The science of dental materials involves a study of the composition and properties of materials and the way in which they interact with the environment in which they are placed.

General Properties of Dental Materials

All materials have physical properties like color, weight, solubility , thermal conductivity , and others , also mechanical properties like hardness or softness , strength or weakness .There is no material till know has ideal physical or mechanical properties . Most materials have some good and bad properties and sometimes a property that is bad in one material may be good or acceptable in another .

Physical properties:

1-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. **Translucence** is the optical property that allows the light to go short way in the material before being reflected out again . Also should like natural tooth substance at different Light conditions, such as day light and artificial light, ex, an artificial tooth may be acceptable in ordinary light but may be discovered by the relative darkness of the material in fluorescent light. For denture the material should have the same appearance of natural gum acrylic material can be made with various shades of pink to look as natural gum.

2- LINER 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 liner coefficient of thermal expansion and contraction which is the change in length per unit length of a material for a 1°C change in temperature.

$$a = \frac{\text{final length} - original\ length\ (cm)}{\text{original length} * temp.change\ (cm.^{\circ}C}$$

Hard tooth structure has the smallest coefficient, metals are intermediate ,

polymers have the largest. Tooth =11*10^{-6} cm/cm. °□□
Gold= 14 *10^{-6} cm/cm. °□□
Impression compound = 250*10^{-6} cm/cm. °□□

Filling material should have the same coefficient as the tooth, if it does not, it will press too hard against the cavity wall on expansion and may cause pressure on the pulp or pull away from the wall when chilled by cold water. The later effect may cause the filling to leak temporarily, which may in turn may lead to further carries.

3-DIMENTIONAL STABILITY:

Many materials change shape when they set or harden. Impression materials should not change dimensions when set. Also dental materials should have no dimensional changes when set.
Amalgam is a filling material for posterior teeth, it may sometimes change shape permanently as a result of a heavy biting force. This is bad property , on the other hand , the investment materials that forms the gold for dental casting should expand for a certain amount to compensate for the contraction of the molten metal after it is cooled from the molten stage.

4-DENSITY

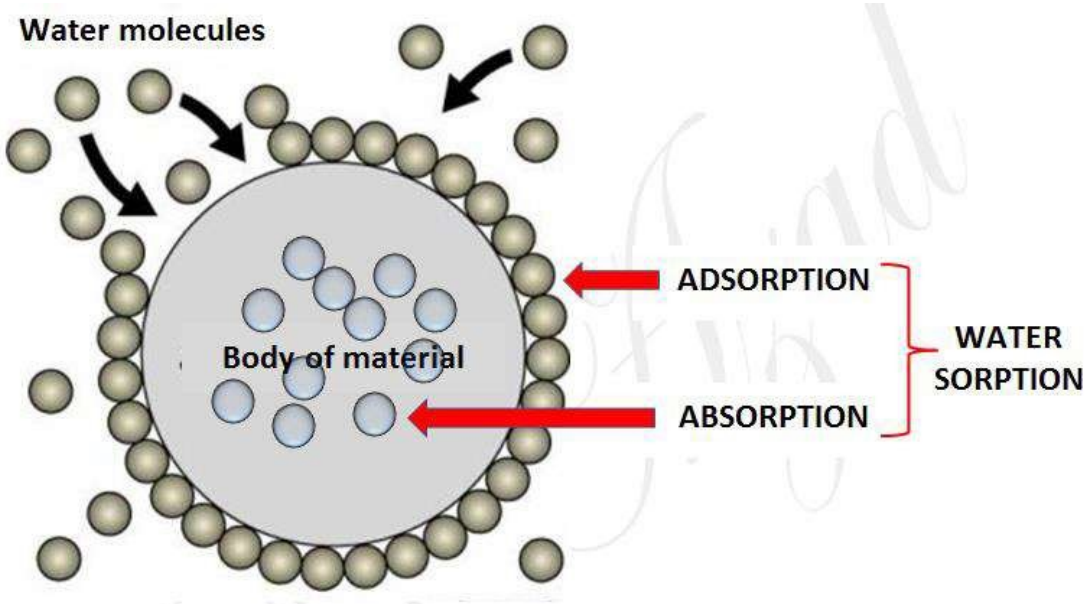
Lightness is nearly always an advantage in restorative materials, but sometimes tin or lead is used inside full lower denture to make it heavy in order to control its mobility. Density of gold = 14gm/cm
Acrylic = 1.2 gm/cm
Cromium /cobalt = 8.3gm/cm
Water = 1gm/cm

5- SOLUBILITY

Restorative materials should not dissolve in the mouth , and if it is dissolves, it should not release toxic substance.
Solubility of silicate = 0.7 -1.6%
Solubility of composite = 0.01 %

6-ABSORPTION OF FLOUIDS:

Some materials will absorb water or other fluids. If it is too much or continued for long time, this will result in serious d dimensional changes and the material will also be un hygienic. On the other hand, some materials like acrylic will absorb water for a day and stop after that, so it is acceptable



7-TISSUE REACTION

Some restorative materials are damaging to the living tissues which are 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. Dental materials should not show any allergic reaction to the tissues and also should not provide good culture for the growth of bacteria and candida infection, like soft lining materials.

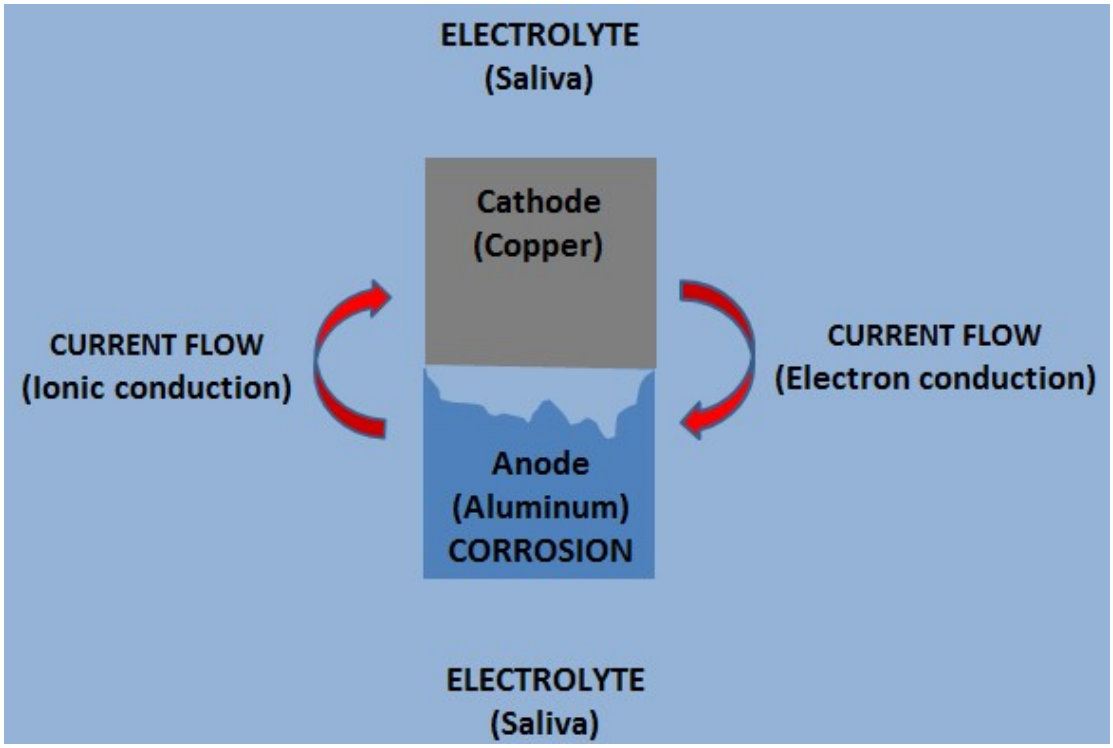
8-THERMAL CONDUCTIVITY

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 between the filling and the pulp. Here is undesirable property 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.

9-ELECTRICAL ACTIVITY

It is the ability of metal to ionize by losing electrons. If there is a high difference in the electrode potentials of metals in contact with the same solution like gold and aluminum an electric cell may develop and the patient may fell discomfort.

The presence of metallic restorations in the mouth may cause a phenomenon called ***galvanic action***, or ***galvanism***. This results from a difference in potential between dissimilar fillings in opposing or adjacent teeth. These fillings, in conjunction with saliva or bone fluids such as electrolytes, make up an electric cell. This cell short-circuited, and if the flow of current occurs through the pulp, the patient experiences pain and the more anodic restoration may corrode, like gold with amalgam.



10- ADHESION AND COHESION

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

MECHANICAL PROPERTIES

One of the most important properties of dental materials of dental materials is the ability to withstand the various mechanical forces placed on them during use as restoration, impression , models, appliances and tools.

STRESS Is the force per unit area induced in a body in response to some externally applied force. It is force\area measured in kg\cm^2 or pound\inch^2 or Pascal.

STRENGTH Is the measurement of the resistance of the material externally applied force. There are many types of stresses according to the direction of the applied force, each type of stress is accompanied by the same type of strain.

STRAIN Is the change in dimension per unit dimension caused by externally applied force.

$$\text{Strain} = \frac{\text{final length} - \text{original length}}{\text{original length}}$$

Percentage of elongation = strain × 100%

1-Tensile stress

It is the force per unit area induced in the body in response to externally applied force which tends to elongate or stretch the body, it is accompanied by tensile strain.

2-Compressive strain

It is the force per unit area induced in the body in response to externally applied force which tends to compress or shorten the body, it is accompanied by compressive strain. Investment materials, restorative materials and models should have high compressive strength.

3-SHEAR STRESS

It is the force per unit area induced in the body in response to externally applied force which is applied to one part of the body in one direction and the rest is being pushed in the opposite direction.

It is the strength of the middle of abeam, which is supported only at its end. It is important in dental bridges.

It is when the material is constantly subjected to change in shape due to frequent application of force like clasp arm of partial denture

It is the ability of the material to break on sudden impact. Low impact strength mean brittle material, like dropping of the denture.

STRESS _ STRAIN CURVE

Proportional limit

When a stress is applied to a material, the material will tend to deform (change in shape and dimension) in an amount proportional to the magnitude of applied stress. The greatest stress which may be produced in the material such that the stress is directly proportional to the strain.

Elastic deformation (elastic limit)

The greatest stress to which the material can be subjected such that it will return to its original shape and dimension when the stress is removed. If the strength is increased beyond the elastic limit or the proportional limit the material will deform and if we remove the stress the material will not

return to its dimension. This is called plastic deformation. If the stress is increased more and more the material will break.

Ultimate strength

Is the greatest stress which break the material.

MODULUS OF ELASTISITY

Is the constant of proportionality. It is when any stress value equal or less than the proportional limit is devided by corresponding strain value.

Modulus of elasticity $= x = \frac{\text{stress}}{\text{strain}}$ kg \cm^2 or PSI or pascal

DUCTILITY

It is the ability of the material to withstand permanent deformation under tensile stress without fracture ; it depends on plasticity and tensile strength. It is the ability of the material to be drawn into a fine wire.

MALLIABILITY

It is the ability of the material to withstand permanent deformation under compressive stress without fracture. It is the ability of the material to be drawn into a sheet.

TOUGHNESS

It is the total work or energy required to break the material. It is the total area under the stress – strain curve. It requires strength and plasticity.

BRITTLENESS

It is the opposite of ductility, it requires lack of plasticity.

FLEXIBILITY

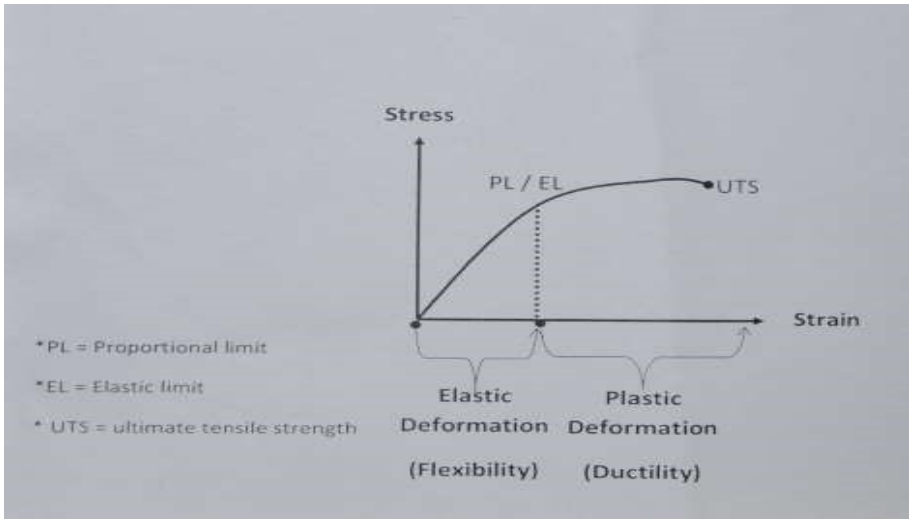
The higher the strain which accrues when the material is stressed to its proportional limit.

RESILIANCE

The amount of energy absorbed by a structure when it is stressed within the proportional limit.

HARDNESS

It is the resistance of the material to deformation caused by penetrating or starching the surface.



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