

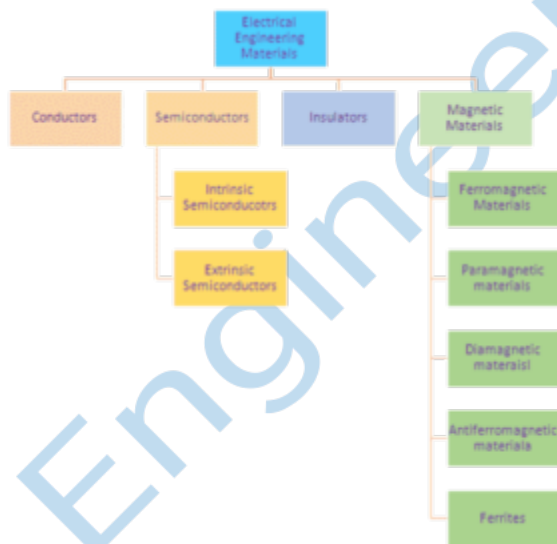
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## Classification of Electrical Materials with Examples

To be a successful Electrical Engineer, we should have a deep knowledge of **Electrical Engineering materials**. Electrical Engineering material science is associated with the study of composition, structure, characterization, processing, properties, application and performance of **electrical engineering materials**. The existence and success of any electrical machine or equipment depends on the availability of suitable electrical engineering materials such as conductors, insulators and magnetic materials etc. Hence, before designing any electrical machine, we should have good knowledge of properties and applications of electrical engineering materials.

The performance of any electrical equipment is completely governed by the quality of material used for that equipment. Therefore, to design a good and successful electrical equipment, we should also have the knowledge of factors governing the quality of engineering materials.

Based on the properties and applications the electrical engineering materials can be categorized in the chart below



## Conductors

### Examples of conductors of heat:



Conductors are the materials which have very high conductivity. The number of free electrons are very high in conductor at room temperature, which is basic reason of high conductivity of conductor's.

**Examples:** Silver, Copper, Gold, Aluminum etc.

The number of free electrons are very high in silver, which makes the silver a best conductors of electricity. The binding force on these free valance electrons by nucleus is very low. Due to which these electrons can be easy freed from the nucleus and can participate in flow of electricity.

## Semiconductors



Semiconductors are have the conductivity between conductors and insulators. Semiconductors are the elements of group-III, group-IV and group-IV elements. Semiconducting materials are having covalent bond.

At normal temperature the conductivity of semiconductor is very low. With increase of temperature the conductivity of semiconductors increase exponentially.

**Example:** Germanium, Silicon, Gallium Arsenic etc.

## Insulating Materials



The conductivity of insulating material is very low. These material are having very high resistivity which makes them very suitable to insulate the **current** carrying parts from earthed metallic structure.

In insulating materials the elections are tightly bounded with nucleus. Due to which that cannot be freed for movement in materials. Due to which the resistivity of insulating material is very high.

**Example:-** Plastics, Ceramics, PVC etc.

## Magnetic Materials

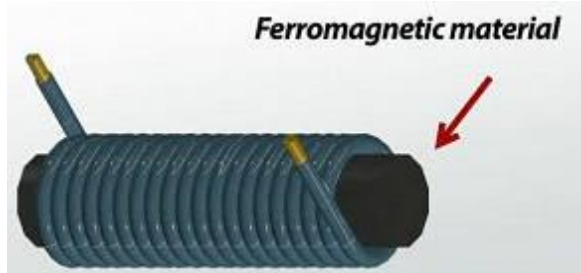
These materials play an important role for existence of various electrical machines. The magnetic materials having high permeability are used for building the core to form the low reluctance path for magnetic flux.

Magnetic materials can be further divided in following categories

- Ferromagnetic materials
- Paramagnetic material
- Diamagnetic materials

- Antiferromagnetic materials
- Ferrites

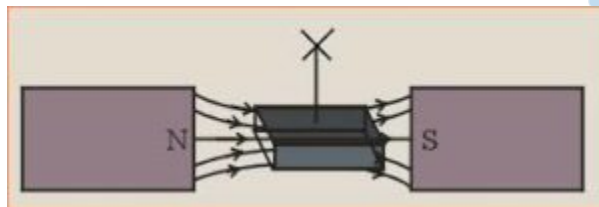
### Ferromagnetic Materials



These materials are having very large and positive susceptibility to external magnetic fields. They are having a strong attraction to external magnetic field and are able to retain magnetism even after remove of external magnetic field. This property of materials is called magnetic hysteresis.

**Example:** Iron, Cobalt, Nickel.

### Paramagnetic Material

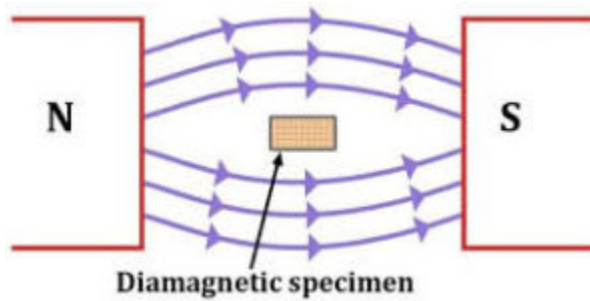


These materials are having very small and positive susceptibility to external magnetic field. In the presence of external magnetic field, these materials attains very small magnetism.

**Example:** Aluminium, Platinum, oxygen, Air etc.

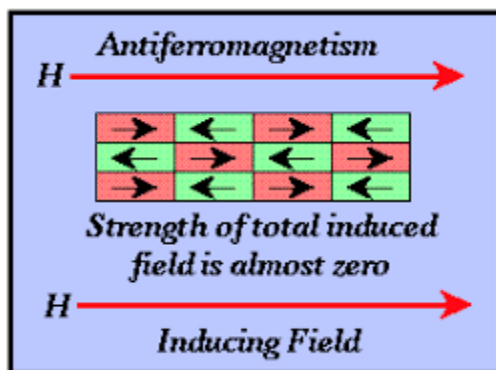


## Diamagnetic materials



These materials are having very weak and negative Magnetic susceptibility to external magnetic field. On application of external magnetic field these are repelled slightly by external magnetic field. These materials does not retains the magnetism after removal of external magnetic field. Mostly all metals i.e. silver, copper, gold, hydrogen etc. are diamagnetic materials.

## Antiferromagnetic materials



These materials are having very small and positive susceptibility to external magnetic field. In the presence of external magnetic field these materials get slightly magnetized in the direction of external magnetic field. In these materials, atoms are having mixed parallel and anti parallel aligned magnetic dipole movement.

**Example:** Cr, MnO, FeO, CoO, NiO, Mn etc.

## Ferrites



These materials are having very large and positive magnetic susceptibility like ferromagnetic materials. These materials are generally compound which are having more complex crystal structures than a pure material. As compare to ferromagnetic materials, ferrites are having lower Magnetic Saturation.

**Example:**  $\text{Fe}_3\text{O}_4$ ,  $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$  etc.

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