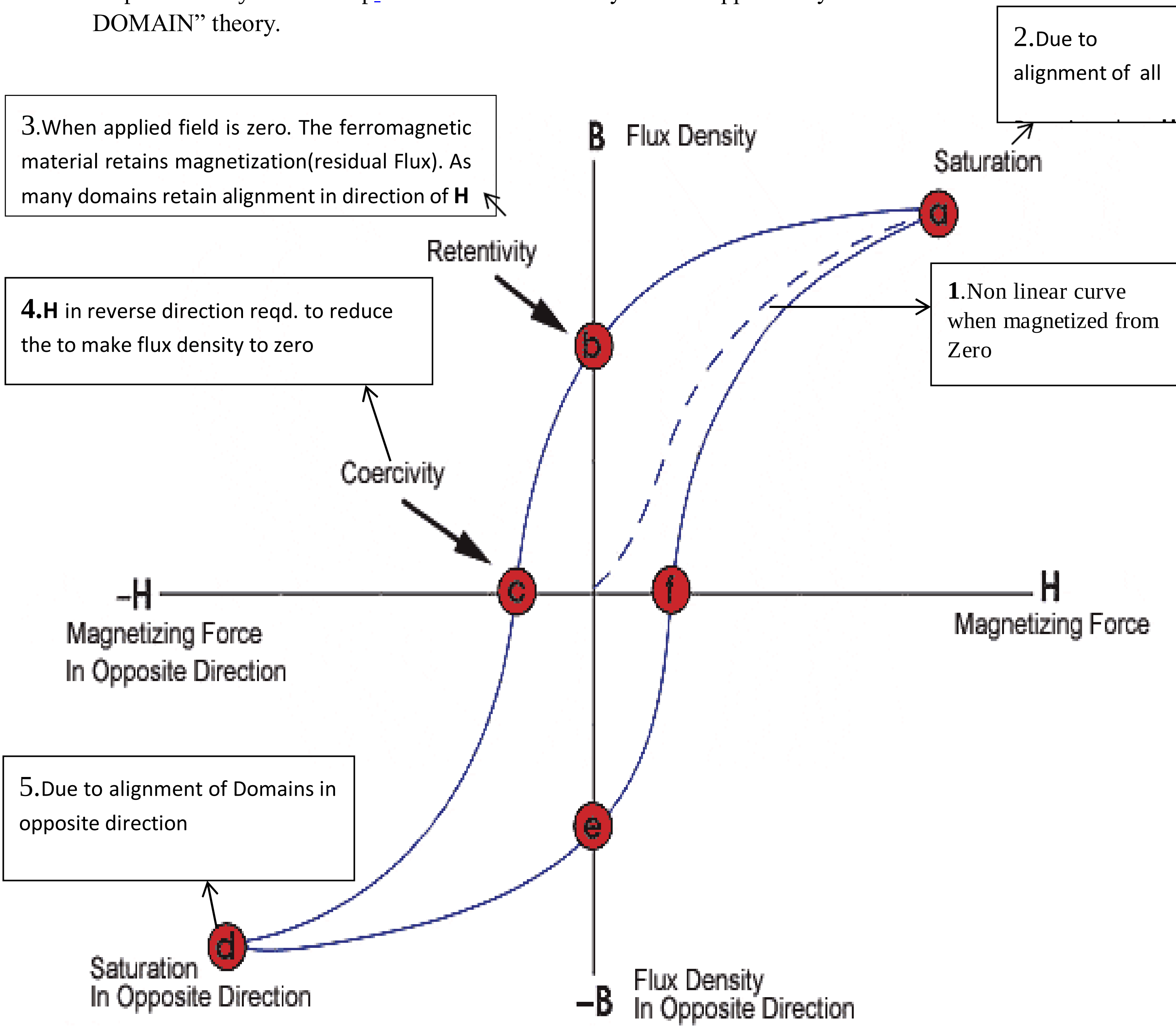
Hysteresis Loop

Definition: Hysteresis refers to the lagging of the magnetization of a ferromagnetic material like iron. In other words when a ferromagnetic material is magnetized in one direction, it will not relax back to zero magnetization even when the imposed magnetizing field is removed hence it has to be driven back to zero, a field in the opposite direction needs to be applied.

If an alternating magnetic field is applied to the material, its magnetization will trace out a loop called a hysteresis loop or B-H Curve.The study is well supported by the "WEISS DOMAIN" theory.



B-H CURVE or HYSTERESIS LOOP

1). On application of a magnetic field on a ferromagnetic material . It shows a non linear rise (1) Flux Density lags behind the applied external field called as **HYSTERESIS**)) ,plotted along Y-axis.The material reached saturation as all the domains align parallel to the applied field. (2).

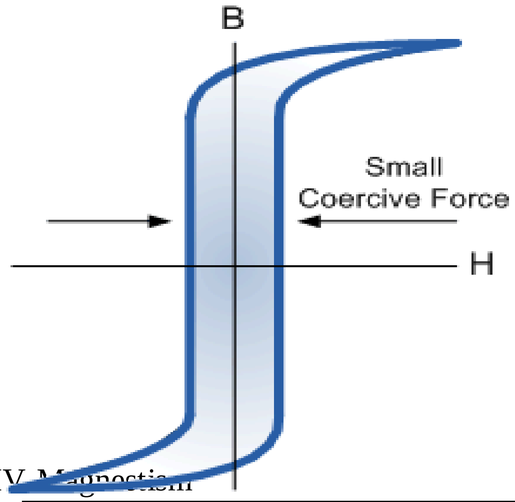
2).On removing the applied field ,**H**=0. Some of the domains retain the alignment resulting in residual magnetism. This loss of retracibility results as the hysteresis loop as shown.

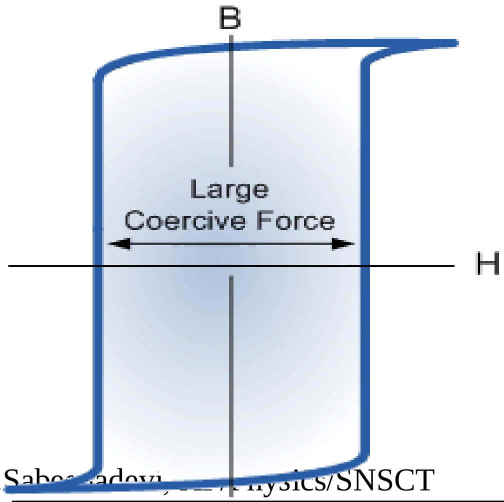
3). The residual magnetic field is called as retentivity, which arises as many of the domains retain their alignment along the direction of the external field that was applied.its value is given by the **Y- intercept**.

Now a external magnetic field is applied in opposite direction so that the residual magnetism gets reduced to zero.This value of the field is called as Coercitivity. This term specifies the hardness or softness of the material towards magnetization. **Hard .Mateials** like steel have high value while **Soft materials** like soft iron have low value of corecitivity.

4). The applied magnetic field strength is further increased in the reverse direction till again saturation is reached by the alignment of all the domains along the direction of the applied magnetic field **H.**

5). The process of reducing the applied field to zero is followed and again the applied field is





SOFT : these ferromagnetic materials havesmall area as energy loss over B-H Curve issmall

HARD: these ferromagnetic materials haveslarge area as energy loss over B-H Curve is large. These form good increased in forward direction.

The said process is repeated by constantly changing the direction of the applied magnetic field by changing the direction of the ac supply to the coil. Magnetic Hysteresis Loop or B-H Loop is obtained.

The B-H loop give us the magnetizing behavior of a given ferromagnetic material.

6). The above process involves loss of energy in form of heat which is proportional to the area of the B-H Loop.

7). Greater the area better magnetism produced and vice versa.as given below are the representation of Soft and Hard ferromagnetic materials.

The amount of work needed to be done in order to align the dipoles of the material parallel to the applied magnetic field is lost in form of heat

$W = \mu_0$ (area of M-H loop) = Work done per unit volume lost in form of heat lost (1)

Now in case of B-H loop/Curve

$B = \mu_0 (H + M) \rightarrow \partial B = \mu_0 (\partial H + \partial M) \quad \rightarrow \partial M = (1/ \mu_0)\, \partial B - \partial H$ (2)

From above equations

W =$W = \oint H \, 6B$ **-** $\mu_0 \oint H \; 6H$

$\oint H \; 6H$ **= 0 hence W =** $\oint H \, 6B$ **= area of B – H Curve.**