STRUCTURE OF MATTER AND PRINCIPLES OF ADHESION

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CHANGE OF STATE

- Matter exists in three forms- solid, liquid and gaseous…
- The difference is mainly because of the difference in their energy states.

INTERATOMIC PRIMARY BONDS

- Atoms are held together by some force. These interatomic bonding forces that hold the atoms together are called cohesive forces.
- The strength of these bonds and their ability to reform after breakage determine the physical properties of a material.

CLASSIFICATION

- PRIMARY BONDS

1. Ionic bonds
2. Covalent
3. metallic

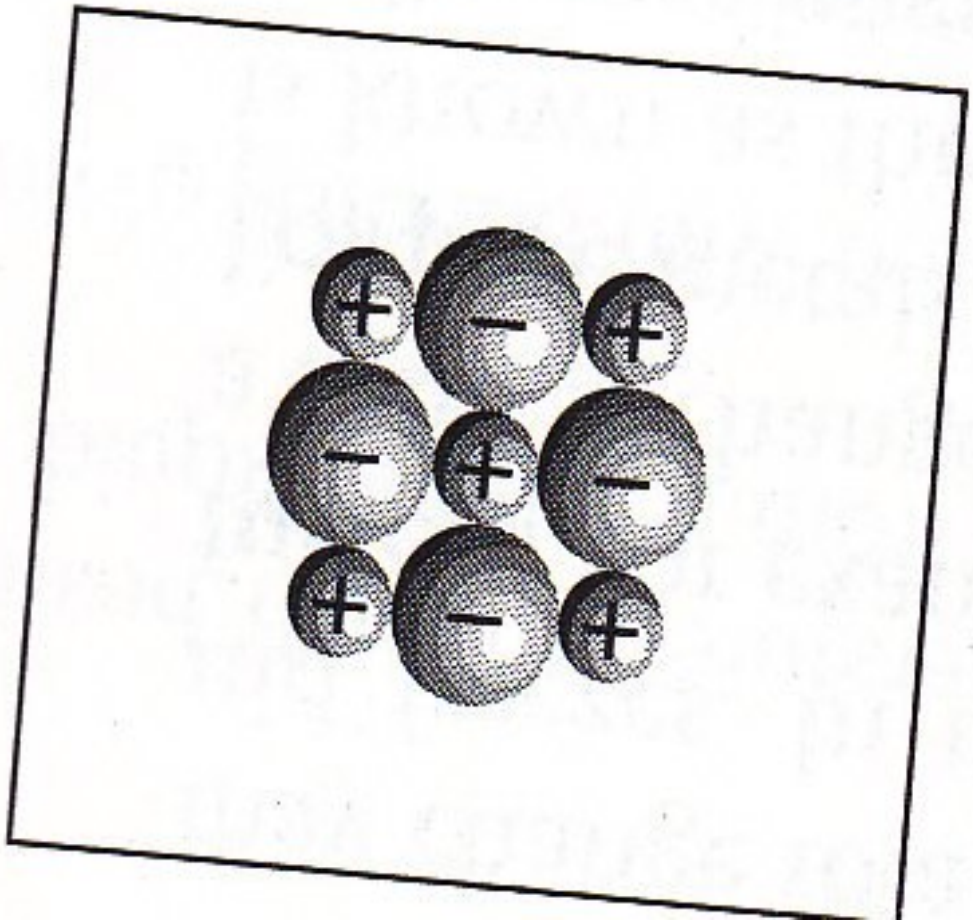
- SECONDARY BONDS

1. Hydrogen bonds
2. Vanderwaals forces

PRIMARY BONDS

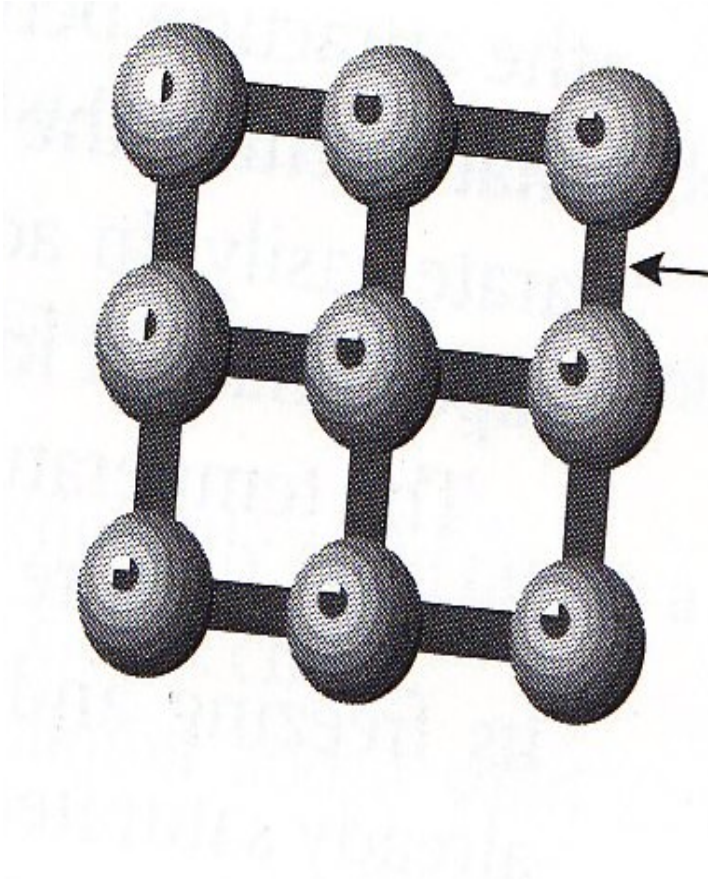
- **Ionic bonds**

- Mutual attraction of positive and negative charges
- Ionic bonds result in crystals.
- Best eg-Na+ Cl-
- In dentistry they are seen in gypsum and some phosphate based cements.



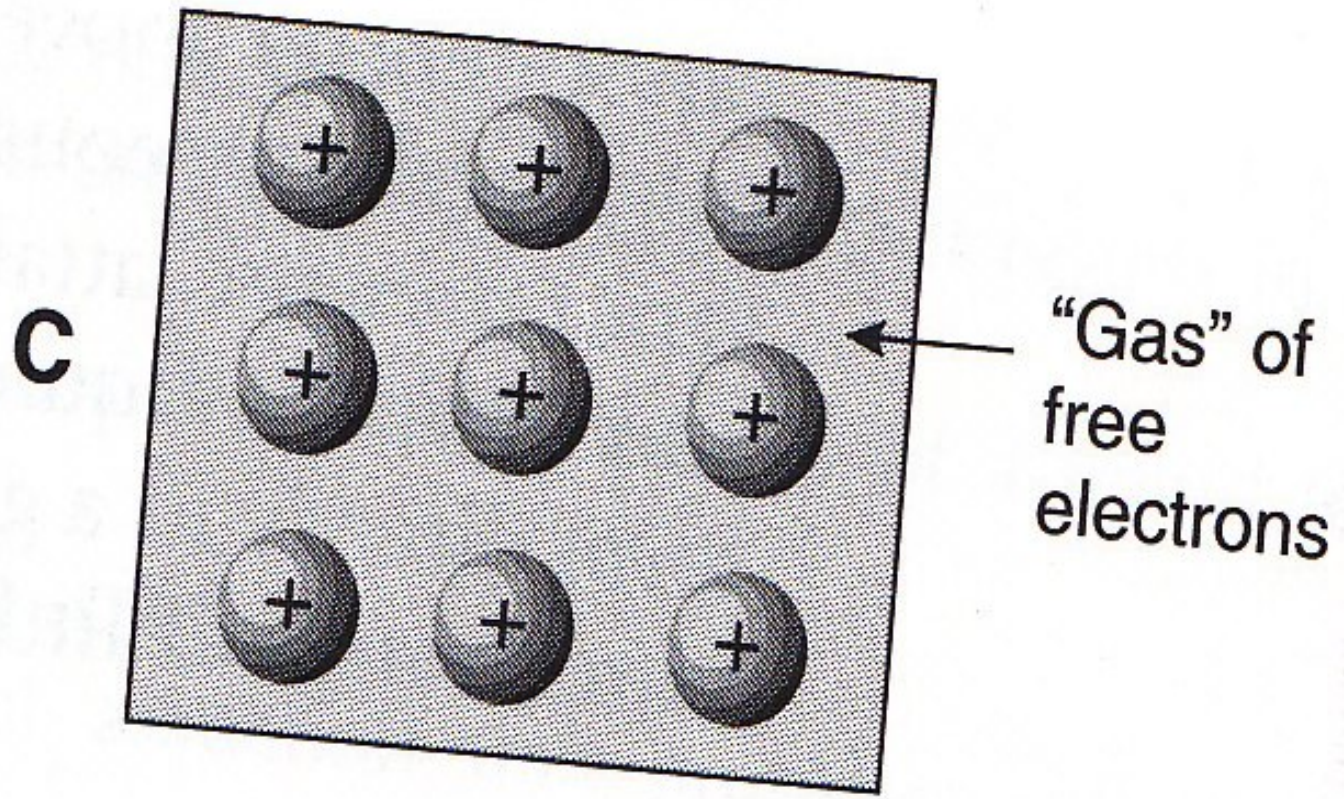
Covalent bonds

- Here, two valence electrons are shared by adjacent atoms.
- Eg- CH_4 molecule-the valence electron of h2 combines with carbon to make the valence shells stable.
- In dentistry they are seen in organic compounds like dental resins..
- Most imp characteristic of covalent bonds is its bidirectional orientation.



- **Metallic bonds**

- The most imp characteristic of a metal is to conduct heat and electricity.
- This property is due to the presence of free electrons present in the metal.
- The metals can donate electrons from their outer shell and these electrons form a “cloud" of free electrons.
- As the electrons are lost, positive ions are formed which can be neutralized by acquiring new valence electrons from the adjacent atoms.
- The electrostatic attraction between this cloud of electrons and the positive ions in the lattice provides a force that bonds the metal atoms together as a solid.
- Such bonds are known as metallic bonds.


C
"Gas" of free electrons

SECONDARY BONDS

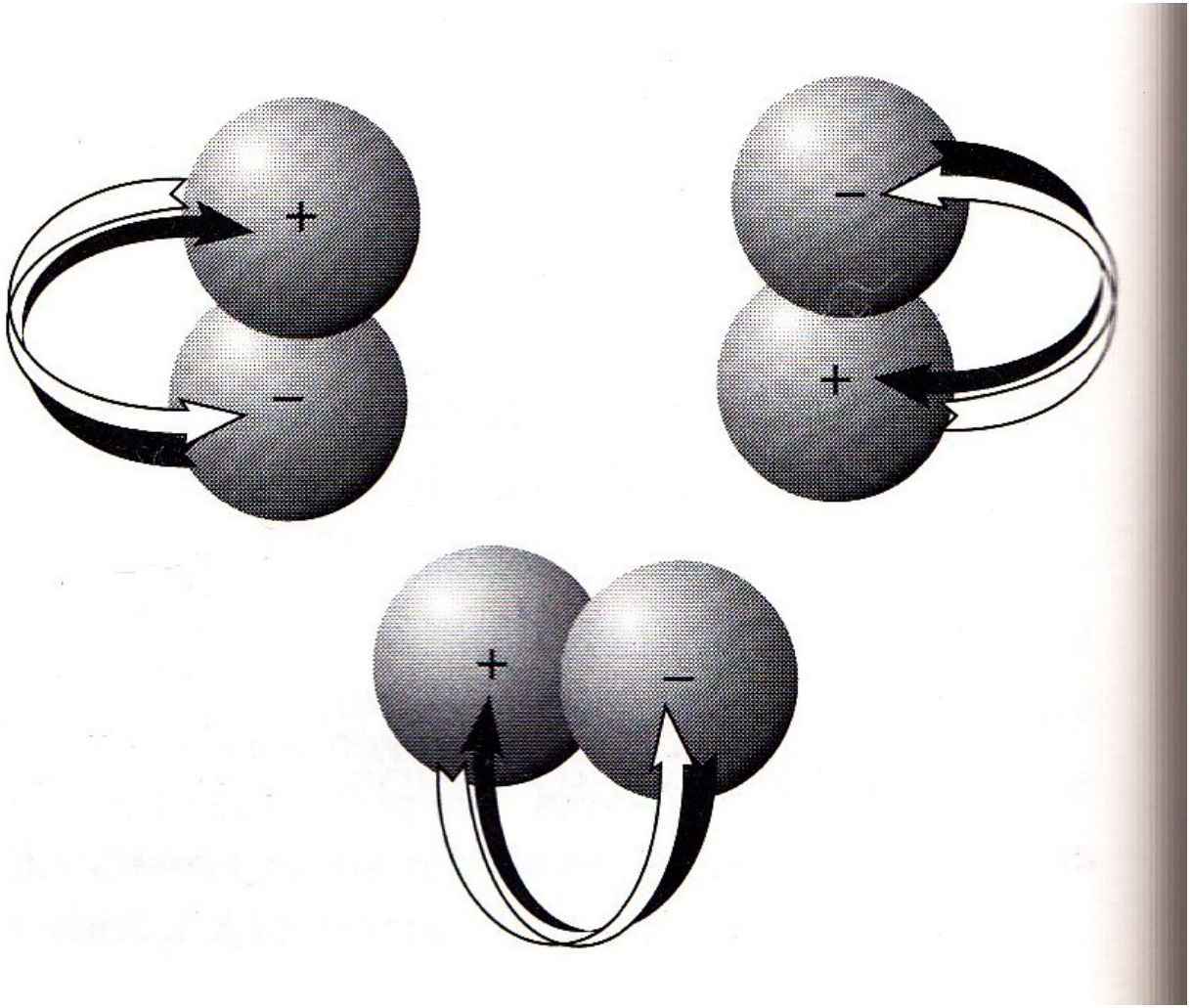
- Like primary bonds, secondary bonds do not share electrons
- Charge variations among molecules or atomic groups induce polar forces that attract the molecules and result in the formation of secondary bonds…

- **Hydrogen bonding**

- Best eg - water molecule.
- Oxygen atom is attached to the hydrogen atom by covalent bonds.
- The protons away from the oxygen atom are not shielded by the electrons and is positively charged.
- The opposite side provides a negative charge.
- As a result a permanent dipole exists.
- Thus when one molecule of water reacts with the other, the positive side of one is attracted to the negative side of the other and hydrogen bonds are formed…..

- **Vander waals forces**

- Formed on the basis of dipole attraction
- In a symmetric molecule, like an inert gas, the electron field constantly fluctuates, so that its charge becomes momentarily positive and negative.
- A fluctuating dipole is thus created that will attract other similar dipoles.
- Such inter atomic forces are quite weak.



THERMAL ENERGY

- Is accounted for by the Kinetic energy of the atoms or molecules at a given temperature.
- The atoms in a crystal are in a constant state of vibration
- The amplitude depends upon the temperature.

increase in temperature→increase in the kinetic energy→increase in the amplitude→increase in the inter atomic spacing →thermal expansion

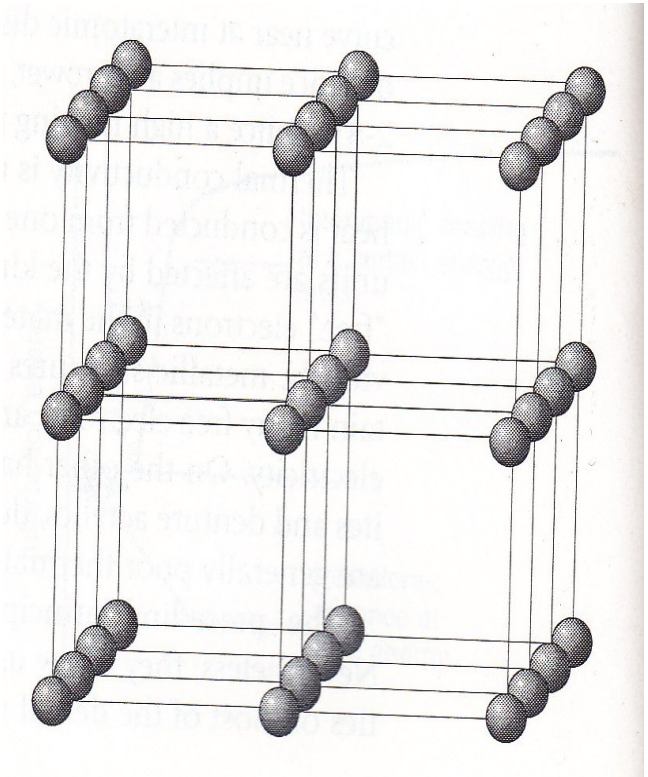
CRYSTAL STRUCTURE

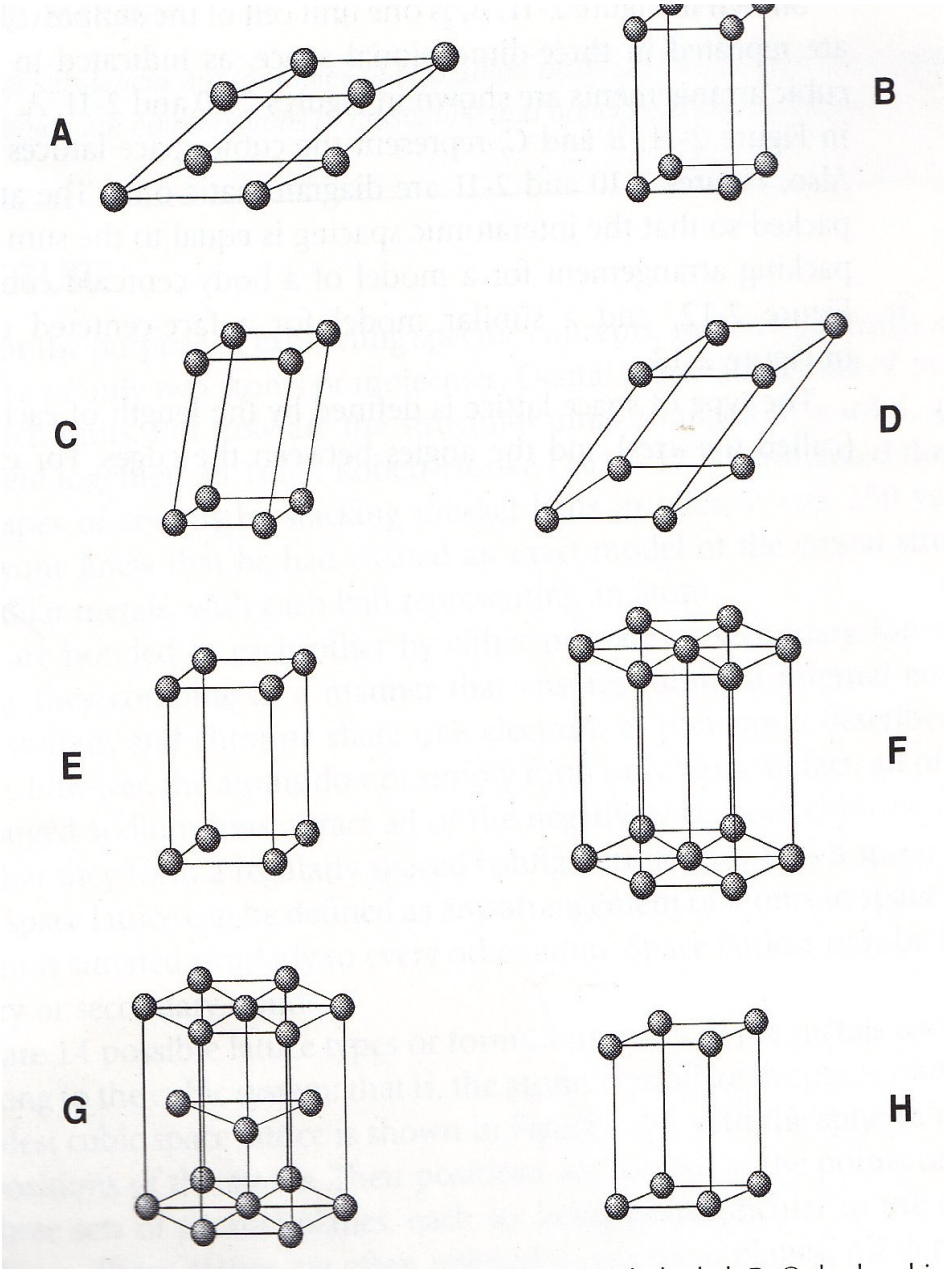
- Atoms are bonded by primary or secondary forces.
- In a solid state, they combine in a manner that ensures minimal energy and in a regularly spaced configuration.
- Thus a space lattice is defined as-

  Any arrangement of atoms in space such that every atom is situated similarly to every other atom.

  They may be due to primary or secondary bonds.

- There are 14 possible lattice types of forms.
- Most of the metals used in dentistry belong to the cubic system

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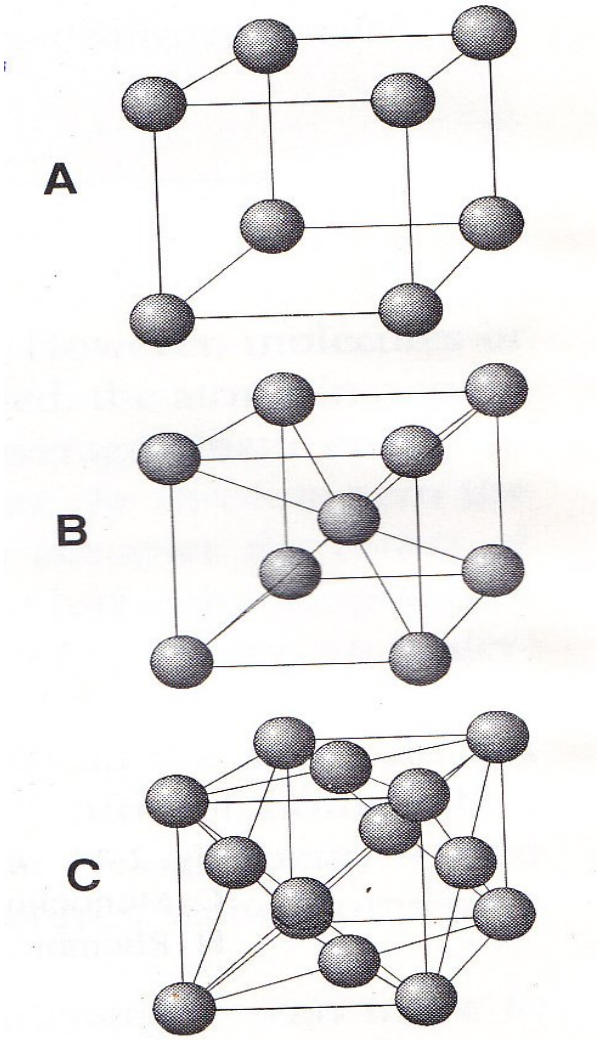
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NON CRYSTALLINE STRUCTURE.
Or
AMORPHOUS STRUCTURE

- In crystalline structure- the atoms are arranged regularly
- In a non crystalline structure-atoms are arranged irregularly or at random.
- Eg- waxes.

- However, at times the atoms may be regularly arranged.
- For eg- glass is considered to be a non crystalline solid.
- In glass the atoms are arranged orderly in a short range.
- Such an ordered arranged of glass is more or less localized with disordered units between them.
- Such an arrangement is typical of liquids, hence such solids are often called **supercooled liquids….**

- Properties-
- They do not have a definite melting temperature
- They gradually soften as the temp is raised.
- The temperature at which there is an abrupt increase in the thermal expansion coefficient, indicating increased molecular mobility, is called **glass transition temperature.**
- Below the Tg, the material loses its fluid characteristics and is resistant to shear deformation.
- Eg- dental resins

DIFFUSION

- Diffusion of molecules occur in gases and liquids.
- However molecules diffuse in solid state as well…

- The diffusion rates for a given substance mainly depends upon the temperature.
- Increase in temp →greater rate of diffusion.
- Also depends on-

  -concentration gradient

  -atom size

  -interatomic bonding

  -lattice imperfections

The diffusion constant that is uniquely characteristic of a given element in a compound, crystal, or alloy is known as the diffusion coefficient

- In crystalline substance-diffusion is low at room temperatures.
- In non crystalline substances-more rapid -even at room or body temperatures.

ADHESION AND BONDING

- Mechanical bonding
- Surface tension
- Wetting

MECHANICAL BONDING

- **Micro mechanical bonding** is most commonly used in dentistry.
- Here the adhesive penetrates into the microscopic or sub microscopic irregularities in the surface of the substrate.
- such a mechanism is utilized in-
  -use of a cement for retention of a cast restoration, post and core,etc.
  -acid etching technique.

SURFACE ENERGY

- The energy at the surface of a solid is greater than its interior.
- Inside a lattice- atoms are equally attracted→interatomic distances are equal →energy is minimal
- At the surface, the outer most electrons are not equally attracted in all directions
- There is only a force from the inside of the lattice pulling the outermost atoms inside the lattice.
- This creates a tension on the outermost surface and to pull the outermost atoms away, energy is needed.

- The increase in energy per unit area of surface is referred to as the **surface energy or the surface tension.**

- the surface atoms tend to form bonds with other atoms that come in close proximity in order to reduce the surface energy of the solid. This attraction across the interface for unlike molecules is called **adhesion.**

WETTING

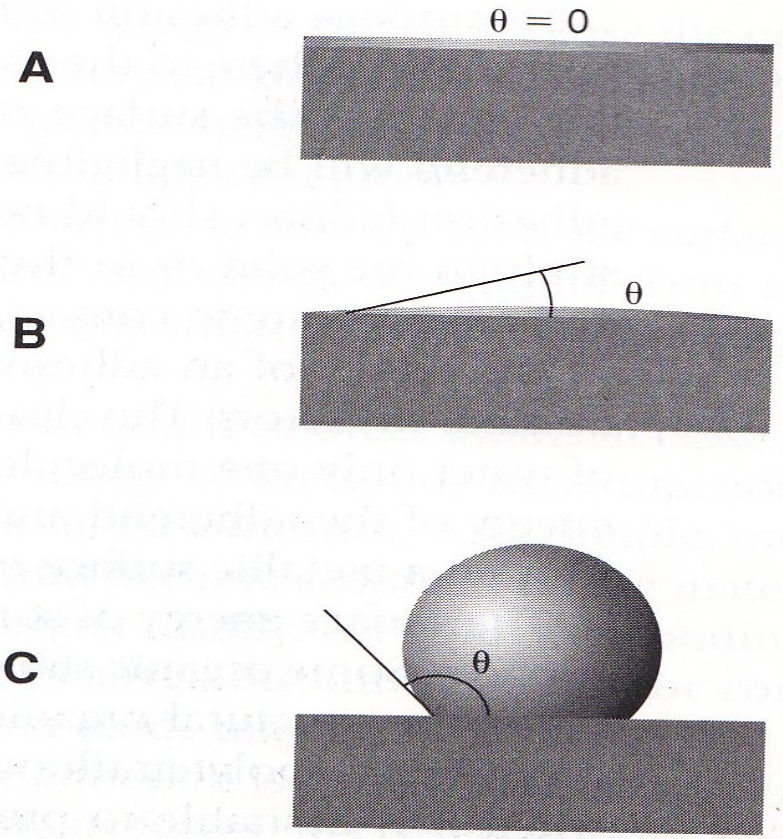
- Any two solid surfaces are difficult to adhere.
- The seemingly smooth surfaces of solids, also have a number of irregularities and when put in apposition to each other, only the high spots come in contact.
- To overcome this, a fluid is used to flow between these irregularities.
- This also provides contact over a greater part of the surface of the solid.

- In this manner, adhesion is produced.
- Eg- two glass plates with a layer of water between them are difficult to separate.
- This is because the surface energy of the glass is great enough to attract the water molecules.
- This characteristic is known as **wetting.**
- In the eg above, water –adhesive and glass- adherend.

CONTACT ANGLE OF WETTING

- It is the angle formed by the adhesive and the adherend at their interface.
- The extent to which an adhesive will wet the surface of an adherend may be determined by measuring the contact angle.

- The contact angle may vary form 0 to 180odegrees.
- 0 degree- complete wetting has occurred and the liquid has completely spread over the solid surface.
- 180 degrees-no wetting occurs.
- Thus smaller the contact angle between the adhesive and the adherend,better is the ability of the adhesive to flow into the irregularities.
- Thus better is the adhesion…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THANK YOU