CLASSIFICATION OF MATERIALS

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CLASSIFICATION OF MATTER ON THE BASIS OF SEMICONDUCTOR THEORY:

- In terms of their electrical properties, materials can be classified into three groups:
- Conductors
- Semiconductors
- Insulators.

INSULATORS

- **Insulators** An **insulator** is a material that does not conduct electrical current under normal conditions.
- Most good insulators are compounds rather than single-element materials and have very high resistivity.
- Valence electrons are tightly bound to the atoms; therefore, there are very few free electrons in an insulator.
- Examples of insulators are rubber, plastics, glass, and quartz.

CONDUCTORS

- **Conductors** A **conductor** is a material that easily conducts electrical current. Most metals are good conductors.
- The best conductors are single-element materials, such as copper (Cu), silver (Ag), gold (Au), and aluminum (Al), which are characterized by atoms with only one valence electron very loosely bound to the atom.
- These loosely bound valence electrons become free electrons. Therefore, in a conductive material the free electrons are valence electrons.

SEMICONDUCTORS

- **Semiconductors** A **semiconductor** is a material that is between conductors and insulators in its ability to conduct electrical current.
- A semiconductor in its pure (intrinsic) state is neither a good conductor nor a good insulator. Single element semiconductors are antimony (Sb), arsenic (As), boron (B), silicon (Si), and germanium (Ge).
- Compound semiconductors such as gallium arsenide, are also commonly used. The single-element semiconductors are characterized by atoms with four valence electrons. Silicon is the most commonly used semiconductor.

ENERGY BANDS

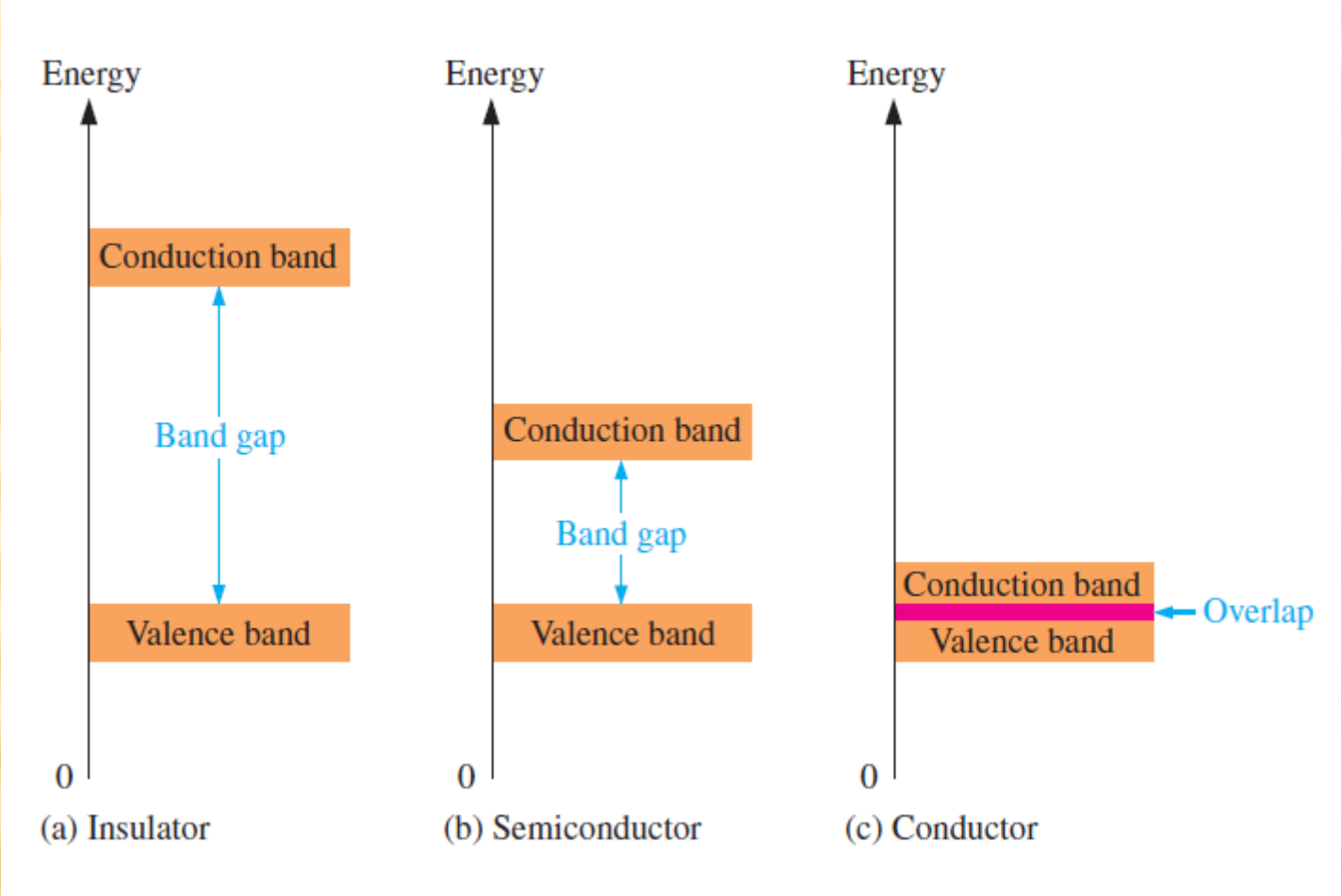
Energy Bands:

- Recall that the valence shell of an atom represents a band of energy levels and that the valence electrons are confined to that band. When an electron acquires enough additional energy, it can leave the valence shell, become a *free electron,* and exist in what is known as the *conduction band.*

- The difference in energy between the valence band and the conduction band is called an *energy gap* or **band gap**.

- This is the amount of energy that a valence electron must have in order to jump from the valence band to the conduction band. Once in the conduction band, the electron is free to move throughout the material and is not tied to any given atom. **Figure 1 shows energy diagrams for insulators, semiconductors, and conductors.**

FIGURE 1: ENERGY DIAGRAMS FOR THE THREE TYPES OF MATERIALS.



ENERGY BANDS

- For insulators, the gap can be crossed only when breakdown conditions occur as when a very high voltage is applied across the material.
- The band gap is illustrated in Figure 1 (a) for insulators.
- In semiconductors the band gap is smaller, allowing an electron in the valence band to jump into the conduction band if it absorbs a photon.
- The band gap depends on the semiconductor material.

THANK YOU