1. $\vec{H}, \vec{I}, \vec{B}_{net}, \chi$

(a) $\vec{H}$, Magnetizing Field

For external magnetic field $\vec{B}_{ext}$, $\vec{H}$ is defined.

$\vec{B}_{ext} = \mu_0 \vec{H}$, unit of $\vec{H}$ is A/m.

(b) $\vec{I}$, Intensity of Magnetization $\quad$ (A/m)

Total magnetic moment of material per unit volume.

$\vec{I} = \dfrac{\vec{M}}{V}$

(It tells how much a material is magnetized)

$\vec{B}_{ext} = \mu_0 \vec{H}$

$$\vec{B}_i = \mu_0 \vec{I}$$

(c) χ, Magnetic Susceptibility

Tells about the ease with which a material can be magnetized.

$\chi = I/H$

$\vec{B}_{net} = \vec{B}_{ext} + \vec{B}_i$

$\Rightarrow \mu_0 \mu_r \vec{H} = \mu_0 \vec{H} + \mu_0 \vec{I}$
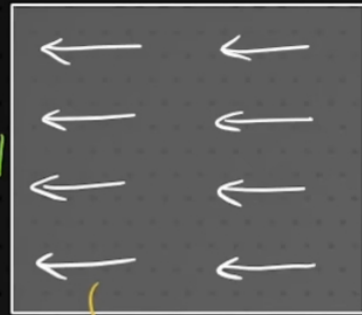
$\Rightarrow \mu_r \vec{H} = \vec{H} + \chi \vec{H}$

$\therefore \boxed{\mu_r = 1 + \chi}$

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2. DIAMAGNETIC AND PARAMAGNETIC MATERIAL

DIA ↓

$$\vec{B}_{ext} = \mu_0 \vec{H}$$
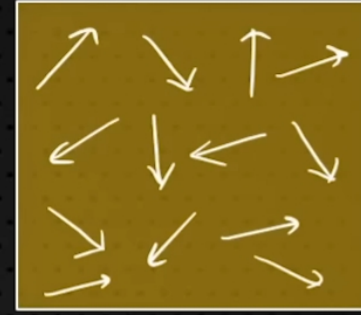
$$\equiv N \qquad S$$

$$\vec{B}_i = \mu_0 \vec{I}$$

EACY atoms dipole moment is zero
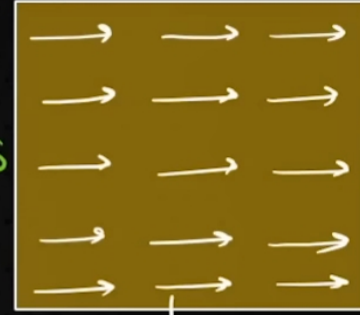
(i) Weakly magnetized

(ii) Material repels $\vec{B}_{ext}$

(iii) $\mu_r = 1 + \chi$

$\mu_r < 1$ and χ is $-ve$

(iv) Graphite, Bismuth

PARA ↓
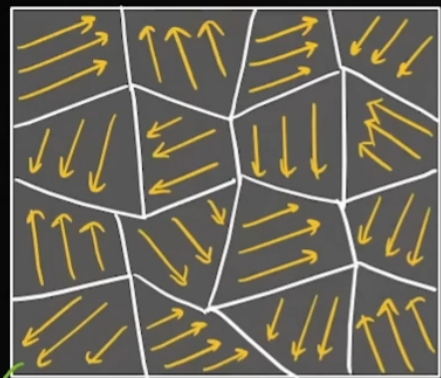
$$\vec{B}_{ext} = \mu_0 \vec{H}$$

$$\equiv S \qquad N$$

$$\vec{B}_i = \mu_0 \vec{I}$$

(i) Weakly magnetized

(ii) Material gets weakly attracted to $\vec{B}_{ext}$

(iii) $\mu_r = 1 + \chi$
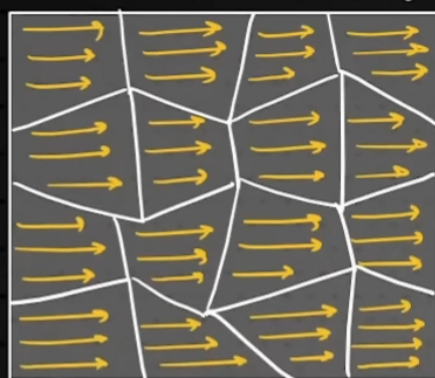
$\mu_r > 1$ and χ is $+ve$

(iv) Al, Li, Mg

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3. FERROMAGNETIC MATERIAL
(Fe, Ni, Co)

$$\vec{B}_{ext} = \mu_0 \vec{H}$$

↳ Domains

$$\vec{B}_{net} = \vec{B}_{ext} + \vec{B}_i$$

Here, $B_i \gg B_{ext}$

$$\Rightarrow I \gg H$$

$$\therefore \chi \gg 1$$

4. CURIE'S LAW

If $T\uparrow$, due to thermal agitation, the alignment of dipoles gets disturbed and overall $I \downarrow$ for a given H.

$$\therefore I\downarrow \Rightarrow \chi\downarrow$$

(a) FOR PARAMAGNETIC MATERIAL

$$\chi = \frac{C}{T}$$

C: Curie const.

T: Abs Temp°

(b) For Ferromagnetic material

On heating it to T_C, it changes to paramagnetic. On further $\uparrow T$

$$\chi = \frac{C'}{T - T_C}$$

T_C: Curie Temp°

5. MAGNETIC HYSTERESIS

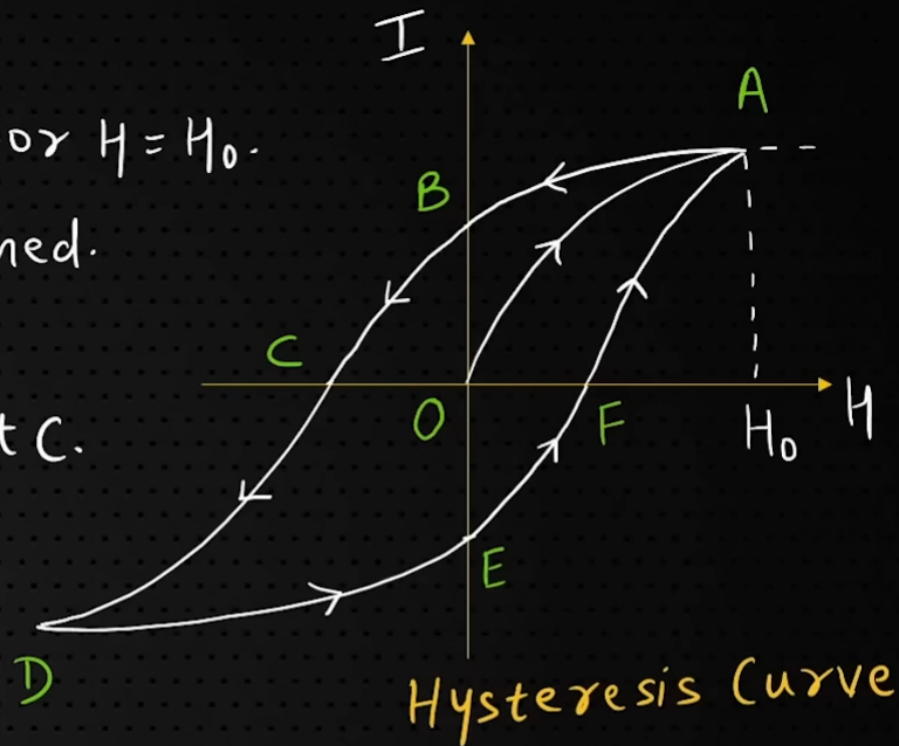(i) $O \to A$: On $\uparrow H$, $I \uparrow$ and gets saturated for $H = H_0$.

(ii) $A \to B$: On $\downarrow H$ to zero, Still I is retained.

         OB is called "RETENTIVITY".

(iii) $B \to C$: $\uparrow H$ in reverse direction, $I = 0$ at C.

         OC is called "COERCIVITY".

(iv) $C \to D$: Further $\uparrow H$ and I again gets saturated at D.

         and so on....

NOTE : (a) Area of LOOP $ABCDEFA$ shows thermal energy or heat produced / Volume in 1 Cyc.

Hysteresis Curve

6. HYSTERESIS CURVE:
SOFT IRON VS STEEL

(i) ∵ Soft Iron gets easily magnetized and Looses almost all magnetism easily (Low coercivity)
It is used for "Electromagnets."

(ii) ∵ Steel is difficult to demagnetize
(OD = coercivity)
it is used to make "Permanent Magnets".

I
soft Iron
B
A
steel
D   C   O   H

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