

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.

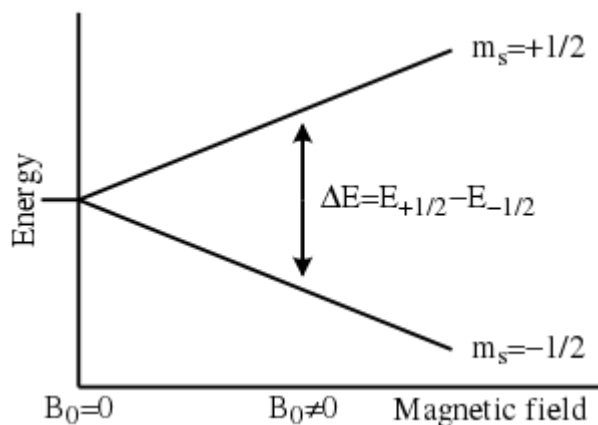
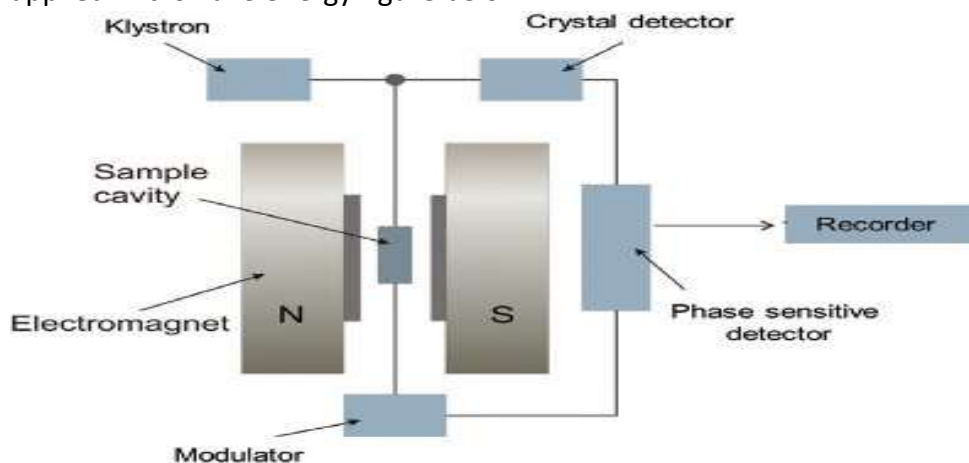


Fig. Showing Strong external magnetic field generates a difference between the energy levels of the electron spins, $m_s = +\frac{1}{2}$ and $m_s = -\frac{1}{2}$.

- 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)

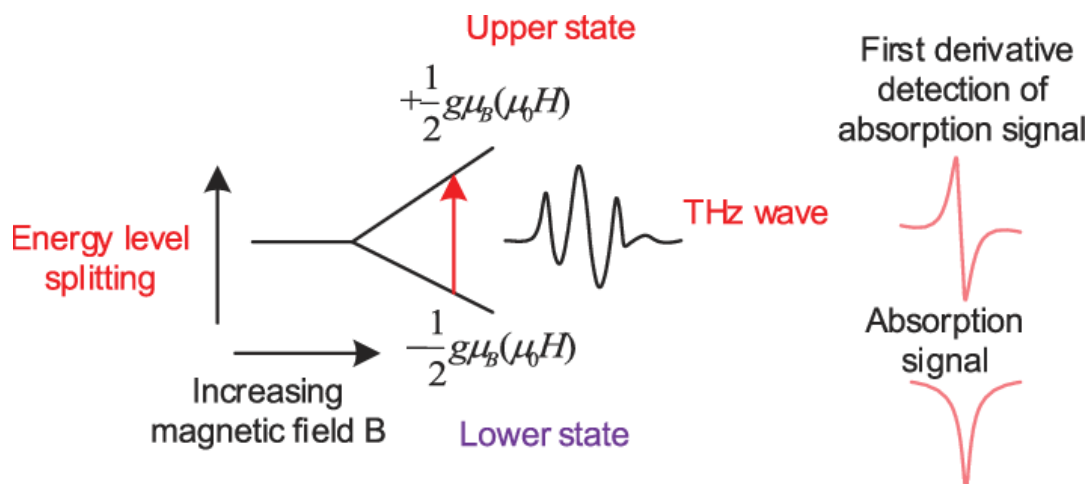


Fig. Showing Working Principle of ESR

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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