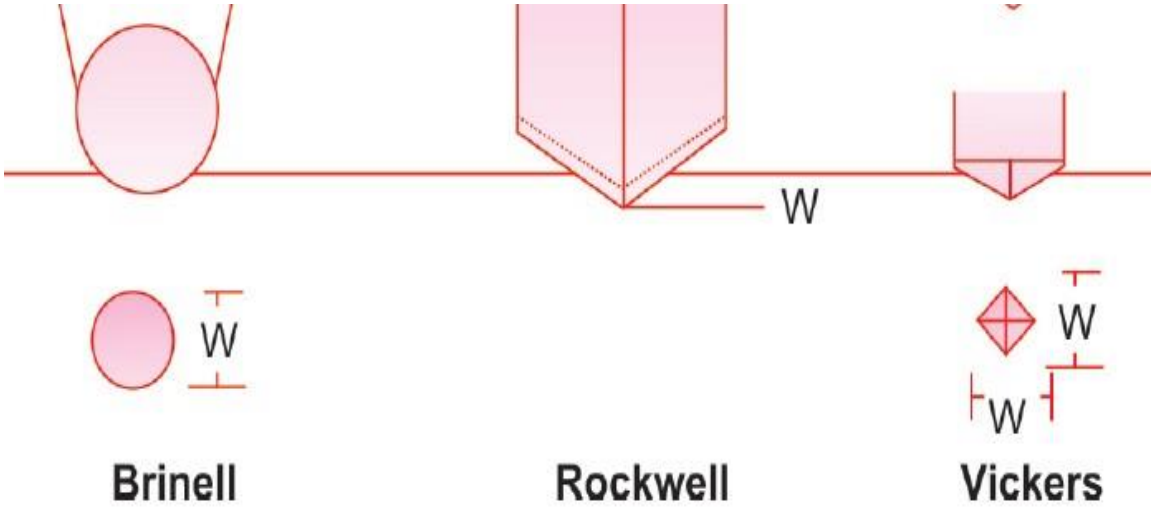
Resilience

It is the amount of energy absorbed by a structure when it is stressed to its proportional limit.



Hardness

- It is the resistance of the material to deformation caused by penetrating or scratching forces for the surface.
- It is done either by using steel ball (Brinell or Rockwell test) or using diamond (Vickers and Knoop test).
- The higher number the harder material.



Physical properties:

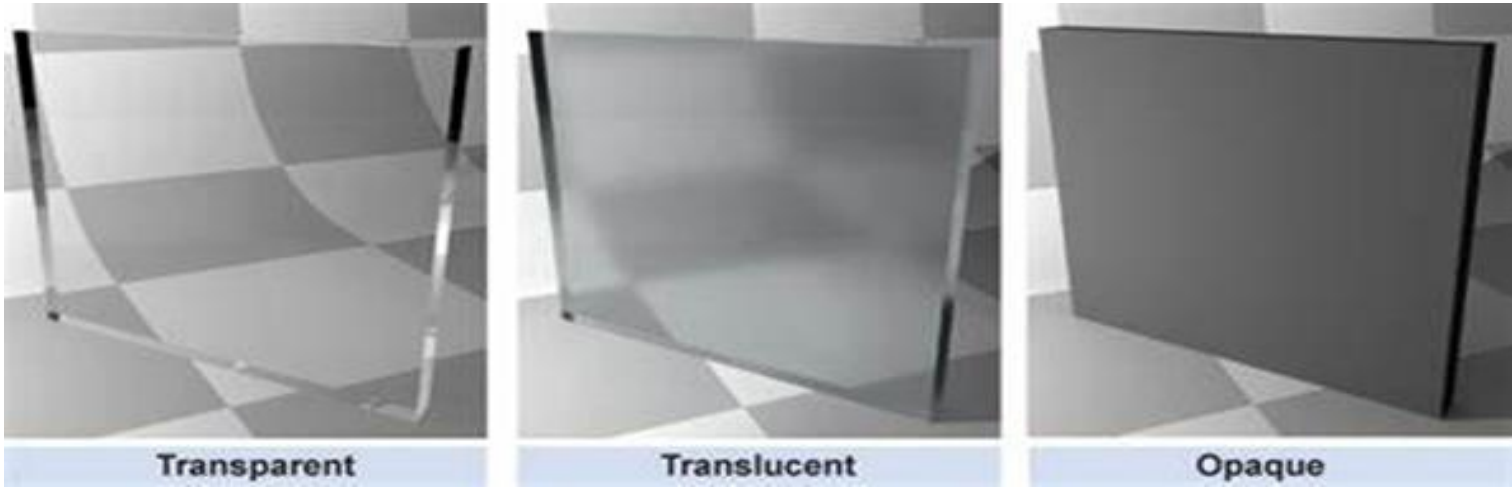
***A) Color*: many dental restorative materials have to look like natural teeth and should not stain or change color by time.**

The anterior filling and artificial tooth material should be translucent.

Physical properties:

A) Color:

- **Transparent materials**: Allows light to pass through; And things can be seen clearly through them,
- **Translucency:** Allows light to pass through as it is scattered, so objects cannot be seen through matter. Such as ceramics, resin and acrylic.
- **Opacity**: Prevents the passage of light, like opaque ceramic materials.



Physical properties:

- **Dimensional stability:** Dental materials should not be suffered dimensional change after harden.
- There are many material change shapes when they set or harden, ex. impression materials, amalgam filling material

Physical properties:

Dimensional stability:

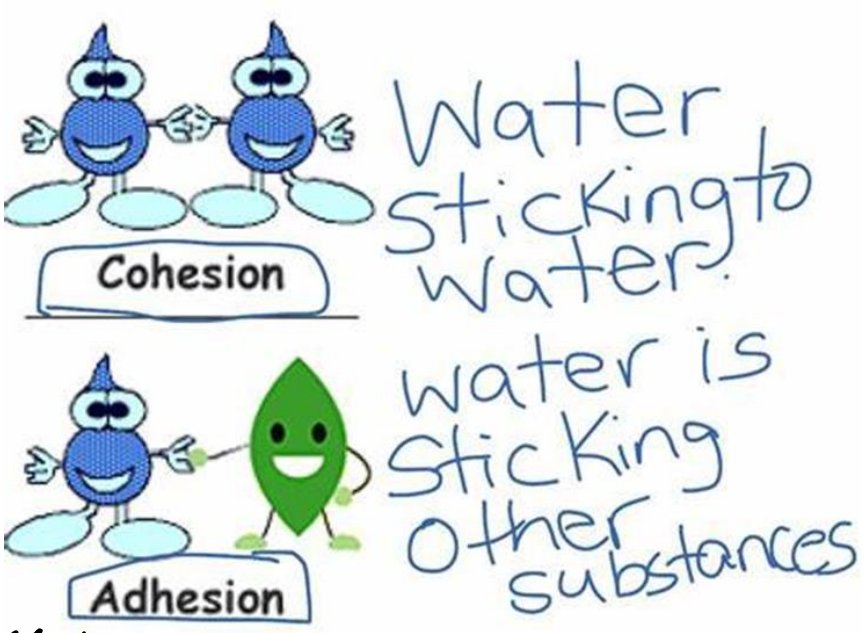
- ***On the other hand,*** the investment material that forms the mold for dental casting should expand for certain amount to compensate for the contraction of the molten metal after it is cooled from the molten stage.

Physical properties:

- **Density:** lightness is always an advantage in restorative materials
- But sometimes tin or lead is used inside lower complete denture to make it heavy to control its mobility.

Physical properties:

- **Adhesion:** is the force which causes two or more different substances to attach when they are brought in contact with one another.
- **Cohesion:** when the molecules of the same substance hold together, the forces are said to be cohesion.



Physical properties:

- **Solubility:** restorative materials should not dissolve in the oral fluid.
- If it dissolves, it should not release toxic substances.

Physical properties:

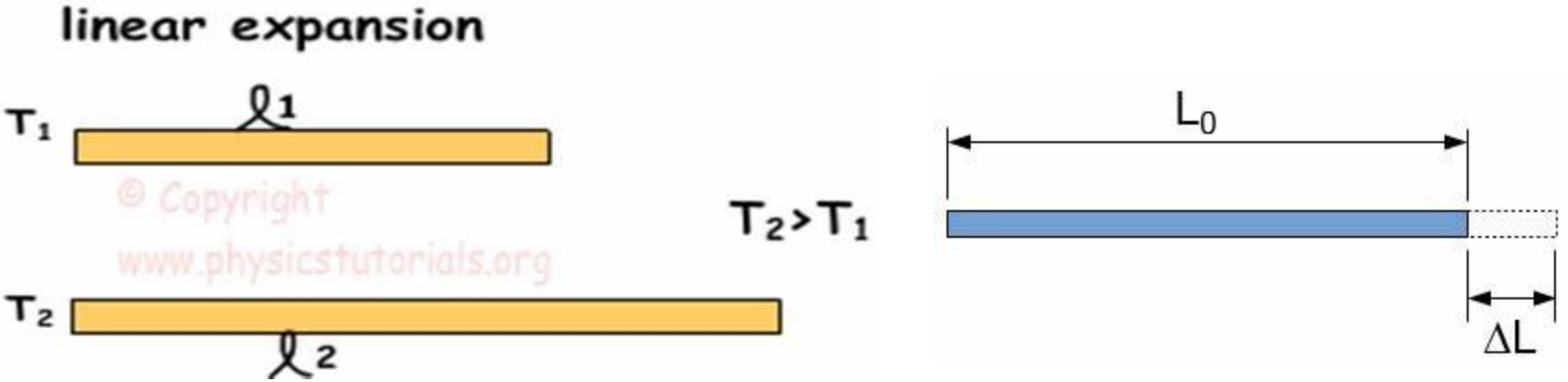
Fluid absorption: some materials will absorb water or other fluids.

- If it is too much or continued for long time, this will result in serious dimensional changes and the material would also be unhygienic.
- On the other hand, some materials like acrylic will absorb water for a day and stops after that, so it is acceptable.

Thermal properties:

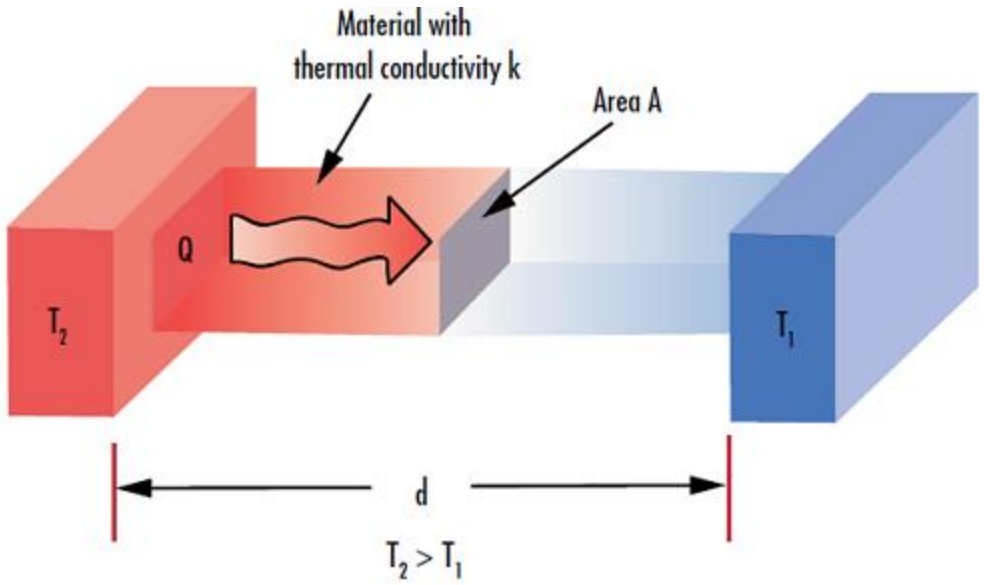
- **Coefficient of thermal expansion and contraction:**

When the temperature rises, a solid material will expand and on cooling it will contract, this is measured by the coefficient of thermal expansion and contraction.



Thermal properties:

- **Thermal conductivity:**
- It points to the ability of a material to transport heat from one point to another without movement of the material as a whole, the more is the **thermal conductivity** the better it conducts the heat.



Thermal properties:

Thermal conductivity:

- Generally, metals are better heat conductors than non-metals.
- Metal filling materials like ***amalgam*** sometimes cause pulp pain by transmitting heat or cold more than natural tooth especially in deep cavities, thus they require heat insulating layer (cement lining) between the filling and the pulp.
- On the other hand the thermal conductivity of ***metallic denture base*** is an advantage as it gives feeling closer to normal condition and the patient will feel normal also it will protect him from drinking very hot drinks which may burn his mouth.

***D- Electrical activity*:**

- It is the ability of metals to 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.

F- Biological properties:

- Some restorative materials are damaging to the living tissue which is in contact with, like silicate filling and zinc-phosphate cement which is acid and may kill the dental pulp unless a protective lining is used (sub lining).
- **Biological requirements of dental materials:**
- ***Dental materials should be***

1) Be nontoxic to the body
2) Be non-irritant to the oral or other tissues
3) Not produce allergic reactions
4) Not be carcinogenic.

Examples of hazards from chemicals in dental materials:

1) Some dental cements are acidic and may cause pulp irritation.
2) Polymer based filling materials may contain irritating chemicals such as unreacted monomers, which can irritate the pulp.
3) Phosphoric acid is used as an etchant for enamel.
4) Dust from alginate impression materials may be inhaled, some products contain lead compounds (patient and dental staff).
5) Monomer in denture base materials is a potential irritant. (patient and dental staff).

Examples of hazards from chemicals in dental materials:

6- Some people are allergic to alloys containing nickel. (patient and dental staff).

7- Some dental porcelain powders contain uranium. (patient and dental staff).

8- Eugenol in materials like restorations and impressions can cause irritation and burning in some patients.


Thank
you