CLASSIFICATION OF MAGNETIC MATERIALS

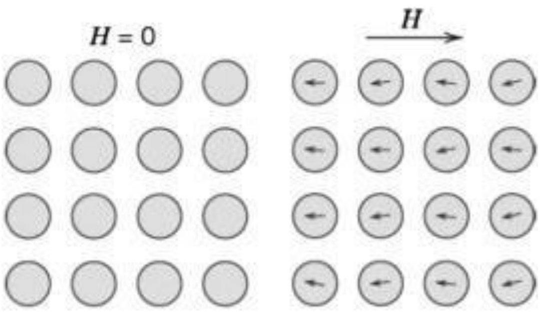
Diamagnetic – materials which lack permanent dipoles are called diamagnetic Paramagnetic – if the permanent dipoles do not interact among themselves, the material is paramagnetic

Ferromagnetic – if the interaction among permanent dipoles is strong such that all the dipoles line up in parallel, the material is ferromagnetic Antiferromagnetic – if the permanent dipoles line up in antiparallel direction, the material is antiferromagnetic

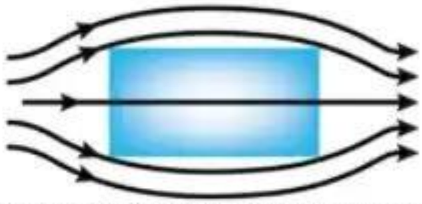
Ferrimagnetic – antiparallel with unequal magnitude

DIAMAGNETIC MATERIALS

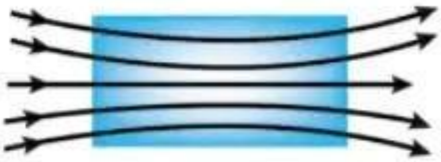
- No permanent dipoles are present so net magnetic moment is zero.
- Dipoles are induced in the material in presence of external magnetic field.
- The magnetization becomes zero on removal of the external field.
- Magnetic dipoles in these substances tend to align in opposition to the applied field.
- Hence, they produce an internal magnetic field that opposes the applied field and the substance tends to repel the external field around it.
- This reduces the magnetic induction in the specimen. Magnetic susceptibility is small and negative.
- Relative permeability is less than one.
- It is present in all materials, but since it is so weak it can be observed only when other types of magnetism are totally absent.
- Ex: Gold, water, mercury, B, Si, P, S, ions like Na^+, Cl^- and their salts, diatoms like H2, N2.



They repel the magnetic lines of force. The existence of this behaviour in a diamagnetic



Magnetic Field lines through Diamagnetic material



Magnetic Field lines through paramagnetic material

material is shown

PARAMAGNETIC MATERIALS :

If the orbital's are not completely filled or spins are not balanced, an overall small magnetic moment may exist.

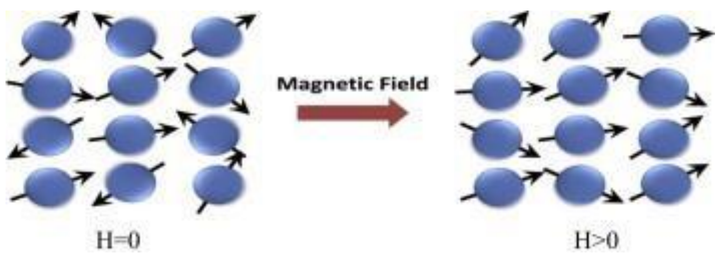
- The magnetic dipoles tend to align along the applied magnetic field and thus reinforce the applied magnetic field. • Such materials get feebly magnetised in

the presence of a magnetic field i.e. the material allows few magnetic lines of force to pass through it.

- The magnetization disappears as soon as the external field is removed.

The magnetization (M) of such materials was discovered by Madam Curie and is dependent on the external magnetic field (B) and temperature T as: $\chi = M/M$ where, C= Curie Constant

- The orientation of magnetic dipoles depends on temperature and applied field. • Relative permeability μr >1
- Susceptibility is independent of applied magnetic field and depends on temperature.Susceptibility is small and positive • These materials are used in lasers.



- Ex: Liquid oxygen, sodium, platinum, salts of iron and nickel, rare earth oxides

FERROMAGNETIC MATERIALS

- They exhibit strongest magnetic behaviour.
- Permanent dipoles are present which contributes a net magnetic moment.
- Possess spontaneous magnetization because of interaction between dipoles
- Origin for magnetism in Ferro magnetic materials are due to Spin magnetic moment. All spins are aligned parallel & in same direction
- When placed in external magnetic field it strongly attracts magnetic lines of force
- The domains reorient themselves to reinforce the external field and produce a strong internal magnetic field that is along the external field.Most of the domains continues to be aligned in the direction of the magnetic field even after removal of external field.
- Thus, the magnetic field of these magnetic materials persists even when the external field disappears.
- This property is used to produce Permanent magnets.
- Transition metals, iron, cobalt, nickel, neodymium and their alloys are usually highly ferromagnetic and are used to make permanent magnets.

Susceptibility is large and positive, it is given by Curie Weiss Law; $\chi = M / M - \theta$ where, C is Curie constant & θ is Curie temperature.

- When temperature is greater than Curie temperature then the material gets converted into paramagnetic.
- They possess the property of Hysteresis.