- MEISSNER EFFECT (FLUX EXCLUSION) :- It is an effect in which a superconductor never has a flux density even when it is placed in applied magnetic field

When no external magnetic field is applied on a superconductor and the superconductor is cooled before the critical temperature T_c, the magnetic flux density inside the material is zero ($B=0$) on applying magnetic field.

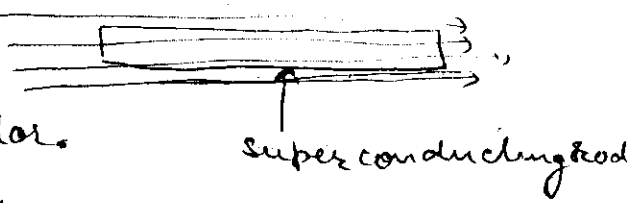
Now if superconductor is placed in a weak external field and is supercooled to $\leq T_c$, persistent currents arise on the surface and circulate in such a way as to cancel the flux density inside the material.

- Hence B is always zero inside a superconducting material, whether material is supercooled first followed by application of external magnetic field or by placing the material in weak magnetic field followed by supercooling.

Note :- This behaviour of flux exclusion of superconductors is different from resistanceless metals. In resistanceless metals, the flux density may or may not be zero depending on the circumstances.

Rod Shaped superconducting specimen as long solenoid

Suppose a magnetic field of flux density $\vec{B}_a$ is applied along the length of superconductor.



B_a produces material flux density of $\mu_r B_a$ where μ_r is relative magnetic permeability of material.

For metals other than ferromagnetic materials $\mu_r = 1$, so that the magnetic flux density within material is also $\vec{B}_a$

However, at $T = T_c$, total magnetic flux density is zero, in superconductors. This happens by development of circulating surface currents producing magnetic flux density $\vec{B}_i$.

$$\therefore \vec{B}_a + \vec{B}_i = 0$$

$$\vec{B}_i = -\vec{B}_a$$

A superconducting speciment in form of rod, therefore, acts solenoid carrying current.

To produce magnetic flux density $\vec{B}_a$, the magnitude of circulating current (surface current) per unit length must be $\vec{J} = \frac{\vec{B}_a}{\mu_0}$

$$\therefore \vec{J} = \vec{H}_a$$ where $\vec{H}_a$ is applied field strength.