

الجامعة السورية الخاصة SPU

كلية طب الأسنان - قسم التعويضات

مقرر مواد سنية 1

Dental Material-1

المحاضرة الثانية

Properties of Dental Materials

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الفصل الأول



الجامعة السورية الخاصة
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Properties of Dental Materials

To select and use a dental material one must understand its properties. Knowledge of the properties of the material predicts its behavior, functioning in the mouth and longevity.

Accordingly one can optimize design and techniques in order to get the best out of a particular material.

*Various properties important
to dental materials are*

Physical properties

Mechanical properties

Thermal properties

Electrical properties

Optical properties

Chemical properties

Physical properties

Physical properties can be observed or measured without changing the composition of matter. Physical properties are used to observe and describe matter. Physical properties of importance in dentistry include appearance, texture, color,, odor, glass transition, temperature, melting point, boiling point, density, solubility, polarity, etc.

الكثافة – Density – 1

It is the mass per unit volume of the material.

Units are gm/cm³ or pound/in²

density is defined as mass divided by volume–

$$\rho = m/v$$

where **ρ** is the density, **m** is the mass, and **v** is the volume

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 Chromium /cobalt = 8.3gm/cm

Water = 1gm/cm

Clinical importance in Dentistry:

- 1- Retention of the upper denture.
- 2- Weight of complete or partial denture.
- 3- During casting.



Complete Denture

الكثافة-Density

الكثافة؛ ويقال لها الكتلة الحجمية ، هي صفة فيزيائية للأجسام تعبر عن علاقة وحدة الحجم بوحدة الكتلة لمادةٍ أو جسمٍ ما، فكلما ازدادت الكثافة ازدادت الكتلة لوحدة الأحجام، وعلى هذا فهي كتلة وحدة الحجم من المادة.

تساوي الكثافة لجسم كتلته الكلية مقسومة على حجمه الكلي. وحدتها الغرام في السنتيمتر المكعب جم/سم³

(بالإنجليزية: g/cm^3)

(أو وحدة الكيلو غرام في المتر المكعب كجم/م³)

الانحلالية -2- Solubility

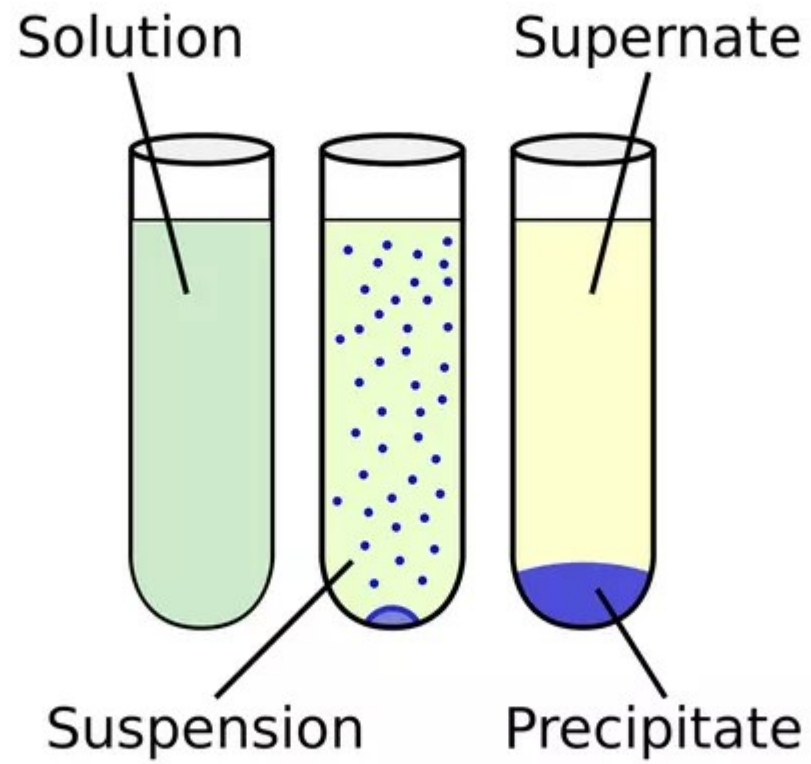
Restorative materials **should not dissolve in the mouth** , and if it is

Solubility of silicate = 0.7 -1.6%

Solubility of composite = 0.01 %



Susceptible to being dissolved



3-Viscosity

The ability of a material to flow.

Thick liquids flow poorly, thin liquids flow easily.

Viscosity is measured in grams/meter.
Second.

اللزوجة هي مقاومة المواد اللينة للانسياب للقوى التي تعمل على تحريكها وذلك يعتمد على قوى الاحتكاك الداخلية بين جزيئات المادة اللينة.

VISCOSITY

Applications in dentistry



❖ Elastomeric impression materials:

These are supplied in two paste forms which on mixing have different viscosity, low, medium, high and very high consistencies.

❖ Gypsum products:

قوام الجبس

When mixed with water, pseudoplastic mix is obtained. Vibrations or shaking of the mix while pouring the cast, makes it thinner and flow better on the impression.

❖ Cement consistencies:

Can be adjusted with P/L ratios, for use as a base, restoration or cementation. The consistency increases with time as well as temperature of the mixing pad. More powder can be added to get higher strength, by cooling the mixing pad and glass slab, powder and liquids.

❖ Casting alloy liquids:

Can be made thinner by adding certain trace elements like iridium, which increases the flow or castability, so that incomplete castings can be avoided.

❖ Cold cure-pour and cure fluid resin:

This helps packing with greater pressure.



VISCOSITY



4-Abrasion Resistance

مقاومة السحل

Restorations must be hard enough to resist **abrasion**, but not so hard to **wear away the opposing teeth**.

Harder materials = more abrasion resistance

تعبّر عن مقاومة المادة للسحل الذي تتعرض له نتيجة تماسها واحتكاكها المستمر مع مادة أخرى-يجب ان تتمتع المادة المرممة بقساوة تكفي لمقاومة السحل ولكن لدرجة لا تسبب اذى أو سحل للأسنان المقابلة

5-DIMENSIONAL STABILITY

ثبات الأبعاد

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.

6-ABSORPTION OF FLOUIDS

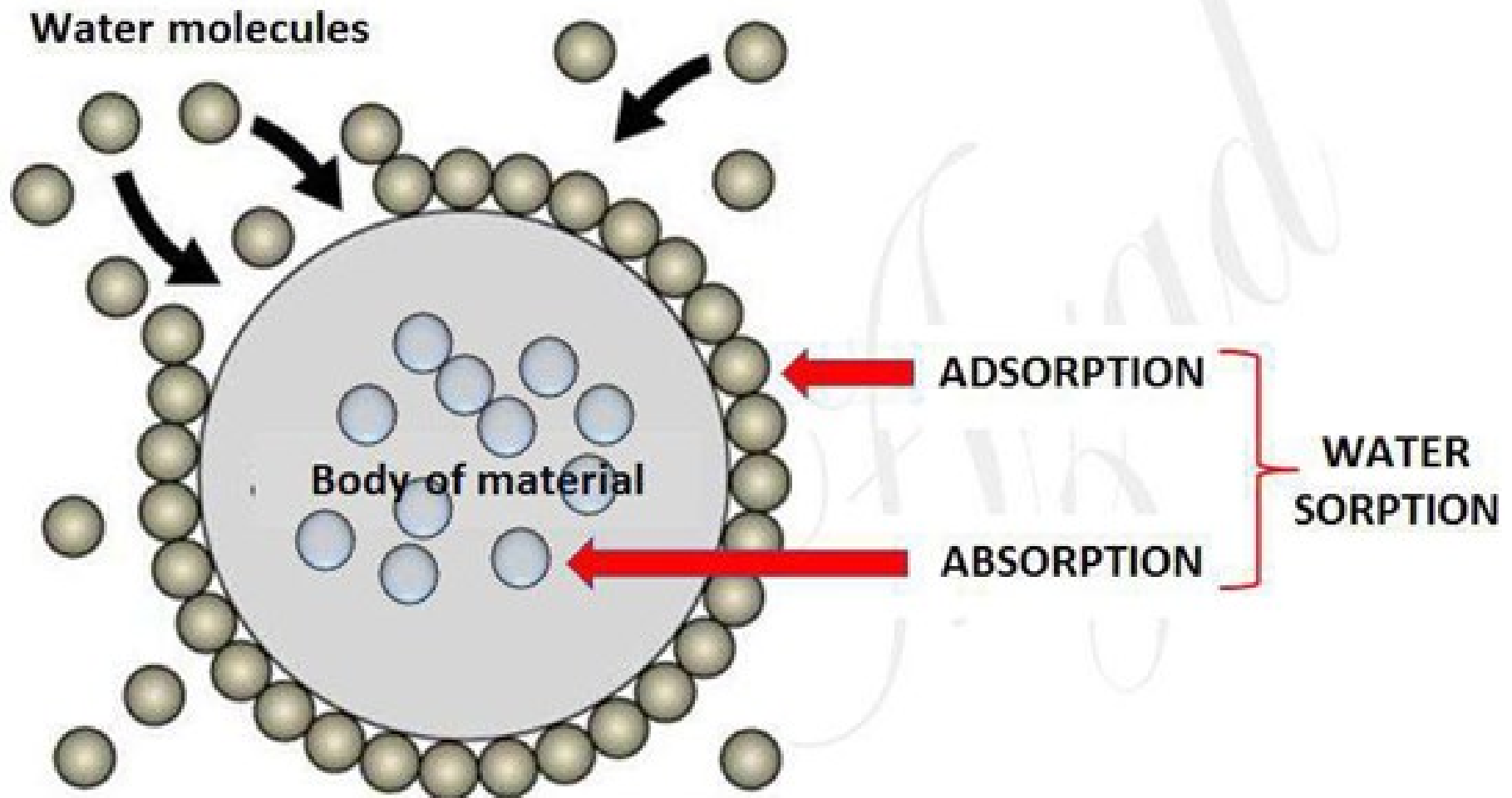
امتصاص السوائل

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 will also be un hygienic.

Importance:

- 1- **Acrylic resin** denture base materials have the tendency for water sorption.
- 2- **Hydrocolloid impression** materials will imbibe water if immersed in it leading to dimensional changes.

ABSORPTION OF FLOUIDS



7-Boiling & Melting Points

درجة (نقطة) الغليان والانصهار

Any material has its certain and specific boiling and melting points.

Mixtures have a boiling and melting range rather than a specific boiling and melting points.

Some materials do not boil or melt, but decompose if heated sufficiently, like wood.

THERMOPHYSICAL PROPERTIES

الخصائص الفيزيائية-الحرارية

THERMOPHYSICAL PROPERTIES

Thermo physical properties can be simply defined as material properties that vary with temperature without altering the material's chemical identity. □ However, it has become customary to limit the scope of the term to properties having a bearing on the transfer and storage of heat

□ These are:

- Thermal Conductivity
- Thermal Diffusivity
- Coefficient of thermal expansion

يمكن تعريف الخصائص الفيزيائية الحرارية ببساطة على أنها خواص المواد التي تختلف باختلاف درجة الحرارة دون تغيير الهوية الكيميائية للمادة.

□ ومع ذلك ، فقد أصبح من المعتاد قصر نطاق المصطلح على الخصائص التي لها تأثير على نقل وتخزين الحرارة، هذه هي:

□ التوصيل (الناقلية الحرارية) الحراري

□ الانتشار الحراري

□ معامل التمدد الحراري

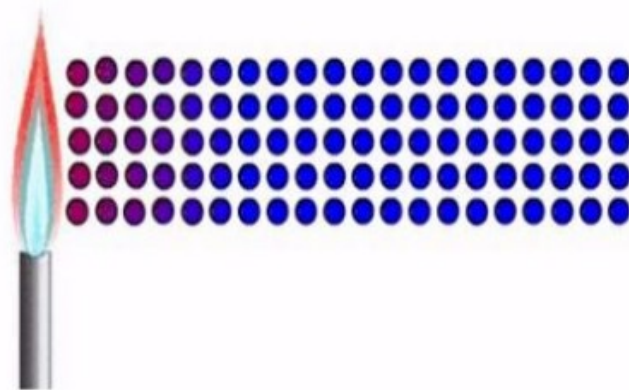
THERMOPHYSICAL PROPERTIES

1- 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

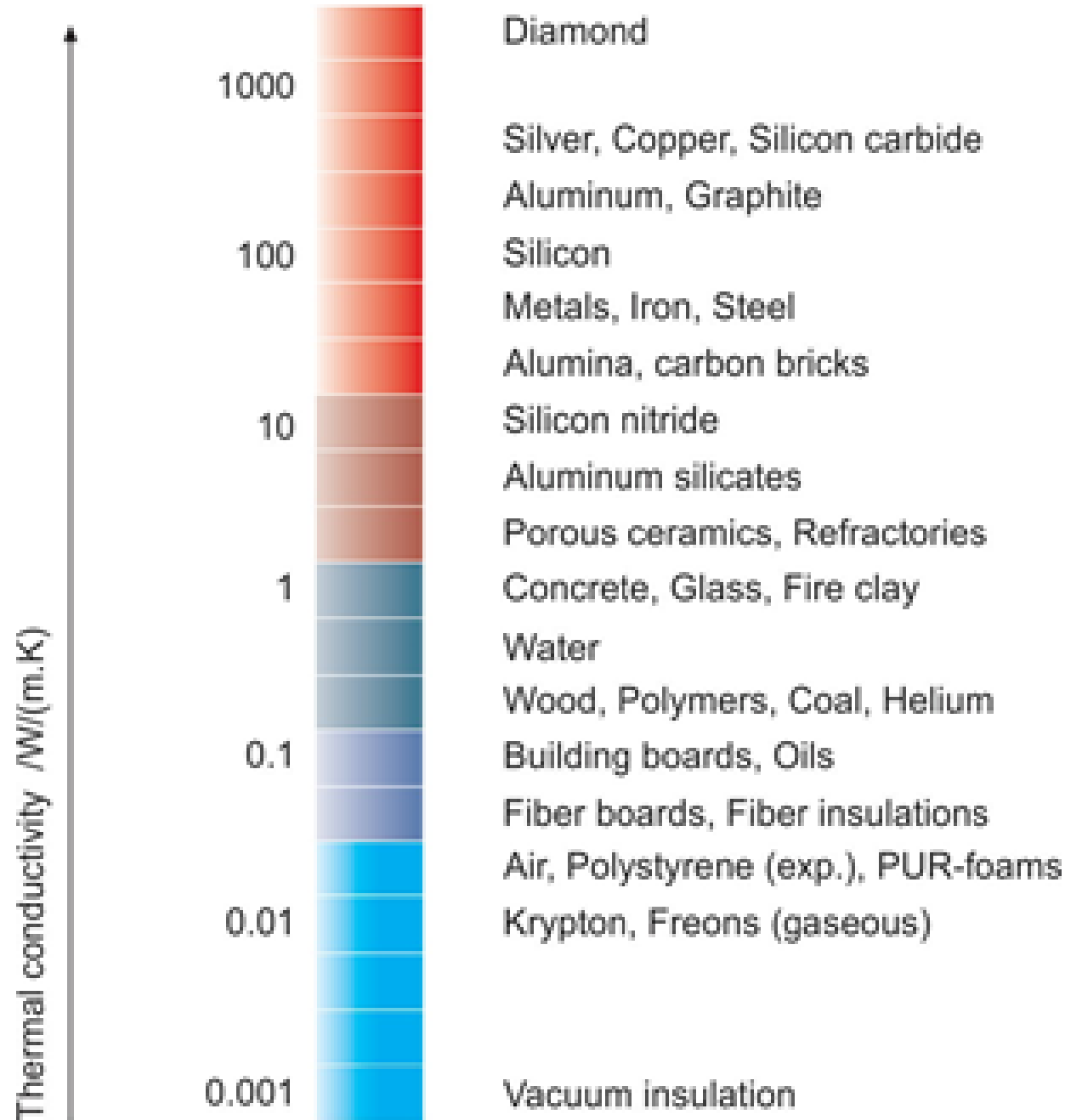
Thermal Conductivity

توصيل حراري هو مقدار الحرارة
بالساعات الحرارية أو الجول الذي
يمر في الثانية عبر جسم بسمك 1
سم ، ومساحة مقطعية 1 سم 2
عندما يكون فرق درجة الحرارة 1
درجة مئوية



قدرة المادة
على نقل
الحرارة

Generally metals are better heat conductors than non-metals. 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



Thermal conductivity of various materials

(Thermal conductivity at RT)

Thermal Conductivity

Materials have different rates of conducting heat

Metals have higher value than plastics or ceramics Therefore, metals would cause patient to feel more sensibility

Enamel and dentin are poor thermal conductors

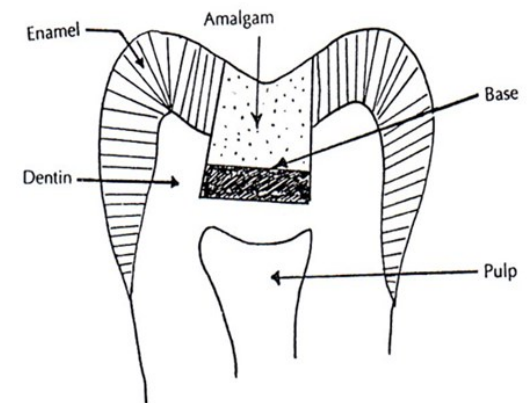
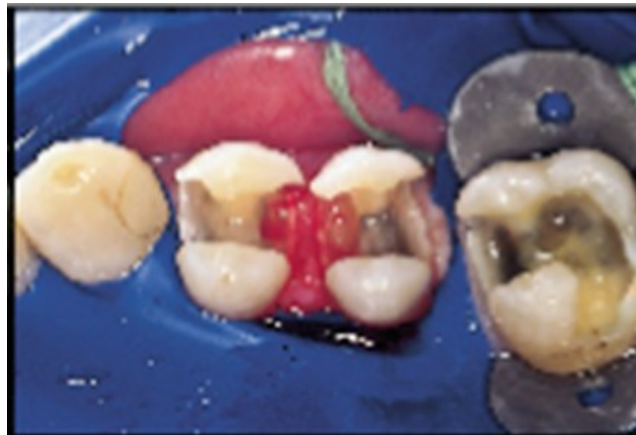
In deep restorations, a **cement base will be used as an insulator**

Gold causes the most sensitivity

Thermal Conductivity

Clinical importance in Dentistry

1- Metallic filling material



Thermal Conductivity

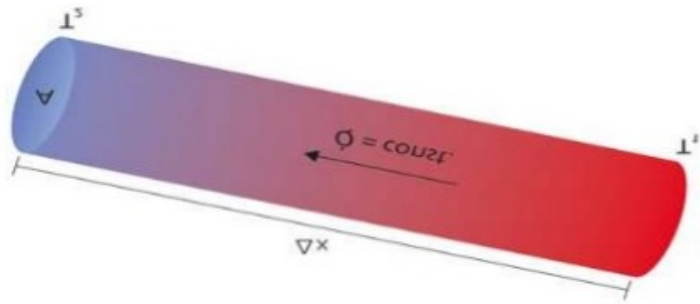
2-Metallic denture base materials



THERMOPHYSICAL PROPERTIES

2-Thermal Diffusivity

It is a measure of the rate at which a body with a non uniform temperature reaches a state of thermal equilibrium □ The thermal conductivity of zinc oxide-Eugenol is slightly less than that of dentin, its thermal diffusivity is more than twice that of dentin



الانتشارية الحرارية : معدل انتشار الحرارة واختزانها داخل الجسم

إنه مقياس للمعدل الذي يصل فيه الجسم بدون درجة حرارة موحدة إلى حالة من التوازن الحراري

Material Thermal Diffusivity (in $10^{-4} \text{ cm}^2 / \text{sec}$)
Pure Gold 11,800 Amalgam 960 Composite 19 to 73 Water 14 Glass Ionomer 22 Dentin 18 to 26 Enamel 47 Zinc Phosphate 30 □ The low thermal conductivity of enamel and dentin aids in reducing thermal shock and pulpal pain when hot or cold foods are taken into the mouth.

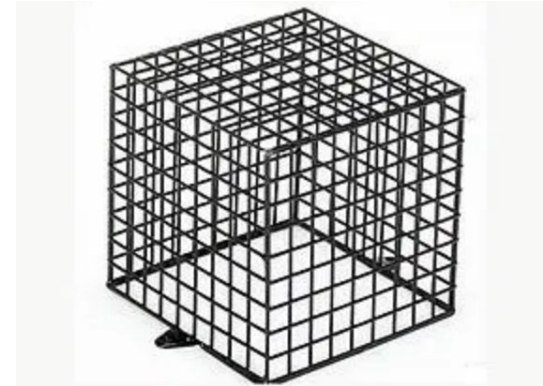
Material	Thermal Diffusivity (in $10^{-4} \text{ cm}^2 / \text{sec}$)
Pure Gold	11,800
Amalgam	960
Composite	19 to 73
Water	14
Glass Ionomer	22
Dentin	18 to 26
Enamel	47
Zinc Phosphate	30

To differentiate between thermal conductivity and thermal diffusivity, consider two materials having same thermal conductivity but with different thermal diffusivity. In the steady state condition both will permit same rate of heat flow. But at the starting of heat transfer process, the material having higher thermal diffusivity will reach steady state first compared to other material, since it retains less heat energy. Heat energy penetrates fast through this material, but after reaching steady state the rate of heat flow will be same. Also remember the fact that, the material having less thermal diffusivity takes more time to reach the steady state.

I will explain this with the help of an analogy.
Consider a sponge material as shown below. If you pour water on top of this, it will absorb lot of it initially and then allow water to flow down. Later, when it can't absorb any more water, all the water you pour is coming down at the same rate as you pour

للتمييز بين التوصيل الحراري والانتشار الحراري ، فكر في مادتين لهما نفس الموصلية الحرارية ولكن مع انتشار حراري مختلف. في حالة الحالة الثابتة كلاهما سوف يسمح بنفس معدل تدفق الحرارة. ولكن في بداية عملية نقل الحرارة ، ستصل المواد ذات الانتشار الحراري الأعلى إلى الحالة المستقرة أولاً مقارنة بالمواد الأخرى ، لأنها تحتفظ بطاقة حرارة أقل. تخرق الطاقة الحرارية هذه المادة بسرعة ، ولكن بعد الوصول إلى الحالة المستقرة سيكون معدل تدفق الحرارة كما هو. إن المادة ذات الانتشار الحراري الأقل تستغرق وقتاً أطول للوصول إلى الحالة المستقرة.

إذا قمت بصب الماء فوق هذا ، فسوف يمتص الكثير منه في البداية ثم يسمح بتدفق المياه. في وقت لاحق ، عندما لا تستطيع امتصاص أي كمية إضافية من المياه ، فإن كل الماء الذي تسكبه ينخفض بنفس معدل صب الماء



THERMOPHYSICAL PROPERTIES

3- Coefficient of Thermal expansion(CTE)

The change in length per unit length of the material for a 1°C change in temperature is called the linear coefficient of thermal expansion(α)

$$\alpha = \frac{L_{\text{final}} - L_{\text{original}}}{L_{\text{original}} \times (\text{°C final} - \text{°C original})}$$

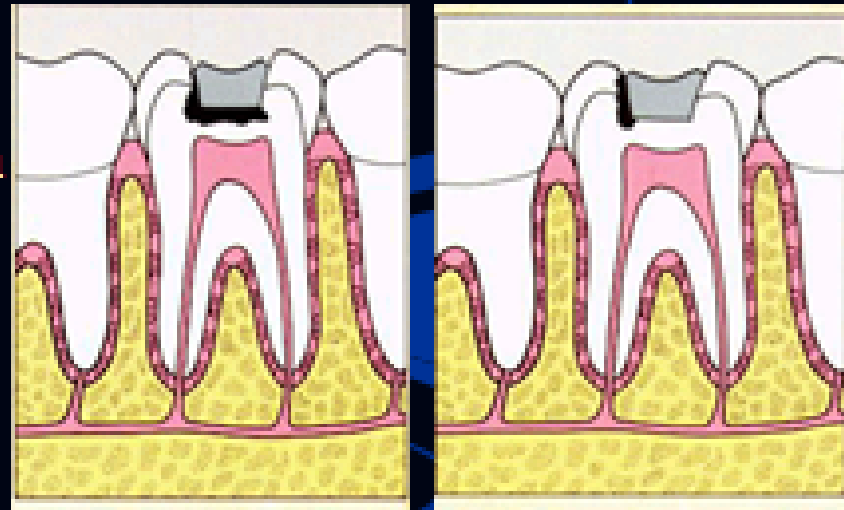
عامل التمدد الحروري : **CTE**
هو معدل الزيادة الجزئية في طول المادة عند ارتفاع درجة حرارتها
درجة مئوية واحدة.

Clinical importance in Dentistry:

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

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

Opening and closing of gap results in
→ breakage of marginal seal between
the filling and the cavity wall,
this breakage of seal
(marginal percolation) leads to:



- i. Marginal leakage
- iii. Recurrent caries

- ii. Discoloration
- iv. Hypersensitivity.

Significance of CTE

1-The mismatch of thermal expansion and contraction between **restorative materials and tooth** may cause stresses at their interface, which may lead to microleakage.

2-**Metal ceramics restorations** require a close match between the CTE of the alloy and porcelain in order to reduce stresses in the porcelain. These stresses can cause immediate or delayed cracking in the ceramic.

3-**An inlay wax** pattern created in the mouth may contract when transferred to the colder room.

4-**Denture teeth set in wax** may shift slightly when room temperature changes.

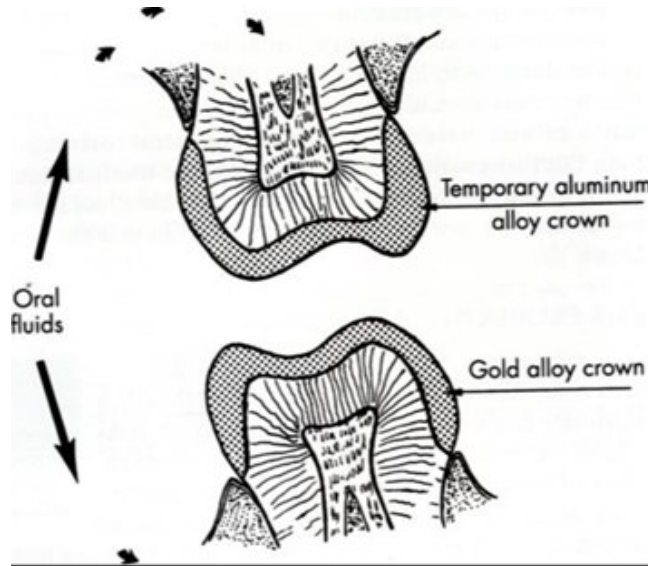
التعريف: هي التيارات الكهربائية المتولدة والتي يشعر المريض بها.

Electrical properties

تحدث هذه الظاهرة عند وجود مواد غير متشابهة في الفم.
الألومنيوم، الخلائط و الذهب على سبيل المثال.

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 feel discomfort



ELECTRICAL ACTIVITY

Galvanism - الظاهرة الغلفانية .

Generation of electrical currents in mouth Results from presence of dissimilar metals in mouth

Causes pain and tastes metallic

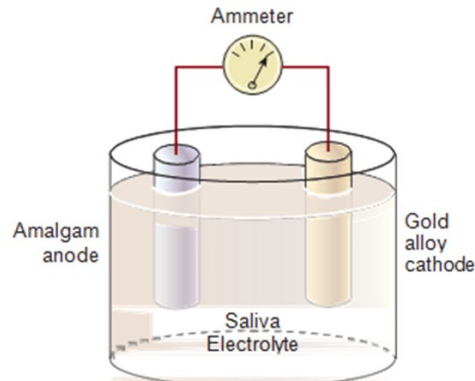
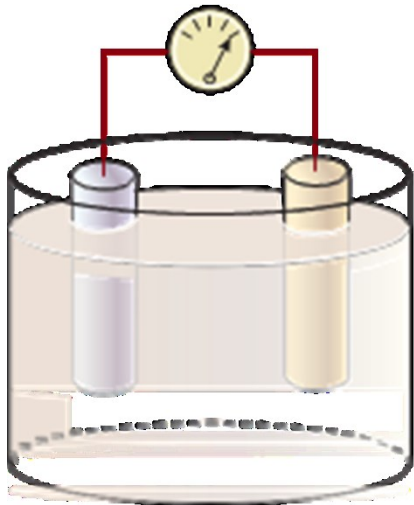


FIGURE 3-9 Diagram of an electrochemical cell consisting of a simulated amalgam anode, a gold alloy cathode, and saliva as the electrolyte.

عبارة عن تيارات كهربائية
تتجم عن وجود انواع
مختلفة من المعادن في الفم
حيث يشعر المريض بحس
حرقة مع الألم

ELECTRICAL ACTIVITY

التآكل - Corrosion

Dissolution of materials in mouth Results
from presence of dissimilar metals
Roughness and pitting

التآكل الكيميائي : انحلال المعادن في الفم ناجم عن الظاهرة
الغلفانية بسبب وجود معادن مختلفة بحيث يبدو على سطحها
مظهر الخشونة والحتفر

Tarnish زوال البريق (التلطيخ)

**Surface reaction of metals to
components in saliva or foods**

ELECTRICAL ACTIVITY

Tarnish is a surface □
discoloration of the
metal or even a slight
loss of the luster. •
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



ELECTRICAL ACTIVITY

- Electrical Conductivity**
- The ability of a material to conduct the electrical current.**
- It is important to consider during electro surgery or electrical pulp testing**

Creep - الزحف

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 time

تشاهد ظاهرة
Creep على
حشوات الاملغم



ظاهرة تعبر عن تبدلات لدنة بطيئة تطرأ على المادة نتيجة تعرضها الى قوى ثابتة ومتكررة بمرور الزمن.

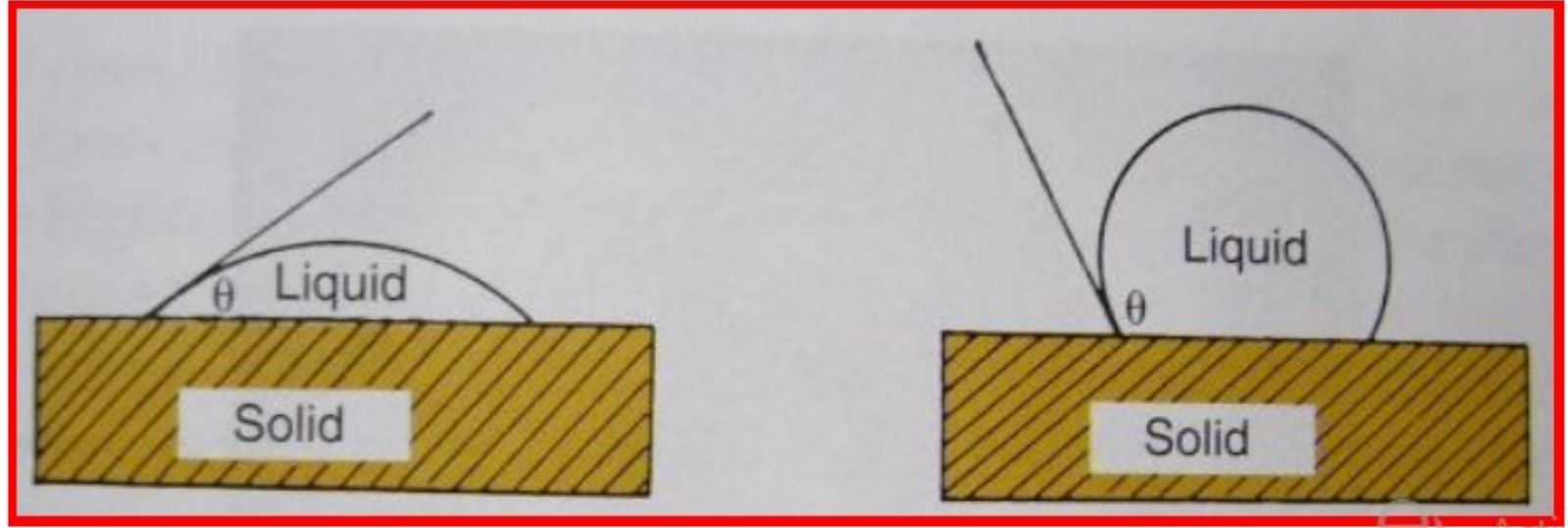
Creep and Flow الزحف-السيلان

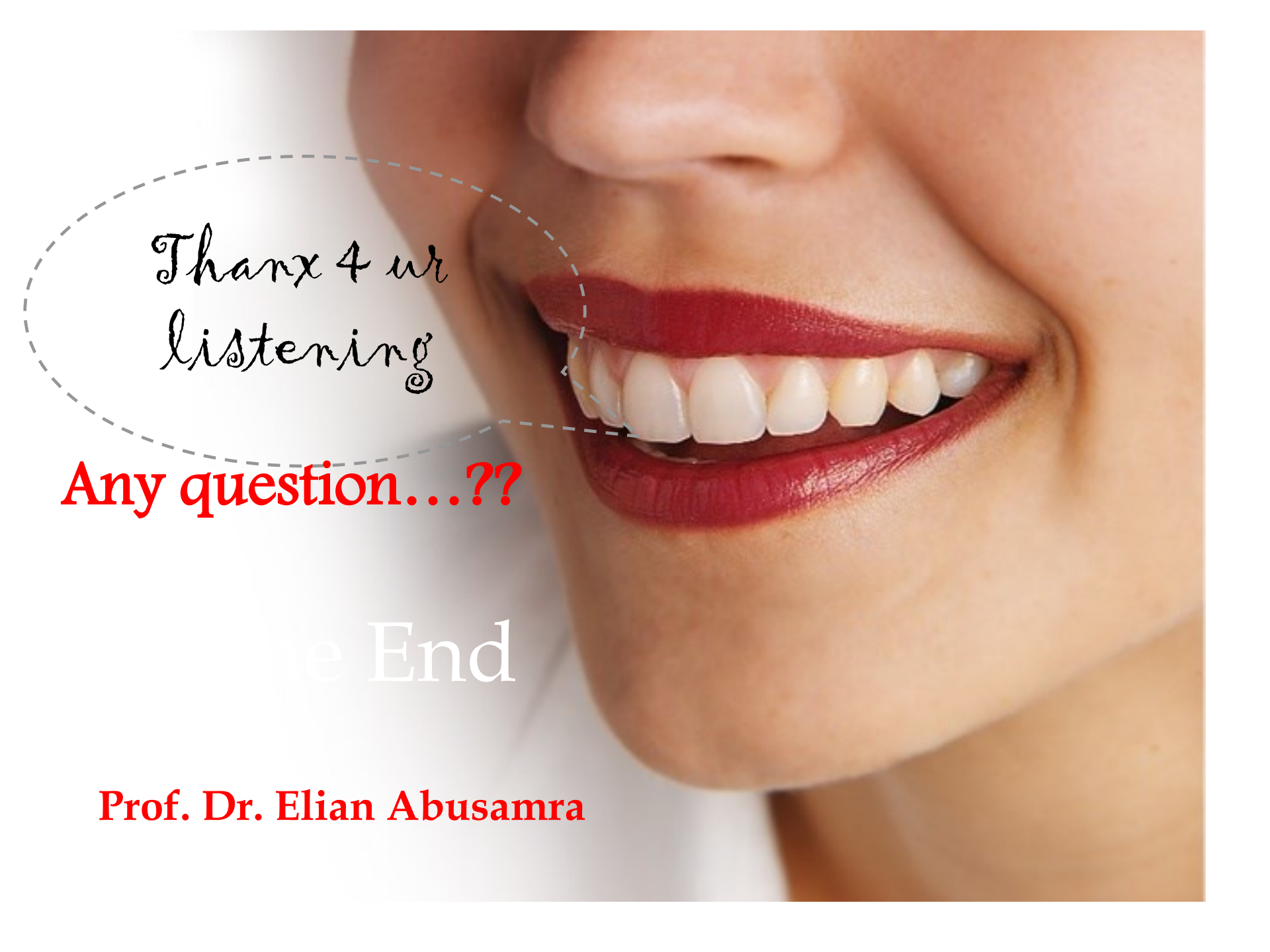


- ▣ **Flow** implies a
- ▣ greater deformation produced more rapidly with a smaller applied stress.
- ▣ The term flow is generally been used in dentistry to describe the rheology of amorphous materials such as waxes.

قابلية التبلل (الترطيب) Wettability

□ هي قدرة مادة معينة على الانسياب على سطح مادة أخرى وتتعلق بزاوية التماس بين المادتين كما تتأثر بنعومة سطح المادة ونظافتها.





*Thanx 4 ur
listening*

Any question...??

The End

Prof. Dr. Elian Abusamra