Lec1 **Dr. Sahar**

Dental materials

Introduction and physical properties of dental materials

Science of Dental Materials: It is the science which deals with the materials used in dentistry, their physical, mechanical & chemical properties and with their manipulation as such properties are related to proper selection and use by the dentist.

In the past the gold bands and wires were used for the construction of partial dentures. In the middle of the nineteenth century, research studies on amal- gam were done by G.V. black .After that the **American dental association** determined the physical and chemical properties of dental materials and the development of new dental materials instruments and test methods.

The primary objective of it is to formulate standards or specification for dental materials and to certify the products which meet those requirements. The study of dental material enables the dentist to understand the behavior of these materials and how to use them to their best advantage. The service that a restoration or appliance gives to the patient is largely determined by the proper selection and use by the dentist. The objective for this course is to learn the physical, chemical and mechanical properties of some of dental materials and their manipulation.

Biological requirements of dental material: A dental material should be:

1.Biocompatible

2.Non-toxic to the body.

3.Non-irritating to oral cavity and tooth tissues.

4.Non-allergenic, non-mutagenic or carcinogenic.

Biocompatibility is formally defined as the ability of a material to provide an appropriate biological response in a given application in the body. So that a single material may not be biologically acceptable in all applications. For example, a material that is acceptable as a full cast crown may not be acceptable as a dental implant.

General properties of dental materials: there two main types of properties

1- physical 2-mechanical.

*There is no material till now which has ideal physical & mechanical properties. Most materials have some good & bad properties.

Physical Properties

1. Dimensional stability:

Is the ability (of a material) to maintain accuracy over time, dental material should not change its dimensions during and after setting. Yet, amalgam restoration which is filling for posterior teeth; it may expand or contract depending on the manipulation, or sometimes change shape permanently as a result of heavy biting force. This bad property can lead to micro leakage and secondary caries. 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.

Dimensional change occurs due to:

A- Water absorption: Dental material should not have high water absorption and if water absorbed too great, it will lead to unhygienic condition. On the other, some materials like acrylic will absorb water for a day and stops after that, so it is acceptable.

B- Solubility: Dental material should not be soluble in water and in oral fluids.

2. Linear Coefficient of Thermal Expansion & Contraction:

Is the amount of deformational change due to thermal loading (the change in length per unit length for 1C temperature change). As the temperature rises, a solid material will expand & on cooling it will contract, this is measured by the linear coefficient of thermal expansion and contraction.

α: coefficient of thermal expansion or contraction

$$\alpha = \frac{\text{final length} - \text{original length (cm)}}{\text{Original length} * \text{temp. change (cm. c)}}$$

Clinical importance in Dentistry:

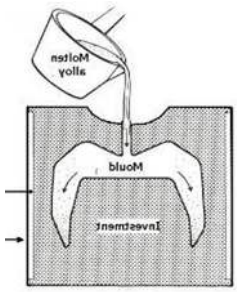
1-Dental restorative materials: Filling materials should have the same coefficient as the tooth, if it dose not, it will press too hard against the cavity wall on expansion & may cause pressure on the pulp and resulting in pain. In contrast, when it is cooled it will contract away from wall of the tooth and cause leakage, which may in turn, lead to further caries.

Shrinkage and contraction of the filling material will cause breakage of marginal seal between the filling and the cavity wall and leads to:

1. Hypersensitivity. 2. Marginal leakage.

3. Discoloration. 4. Recurrent caries.

2. Gold alloy is used to cast crown or bridge .After cooling of the gold from the melting temperature, it will contract and so the crown will be smaller. To compensate for this contraction, we use certain type of investment, which expand in the same amount.



3. Porcelain and metal in ceramic-metal restorations (crowns and bridges) should have the same coefficient of thermal expansion to provide metal

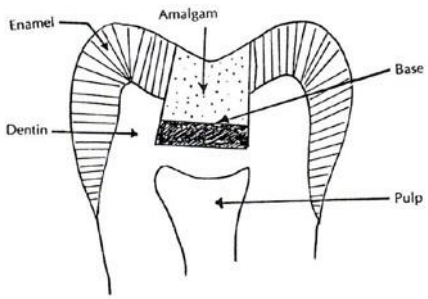


3. Thermal Conductivity:

It is the amount of heat in calories or joules passing per second through a body 1cm thick, 1cm2 cross sectional area when the temperature difference is 1°C.

Clinical importance in Dentistry:

1- Metallic filling materials (Amalgam). Generally, metals are better heat conductors than tooth structure. Amalgam filling sometimes cause pulp pain by transmitting heat or cold more than natural tooth especially in deep cavities thus they require heat insulting layer between the filling & the pulp.



2- Metallic denture base materials. The thermal conductivity of metallic denture base material is an advantage as it gives feeling closer to the normal condition& the patient will feel normal also it will protect him from drinking very hot drinks

which may burn his mouth.



4. Electrical Activity:

Galvanism in dentistry: Phenomenon of electric cell and flow of electrons in oral cavity which is perceived by patient as pain or discomfort and metallic taste. Requires presence of two metals of different electric potential and an electrolyte (saliva).

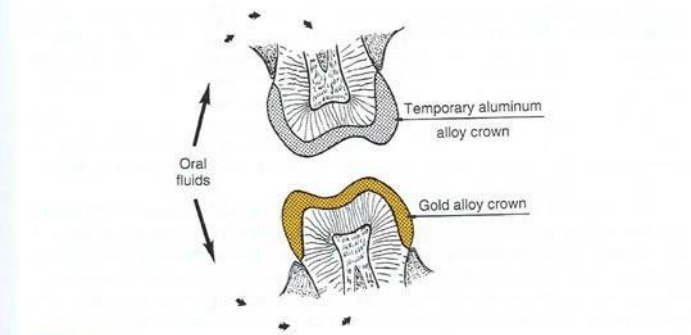


FIGURE 2–1 Diagrammatic sketch of opposing teeth with a gold crown and a temporary aluminum alloy crown indicating how galvanism can occur.

5. Optical Properties

Dental materials have to look like natural teeth and gum and should not stain or change color by time.

Translucency: Is a property of the material that allows the passage of light short away inside the material before being reflected back again.

The dental restorative materials should be translucent in order to look like a natural teeth, and also should not be stained or changed the color by time; ex anterior filling and artificial teeth.

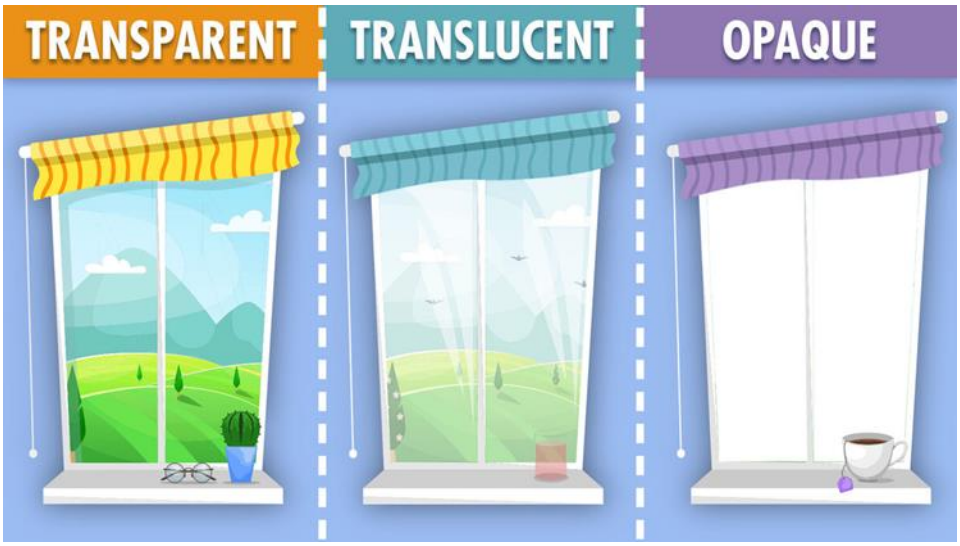
Transparency: Is a property of the material that allows the passage of light in such a manner that little distortion takes place so that objects can be clearly seen through them.

Opacity: Is a property of the material that prevents the passage of light. Opaque material absorbs all of the light. Objects cannot be seen through them.

Complete transmission -Transparent

Incomplete transmission- Translucent

No transmission (absorption)- Opaque



COLOR

It is the visible aspect of an object other than form and size.

A- Hue: It is the dominant wave length. It represents the color of the material, i.e yellow, green, red and blue.

B- Chroma: It represents the strength of the color or degree of saturation of the color (color intensity).

A beaker of water containing one drop of colorant is lower in chroma than a beaker of water containing ten drops of the same colorant.

C- Value.

Refers to the lightness or darkness of a color.

6. Density:

Is the mass per unit volume. Lightness is nearly always an advantage in restorative materials, but sometimes TIN or LEAD is used inside complete lower denture to make it heavy to control its mobility.



Complete Denture

7. Electrochemical properties:

The use of wide variety of metals for restorations and prosthtic devices the successful clinical performance and long term durability which require adequate corrosion resistance in the oral environment .

Corrosion: is the electrochemical process and is dependent on the ability to conduct electrical current either by means of free electrons in metals or via ions in solutions.

Tarnish: is a surface discoloration on a metal or a slight loss or alteration of the surface finish or luster.

8. Adhesion and cohesion:

Adhesion is the force which 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.

