Chemistry and Physics of Dental Materials

Oral Environment hazards to Dental Materials

- pH changes
- Temperature changes
- Moisture
- Force
- Corrosion

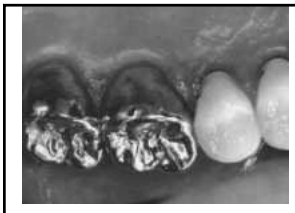


pH CHANGES

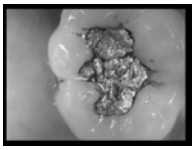
- pH falls from 7.1 to 4.5 in 7 minutes when eating (acidic foods, bacteria)
- pH change promotes tarnish of “base metals” (tin) but not “noble metals” (gold, silver)
- Dental materials must be acid resistant



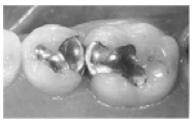
Tarnish is an insoluble surface corrosion



Gold crown, a noble metal
Also called a “precious” crown,
They don’t corrode



Dental amalgam contains
Nonprecious metals that can
corrode and tarnish

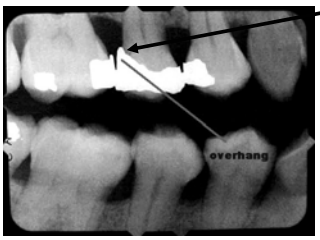


Amalgams can be polished
to remove tarnish and corrosion

MOISTURE (saliva)

- Saliva acts as a conductor for electrons thus causing a shock (galvanic shock)
- Saliva carries potentially harmful materials into minute spaces (microleakage)
- H2O in saliva acts as universal solvent

microleakage

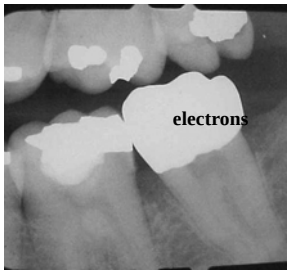


Interface – where restoration meets tooth

Microleakage - moisture penetrates interface carrying harmful products (acid, bacteria)

Bonding – microleakeage reduced when restorations bonded

Galvanic Shock

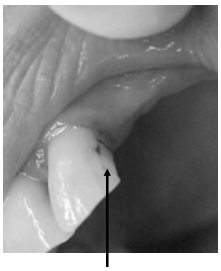


Movement of Electrons when two dissimilar metals come in contact, the pH is low and moisture is present

OTHER EXAMPLES?

TEMPERATURE CHANGES

- Materials and teeth expand and contract with temperature change
- Coefficient of thermal expansion (COTE) measures change
- COTE for tooth and material must be similar to prevent microleakage at the interface



Interface

BITING FORCES

Biting forces equal 20,000 pounds per square inch, which is the same as this



DEFINITIONS

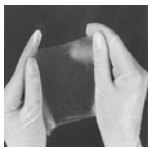


FORCE –
Push or pull
on an object (Ms. Maida)

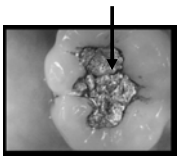
STRESS –
Resistance by the object
(Ms. Maida) against
the force

STRAIN- change in
molecular arrangement
within the object (Ms. Maida)

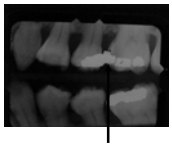
Types of Stresses



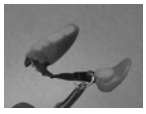
Tensile



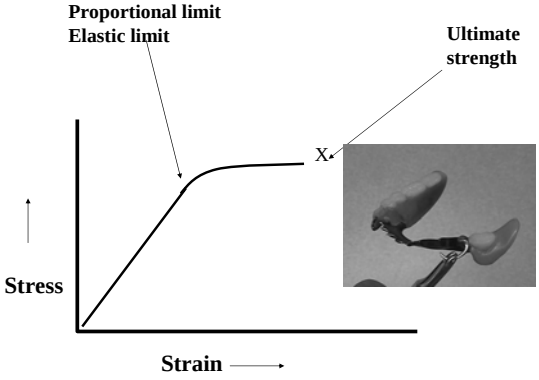
Compressive



Shear

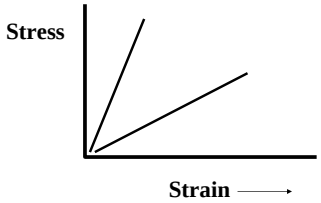


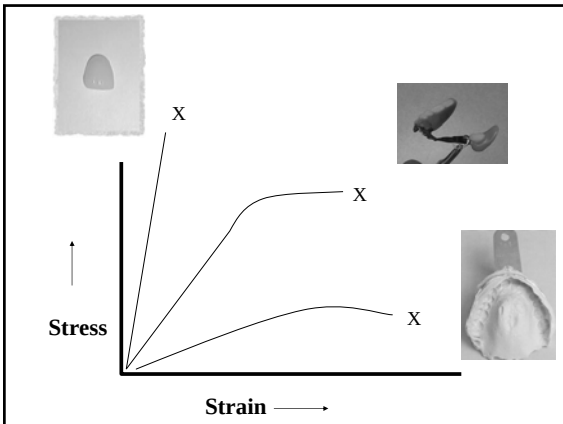
Bending



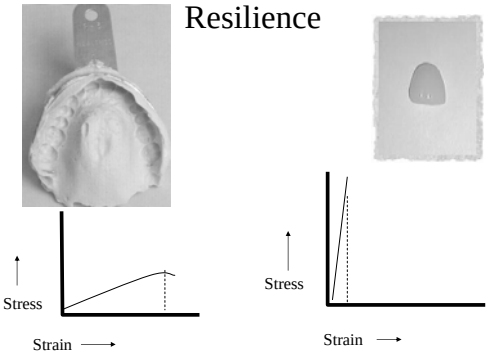
Modulus of Elasticity (= stress/strain)

- How much a material can deform and return to its original shape. The lower modulus, the more elastic



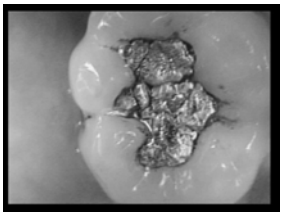


Resilience



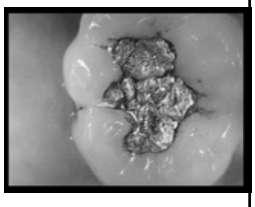
Creep

- Under compression, a crystalline substance will expand
- Amalgam is crystalline, so it "creeps" out the preparation
- The flashing created can break off, leaving a "ditched" margin



CORROSION

- Electrochemical deterioration of a metal
- Appears as pits on surface
- May require polishing or replacement
- Tarnish is a thin corrosion layer evenly distributed on the surface, polishing will usually remove it



Hardness

- Hardness is critical, too hard, teeth can be broken, too soft, it is ineffective
- Tests used in dentistry to measure hardness include Brinnell, Knoop, Vickers
- Mohs is used to measure scratch resistance



Hardness

- Predict – Which has a higher Knoop Hardness Number, tooth enamel or the abrasive in prophy paste?

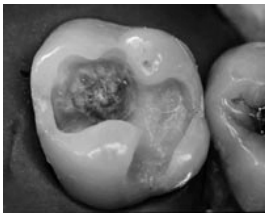


Adhesion (bonding)

- Most dental adhesives work on the micromechanical level involving an “acid etched” surface
- Bonding advantages – better retention, less microleakage at the interface, reduced recurrent caries
- Any restoration can now be bonded to either enamel or dentin or both

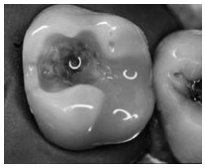
Adhesion Process

- Etch
- Prime
- Apply adhesive
- Apply restoration



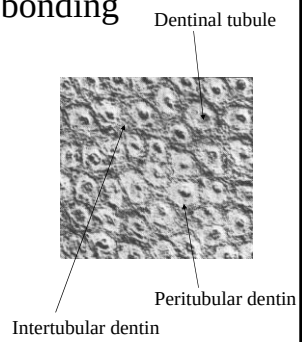
“Etchant” or “Tooth Conditioner”

- Usually 37% Phosphoric acid
- Etchant creates “micropores” in enamel that make tooth structure appear “chalky white”
- Etchant removes smear layer from dentin, opens dentinal tubules



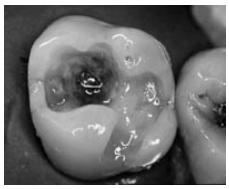
Dentin bonding

- “smear layer” is ground up dentin that coats surface



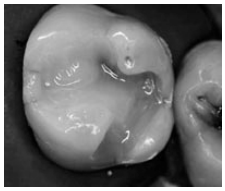
Primer

- Primer is a low viscosity, “hydrophilic” resin (plastic)
- It flows into micropores on enamel surface, or
- It flows into dentinal tubules, combines with collagen on surface of dentin



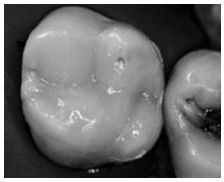
Apply Adhesive

- Adhesive is made of same material as primer but not a thin (more viscous)
- It combines with the primer and "polymerizes"



Apply composite

- Composite filling material is applied and bonds with adhesive
- The primer, adhesive and filling material polymerize together



Solubility

- The amount a material dissolves in a liquid
- Dental cements that dissolve cause crown failure
- Check margins for defects



Color



Before whitening



After whitening

