UNIT-III

MAGNETIC AND DIELECTRI MATERIALS

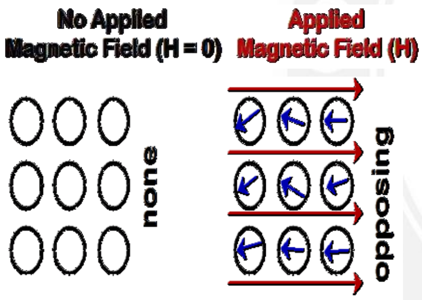
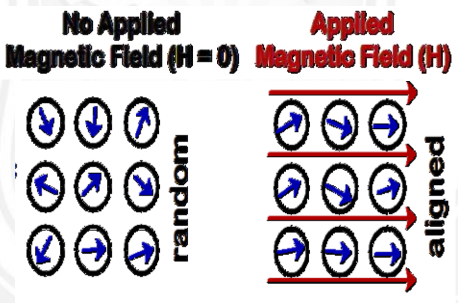
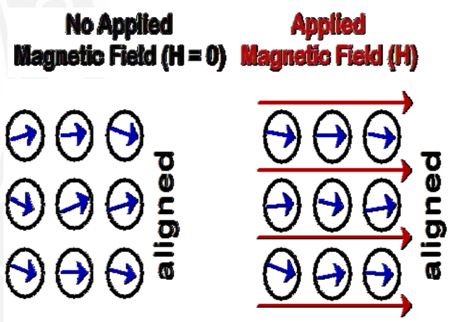
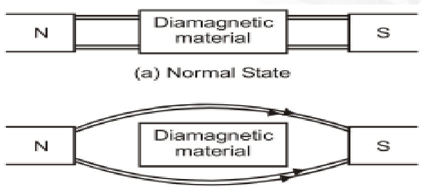
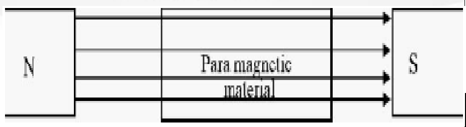
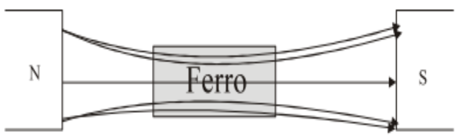
3.1. Microscopic Classification Magnetic Materials

3.1.1. Comparison of Dia, Para and Ferromagnetism

3.1.2.Antiferromagnetism

3.1.3. Ferrimagnetism and Ferrites

3.1.1. Comparison of Dia, Para and Ferromagnetism

S. No	Dia Magnetism	Para Magnetism	Ferro Magnetism
1.	There is no permanent magnetic moment in this material	It has permanent magnetic moment	It has enormous permanent magnetic moment
2.	No spin alignment 	Random alignment 	 Parallel and Orderly alignment
3.	Repulsion of magnetic lines of force from center of the material. 	Attraction of magnetic lines of force towards the center. 	Heavy attraction of magnetic  lines of force towards center.
4.	Permeability is less than 1	Permeability is greater than 1	Permeability is very much greater than 1
5.	Susceptibility is negative	Susceptibility is positive and low	Susceptibility is positive and high
6.	It is independent of	It is dependent of Temperature	It is dependent of Temperature

	Temperature	$\chi = \frac{C}{T}$	$\chi = \frac{C}{T-\theta}$
7.	Below critical temperature, it behaves as superconductors.	Below Curie temperature, it is converted into dia magnetic.	Above Curie temperature, It is converted into paramagnetic.
8.	Examples: Au, Ge, Si, Sb, Bi, etc.	Examples: $MnSO_4$, $CuSO_4$, Al, etc.	Examples: Ni, Co, Fe, Steel etc.

3.1.2.Antiferromagnetism

The spins are aligned in antiparallel manner due to unfavorable exchange interaction among them resulting in zero magnetic moment. Even when the field is increased, it has almost zero induced magnetic moment.

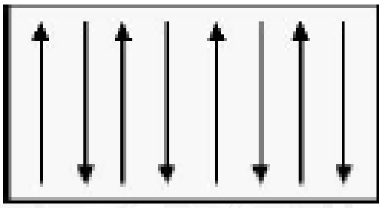


FIG 3.1.2(a) Alignment Of Magnetic Moment

Properties

1. The susceptibility is very small and is positive. It is given by

$\chi = \frac{C}{T+\theta}$ for $T > T_N$ Where T_N is the Neel temperature.

2. Initially, the susceptibility increases slightly as the temperature increases and beyond a particular temperature is known as Neel temperature, the susceptibility decreases with temperature as in fig3.1.2(b)

E.g.: Ferrous oxide, manganese oxide, chromium oxide.

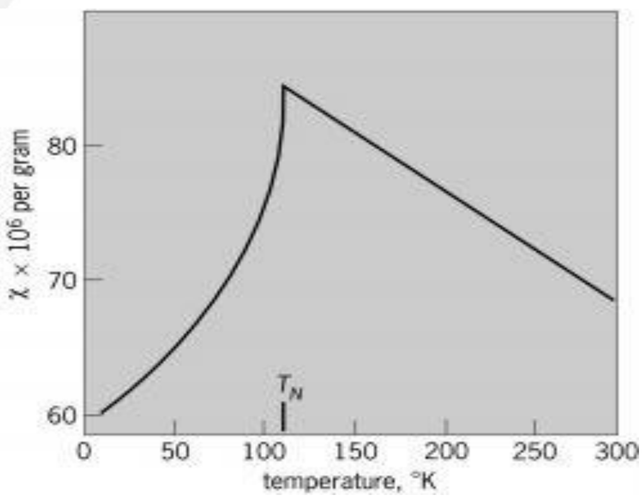


Fig 3.1.2(b) Variation of susceptibility with temperature

3.1.3 Types of magnetic materials

Soft and Hard Magnetic Materials

S.No	Soft magnetic materials	Hard magnetic materials
1	They can be easily magnetized and demagnetized	They cannot be easily magnetized and demagnetized
2	They have narrow hysteresis loop	They have broad hysteresis loop
3	Hysteresis loss is small due to small hysteresis loop area.	Hysteresis loss is large due to large hysteresis loop area.
4	Coercivity and retentivity are small.	Coercivity and retentivity are large.
5	They have low eddy current loss	They have large eddy current loss
6	Magnetic energy stored is small.	Magnetic energy stored is large.
7	Susceptibility and permeability are large.	Susceptibility and permeability are small.
8	Movement of domain wall is easy and hence large magnetization is produced even for small applied field.	Movement of domain walls is difficult due to the presence of impurities. Hence large field is required to produce required magnetization.
9	They are free from strains and impurities.	They have impurities and large defects.
10	E.g. Ferrites, Iron, Garnet, Silicon alloys.	E.g., Tungsten steel, cobalt steel, carbon steel.
11	They are used to make temporary magnets. They are also used in switching devices, electromagnets, matrix storge computers.	They are used to make permanent magnets. These magnets are used in magnetic detectors, microphones and magnetic separators.