

MAGNETOELECTRIC EFFECT

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KEY POINTS

1. Ferroics

- Ferroelectric
- Ferromagnetic

2. Multiferroics

- Type 1 and Type 2 multiferroics

3. Magnetoelectric effect

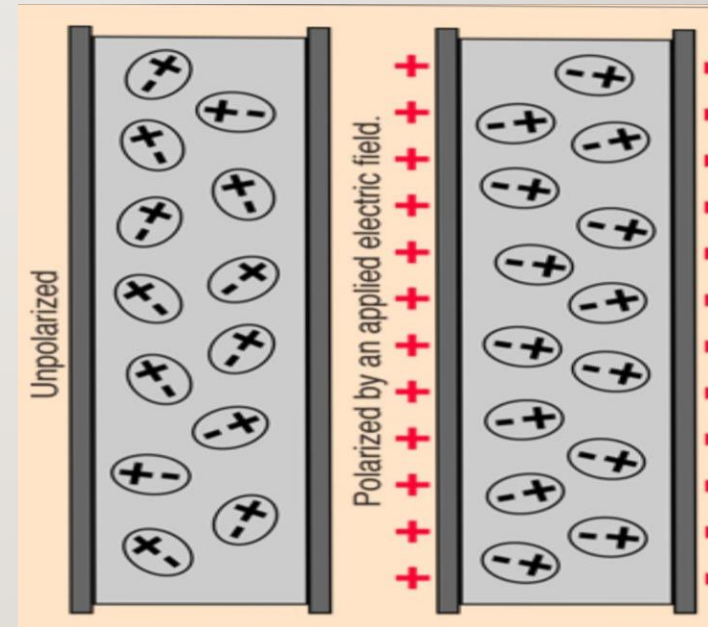
- DME
- CME

WHAT IS FERROICS?

- Ferroics is a genetic name given to the study of ferroelectrics, ferromagnets and ferroelastic
- The basis of this study is to understand the large change in physical properties (polarization, magnetization and deformation) that occur over a very narrow temperature range.
- Ferroelectricity – an electric polarization that is switchable by an applied electric field.
- Ferromagnetism – a magnetization that is switchable by an applied magnetic field.
- Ferroelasticity – a deformation that is switchable by an applied stress.

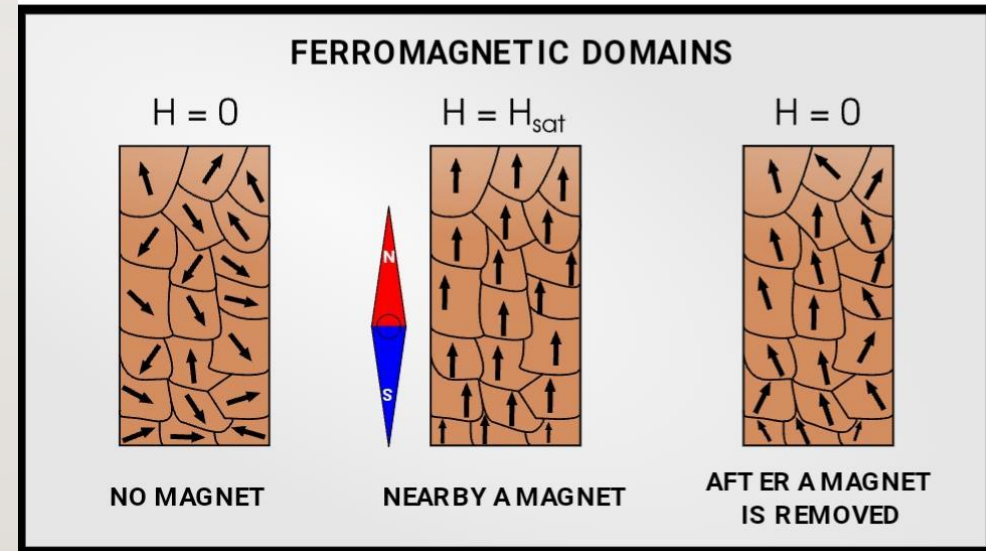
FERROELECTRICS

- The dielectric materials that are spontaneously polarised
Example- Barium titanate, Lead titanate, Rochelle salt etc
- Spontaneous polarization-
when E is zero but P is not zero

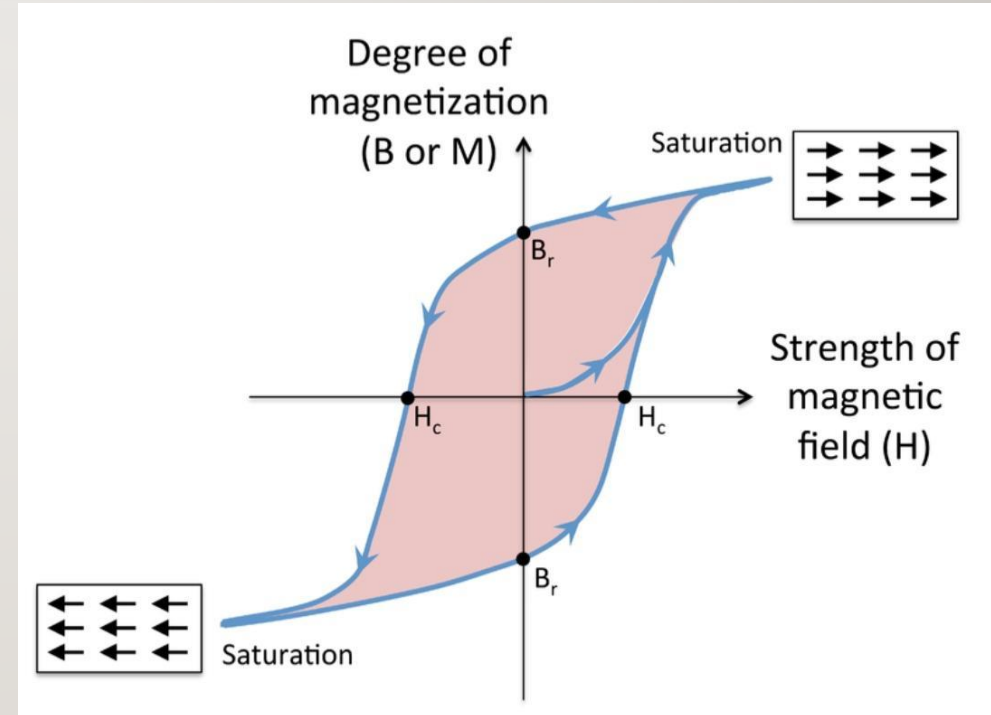
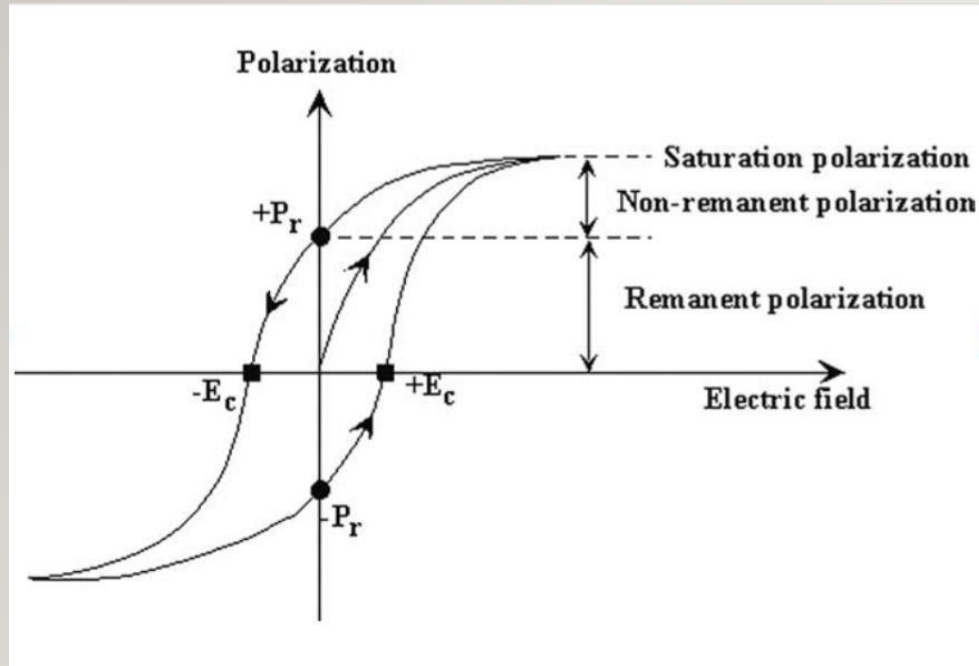


FERROMAGNETS

- The materials which exhibit spontaneous net magnetization are called ferromagnets
- Example- Iron, Cobalt, Nickel etc.
- Spontaneous magnetization-
When H is zero but M is not zero.



HYSTERESIS CURVE

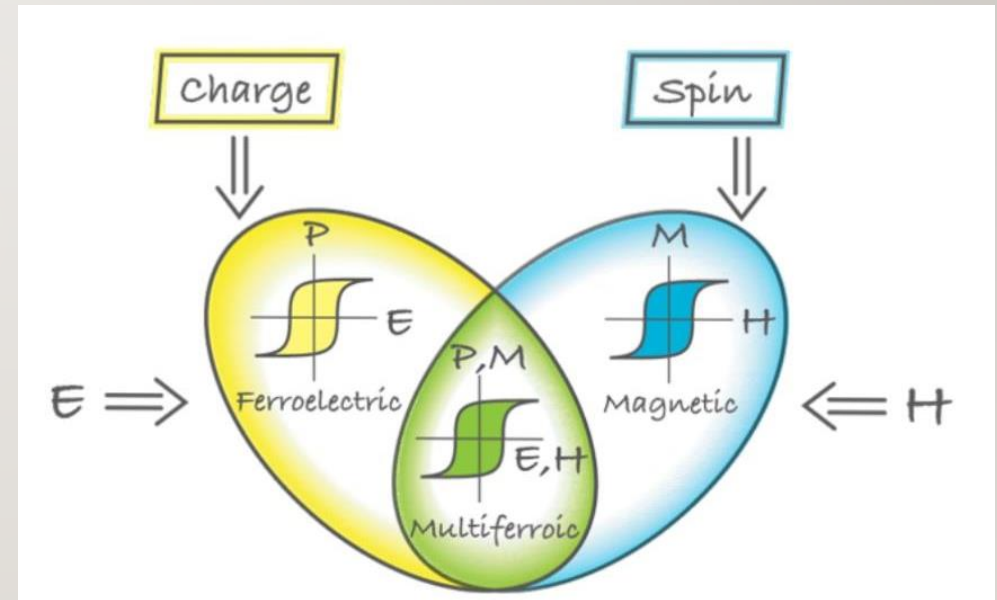


MULTIFERROICS

- The materials that exhibit more than one of the primary ferroic properties in the same phase are called as multiferroics.

Magnetoelectric materials

- ME materials are a class of multiferroics where both ferroelectric and ferromagnetic order parameters coexist
- The materials that are simultaneously both ferromagnetic and ferroelectric are called as magnetoelectric materials



TYPES OF MULTIFERROICS

TYPE - I

1. Ferroelectric and Magnetism occurs at different temp and arise from different mechanisms
2. Coupling betn ferroelectric and ferromagnetic parameters is weak
3. The str distortion which give rise to ferroelectricity occurs at high temp and the magnetic ordering which is usually antiferromagnetism sets in lower temp.
4. Example – BaTiO_3 , BiFeO_3

TYPE - 2

1. The magnetic ordering breaks the inversion symmetry and directly causes the ferroelectricity
2. Coupling betn ferroelectric and ferromagnetic parameters is strong
3. Ordering temp for the 2 phenomena are identical.
4. Example – TbMnO_3 , TbMn_2O_5

MAGNETOELECTRIC EFFECT

- Magnetolectric effect (M.E) denotes any coupling between the magnetic and the electric properties of a material, a material where such a coupling is intrinsically present is called a magnetolectric material.
- The traditional methode for measuring magnetolectric effect is to stimulate the sample between the electromagnet and to measure the voltage generated across the sample. These voltages can be so small that a lock-in amplifier is required to pull the signal out of ambient noise.

TYPES OF MAGNETOELECTRIC EFFECT

DIRECT M.E EFFECT

- Polarization on an applied magnetic field

CONVERSE M.E EFFECT

- Magnetization on applied electric field

THANK YOU

