

# Get Ready to crack CSIR-NET 2021 (Short Notes on Electron Spin Resonance(ESR))



## **ESR (ELECTRON SPIN RESONANCE SPECTROSCOPY)**



**Fig. Showing ESR machine in lab**

**It is a branch of absorption spectroscopy** in which radiation having **frequency in microwave region** is absorbed by paramagnetic substance to induce transition between magnetic energy level of electron with unpaired spins.

**Magnetic energy splitting is done by applying static magnetic field.**

Absorption spectroscopies operate at microwave frequency  $10^4$ - $10^6$  MHz.

### **APPLICATIONS OF ESR SPECTROSCOPY**

#### **STUDY OF FREE RADICALS**

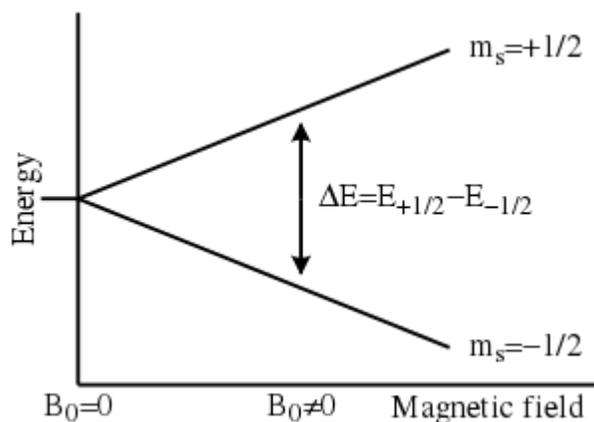
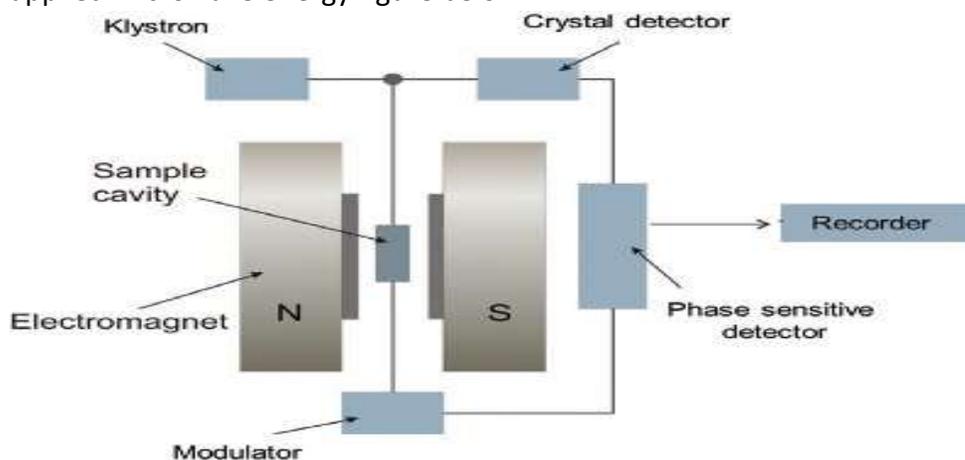
- With the help of this we can study about free radicals. Even in very low concentration we can study free radicals by using ESR SPECTROSCOPY.
- Structure of organic and inorganic free radicals can be identified.
- We can also investigate molecules in triplet state.
- Spin label gives the information about polarity of its environment.

#### **STRUCTURAL DETERMINATION**

- In certain cases, ESR provides the information about the shape of the radicals.

## PRINCIPLE OF ESR

- ESR spectroscopy is based upon the absorption of microwave radiation by an unpaired electron when it is exposed to a strong magnetic field.
- The electronic energy levels of the **atom or molecules will split into different levels**. Such an **excitation is called a magnetic resonance absorption**.
- With an **ESR instrument a static/magnetic field and microwave are used** to observe the behavior of unpaired electrons in the material being studied.
- In principle, **ESR finds paramagnetic centers (e.g., radicals)** that may or may not be radiation induced.
- **A strong external magnetic field** generates a difference between the energy levels of the electron spins,  $m_s = +\frac{1}{2}$  and  $m_s = -\frac{1}{2}$ , which results in resonance absorption of an applied microwave energy figure below.



**Fig. Showing Strong external magnetic field generates a difference between the energy levels of the electron spins,  $m_s = +\frac{1}{2}$  and  $m_s = -\frac{1}{2}$ .**

- The study of the behavior of electrons in a condition of the sample.
- **ESR is used to observe and measure the absorption of microwave energy by unpaired electrons in a magnetic field as and electrons energy levels.**

### Working Principle of ESR

- The gap between the and energy states is widened until it matches the energy of the microwaves this is done by **increasing an external magnetic field**.
- At this point the **unpaired electrons can move between their two spin states**.
- **Absorption lines are detected** when separation level of energy is equal to the energy of the incident light.
- It is this **absorption** that is **monitored** and converted into a spectrum.
- (As shown in diagram below)

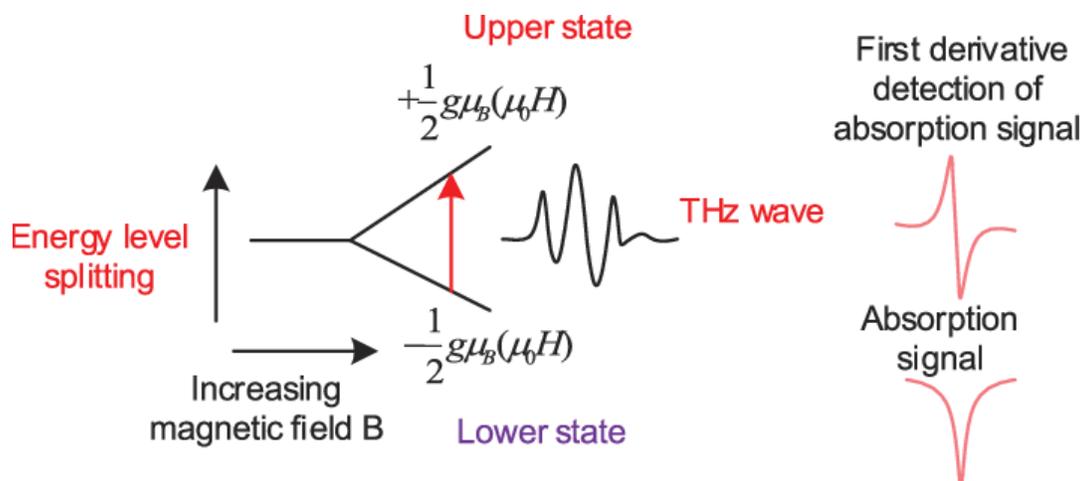


Fig. Showing Working Principle of ESR

### ESR IS SHOWN BY FOLLOWING:

- Atom having an odd number of electrons.
- Ions having partly filled inner electron shells.
- Free radicals having unpaired electrons etc.

### Advantages:

- With the help of ESR Spectroscopy several types of irradiated food can be identified.
- It can detect paramagnetic ion and free radicals in a variety of materials.

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