Laboratory 7

Measurement of magnetic susceptibility and Barkhausen Effect

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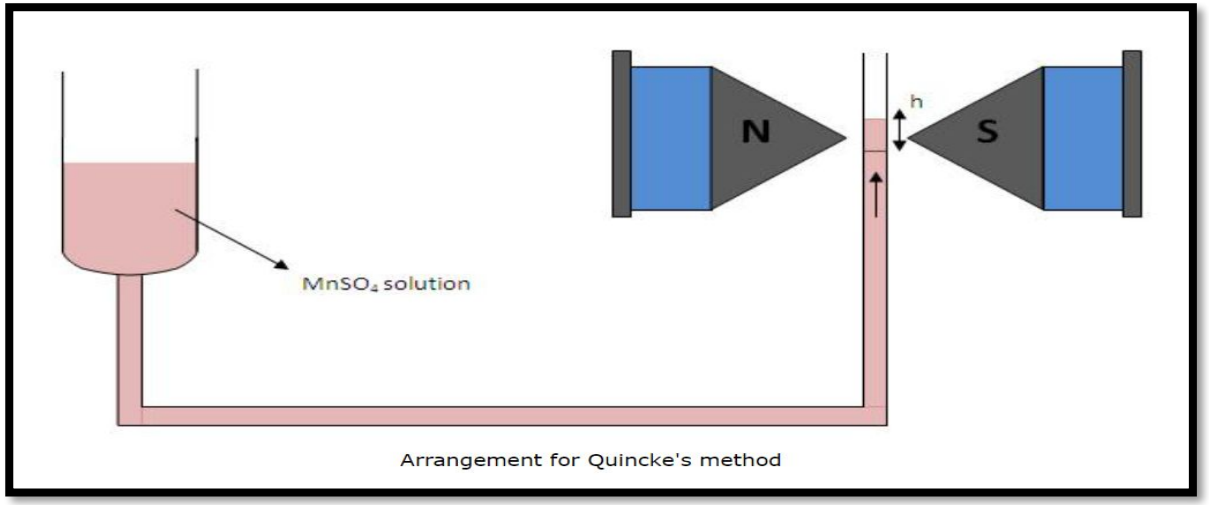
Quincke's Method

Aim: - To determine the volume magnetic susceptibility of Manganese sulphate solution at different concentrations.

- Used to determine the magnetic susceptibility of a paramagnetic substance in the form of liquids, aqueous solutions and liquified gases.
- This method is based on the force experienced by a magnetized material in a non-uniform magnetic field.
- The solution under investigation is placed in a vertical U tube which is then placed between electromagnets.
- When current is switched ON, strong field is experienced by upper surface of the column and weak field is experienced by lower surface.



Arrangement for Quincke's method

The magnetic susceptibility χ_m is a proportionality constant which is dimensionless and indicates the degree of magnetization of a material in response to an applied magnetic field.

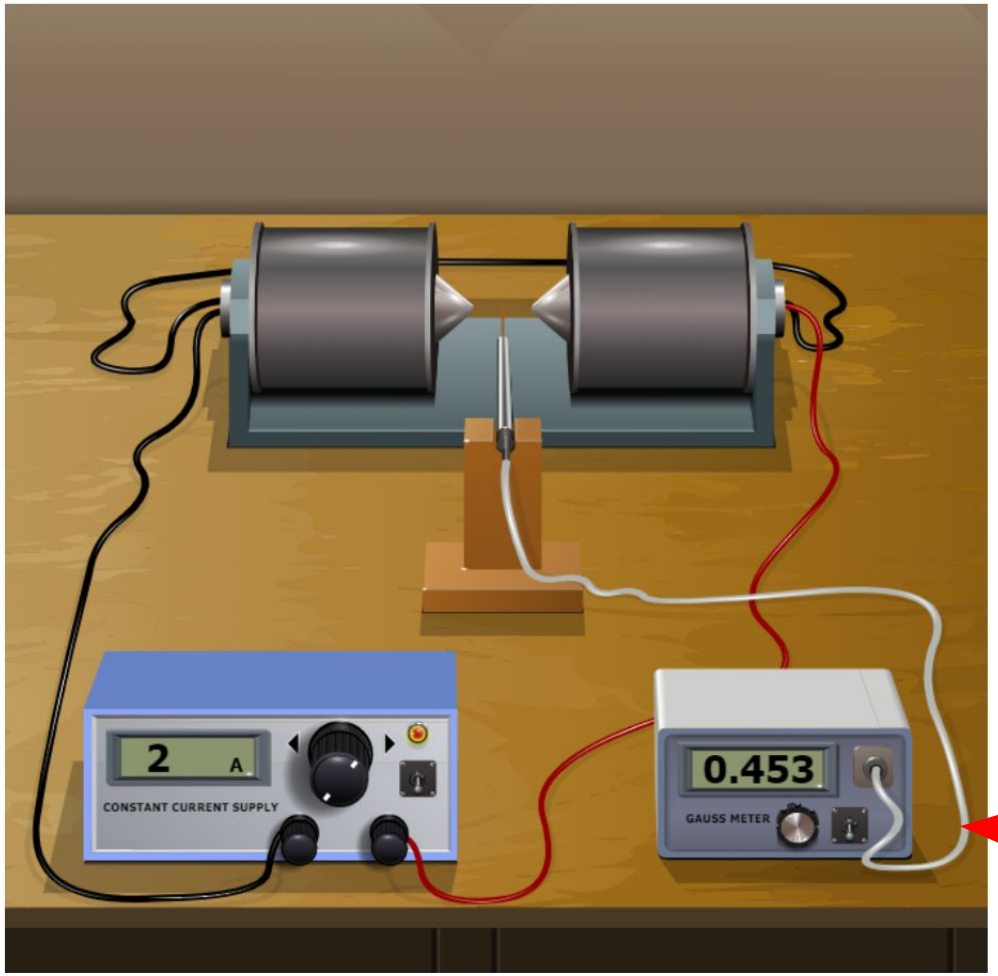
The susceptibility of the paramagnetic solution can be given by:

$$\chi_{sol} = \frac{2gh(\rho - \sigma)}{\mu_0 H_m^2}$$

Setup 1

Step 1: Insert the probe.

Quincke's Method



VARIABLES

Select set up:

Magnetic field Vs Current

REMOVE PROBE

Current: 2 A

RESET

RESULT

Step 2: Adjust the current.

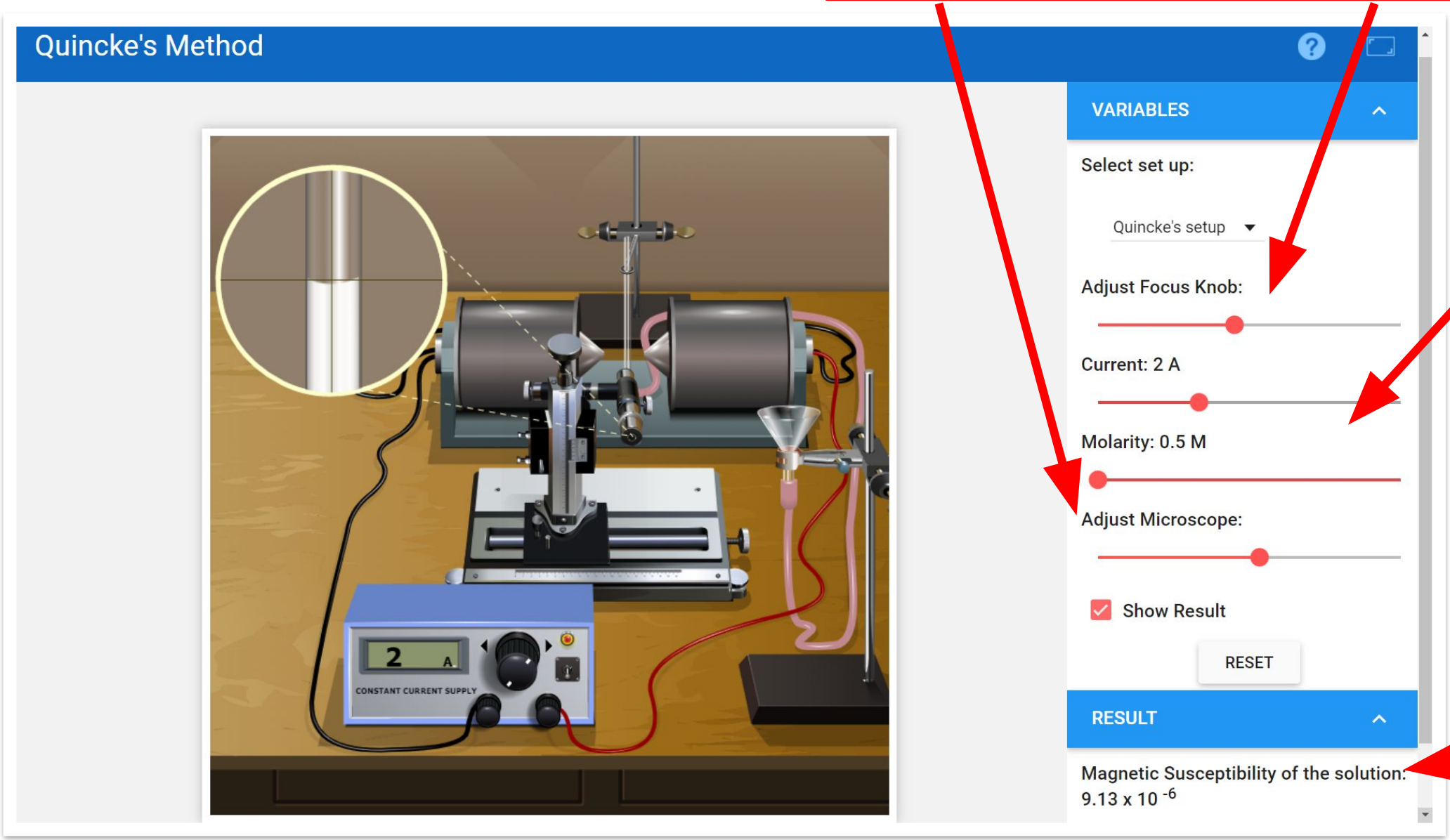
Step 3: Note the magnetic field.

Setup 2

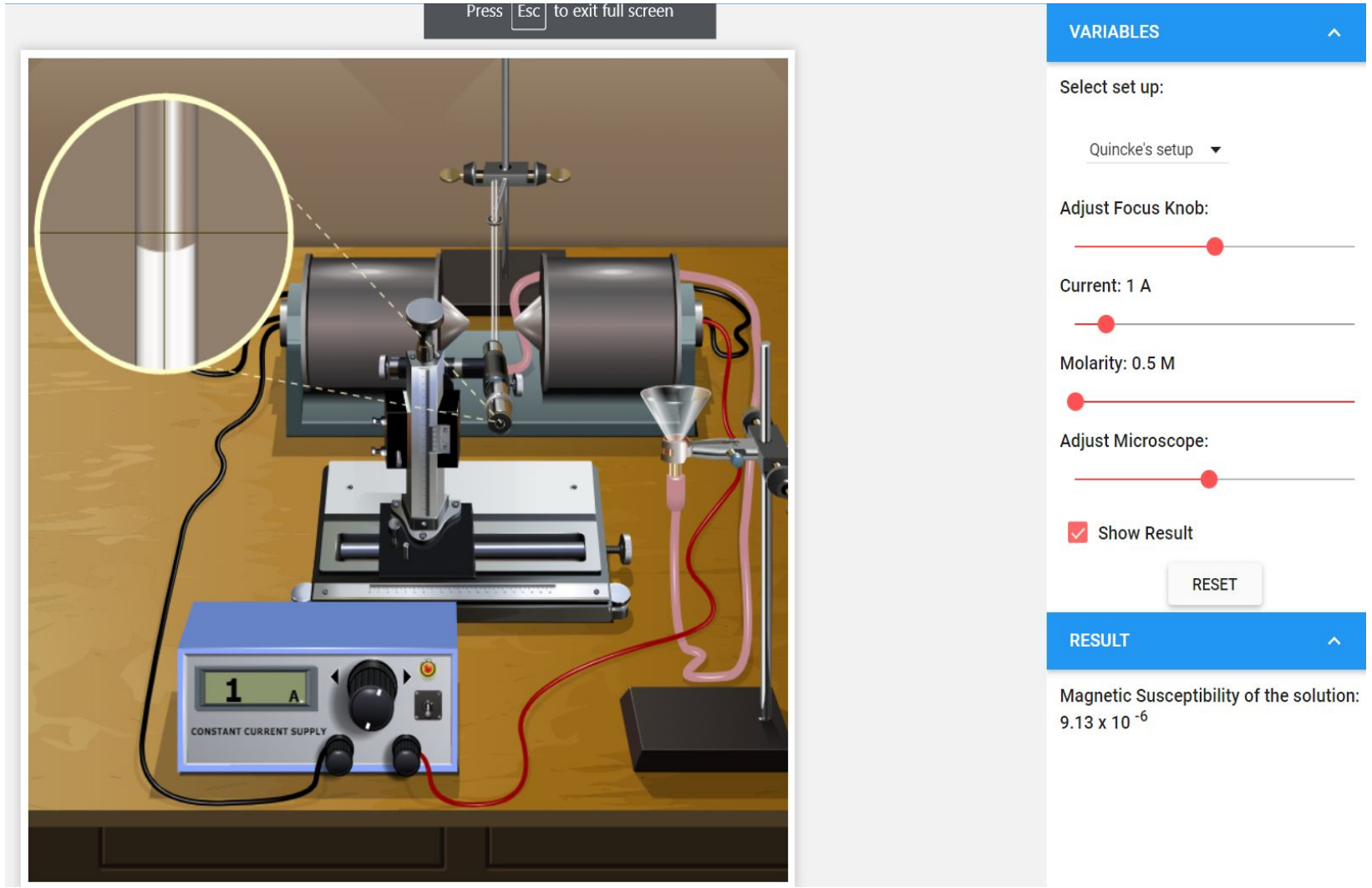
Step 1: Adjust the focus and microscope position.

Step 2: Set the molarity and vary the current.

Step 3: Note the magnetic susceptibility of the solution.



4. Now Select **Quincke's setup**



Further steps to follow: -

- By adjusting the current level of the solution
- Now adjust the microscope and focus knob
- Plot a graph between Magnetic molarity and Magnetic Susceptibility of the solution.

Observation Tables

Setup 1

Current I (A)	Magnetic Field B (Gauss)

**Plot a graph between current and magnetic field

Setup 2

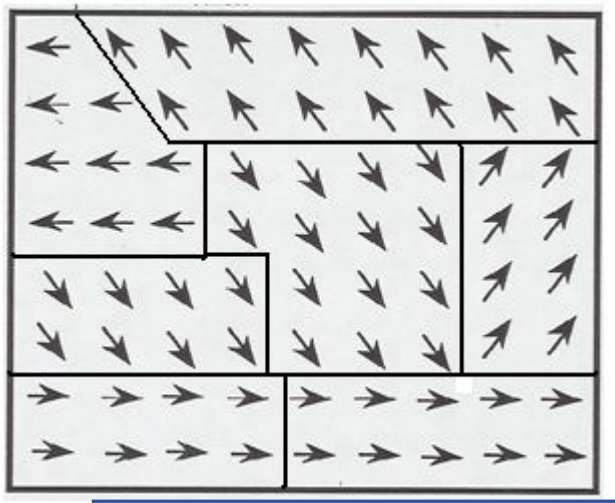
Current = A

Molarity (M)	Magnetic Susceptibility (χ_{sol}) x 10^{-6}

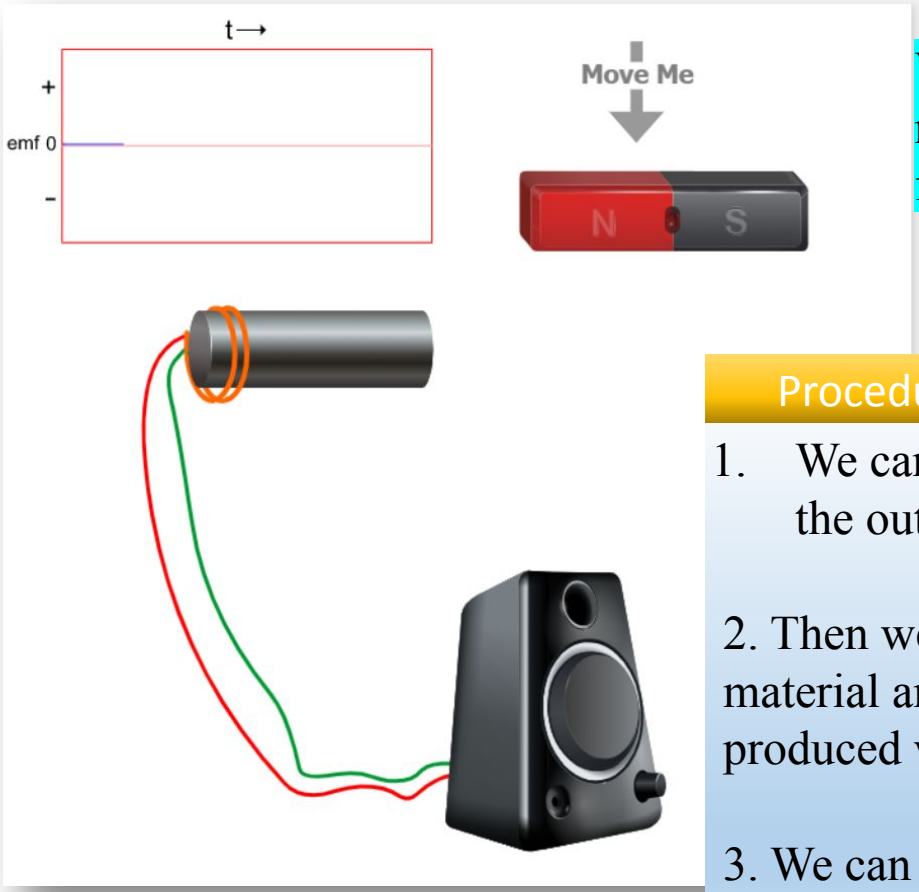
**Plot a graph between molarity and susceptibility.

Barkhausen Effect: https://en.wikipedia.org/wiki/Barkhausen_effect

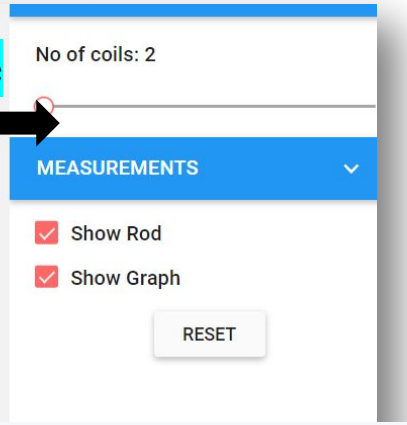
- Series of sudden changes in the size and orientation of ferromagnetic domains, or microscopic clusters of aligned atomic magnets, that occurs during a continuous process of magnetization or demagnetization.



Domains in ferromagnetic material



We can change no of coils from here



Procedure: -

1. We can firstly remove the rod and look at the output graph by moving the magnet.

2. Then we can insert the rod of ferromagnetic material and look at output graph of EMF produced with time.

3. We can change the no. of coils and see how produced EMF changes.

Practical use: -

The amount of Barkhausen noise for a given material is linked with the amount of impurities, crystal dislocations, etc. and can be a good indication of mechanical properties of such a material.

Thank You