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Research

Electron Magnetic Resonance in Nanoparticles and its Characteristics

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ABSTRACT

Electron Magnetic Resonance (EMR) is an interdisciplinary field in which electron spin creates a magnetic field in condensed matter physics. In an atom, electron has a negative charge and when it spins, it produces magnetism. In this paper, simulation of Electron Magnetic Resonance in nanoparticles is performed. These calculations are established on the "*giant spin*" method. Two major graphs EMR Absorption spectra and First derivative of EMR-Absorption curve for temperatures for 30K, 100K, 200K, 300K and 400K are plotted; maintaining other parameters constant. Observations and Results are noted.

Background/Literature Review

What exactly is the spin of an electron? Most of the simple and fundamental particles have a property called angular momentum. In this case, of an electron, it gives an impression to the outside world that the electron is actually spinning. However, when electrons act together or with electromagnetic radiation (photons), they can interchange angular momentum and energy. All such changes undergo inside an atom, molecules, and solids. For EMR, microwaves can be used to look at the electrons in solids. In Magnetic substances, not all of the electron spins are paired. Hence, EPR is used to study magnetism. It has a very significant role in technological importance where magnets play a vital role in our everyday lives. For instance in electric motors, memories in computer hard drive, etc. EPR/ESR is also useful to chemists who can attribute unpaired electrons to molecules, this process called spin labeling. They can perform EPR in the labeled molecule and using that unpaired electron as a local probe that illustrates performance inside the molecule.

Objective

Simulation of electron magnetic resonance in nanoparticles.

Subjects

Electron magnetic resonance in nanoparticles.

Results

What is claimed in this research article are

1. Characteristics of Electron Magnetic Resonance in nanoparticles are plotted for temperatures of 30K, 100K, 200K, 300K and 400K.
2. Highest peak values for EMR Absorption Spectra are noted.
3. Highest and lowest peak values for first derivative spectra of EMR-Absorption curve are noted.

Conclusion

In this research article all, the values are taken as default values, which are documented in Tables. Results, graph, voltages, etc., vary for the change in the parameters and its values. The author also wants to take note: whenever the temperature is increasing graphs are sharper and the signal is varying but Magnetic field strength (G) is constant for all the graphs even for a change in temperatures.

Keywords: *Electron Magnetic Resonance, EMR, Nanoparticles.*

INTRODUCTION

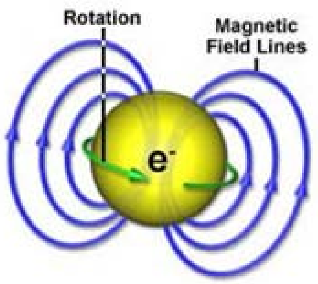
Electron Magnetic Resonance (EMR) can be compared to another resonance method; one is Nuclear Magnetic Resonance (NMR) and other is Ion Cyclotron Resonance (ICR). The major difference from others is EMR is more focused on electrons rather than nuclei unlike in Nuclear Magnetic Resonance (NMR) or Ion Cyclotron Resonance (ICR).

There are various methods in EMR, including Electron Paramagnetic Resonance (EPR), Electron Spin Resonance (ESR) and Electron Cyclotron Resonance (ECR). One of the major difference between ESR and NMR is that it pairs up electrons. In the majority of materials, electrons pair up so that one of them has its spin pointing one way, and other has its spin pointing in the opposite direction.

What exactly is the spin of an electron? Most of the simple and fundamental particles have a property called angular momentum. In this case, of an electron, it gives an impression to the outside world that the electron is actually spinning. However, when electrons act together or with electromagnetic radiation (photons), they can interchange angular momentum and energy. All such changes undergo inside an atom, molecules and solids. For EMR, microwaves can be used to look at the electrons in solids.

In Magnetic substances, not all of the electron spins are paired. Hence, EPR is used to study magnetism. It has a very significant role in technological importance where magnets play a vital role in our everyday lives. For instance in electric motors, memories in computer hard drive, etc. EPR/ESR is also useful to chemists who can attribute unpaired electrons to molecules, this process called spin labeling. They can perform EPR in the labeled molecule, and using that unpaired electron as a local probe that illustrates performance inside the molecule.[1]

Figure I. Illustrates Electrons, which are like tiny magnets.[1]



In the giant spin method, electric current or external electric field can introduce diagonal spin causing spin accumulation at opposite boundaries. The spin conversion without magnetic field makes spin effect an essential tool for spin manipulation in any spintronic devices.[2]

ELECTRON MAGNETIC RESONANCE IN NANOPARTICLES

Electron Magnetic Resonance for the temperature of 30K

A simulation for Electron Magnetic Resonance was performed for the temperature of 30K.[3]

Figure 2. Illustrates EMR Absorption Spectra for temperature of 30K

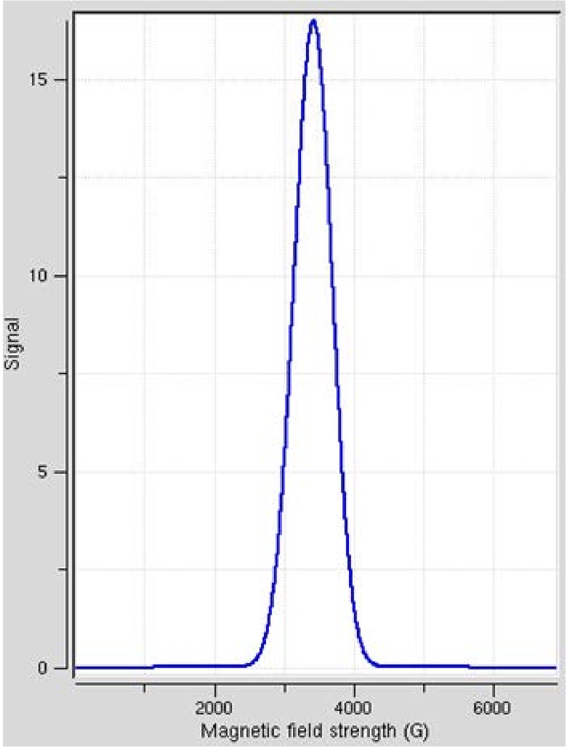


Figure 3. Illustrates first derivative spectra of EMR-Absorption curve for temperature of 30K

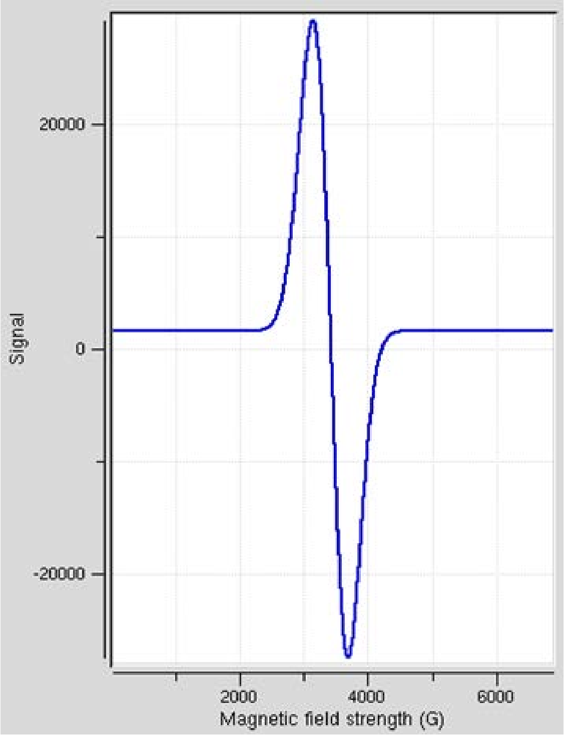


Table 1. Simulation Notes for Electron Magnetic Resonance for 30k

Sl No	Simulation Specifications	Value
1	Effective anisotropy field (Oersted)	250
2	Size of magnetic nanoparticles	3nm
3	Temperature	30K

Observations

1. In figure 2, Highest Magnetic Resonance spectra were 16.516 @ 3412.91G.
2. In figure 3, the highest first derivative spectra of EMR-Absorption curve was 29268.8 @ 3137.82G.
3. In figure 3, the lowest first derivative spectra of EMR-Absorption curve was -27407.1 @ 3688.01G.

Electron Magnetic Resonance for Temperature of 100K

Simulation results, observations, and table for Electron Magnetic Resonance for the temperature of 100K.

Figure 4. IIllustrates EMR Absorption Spectra for Temperature of 100K

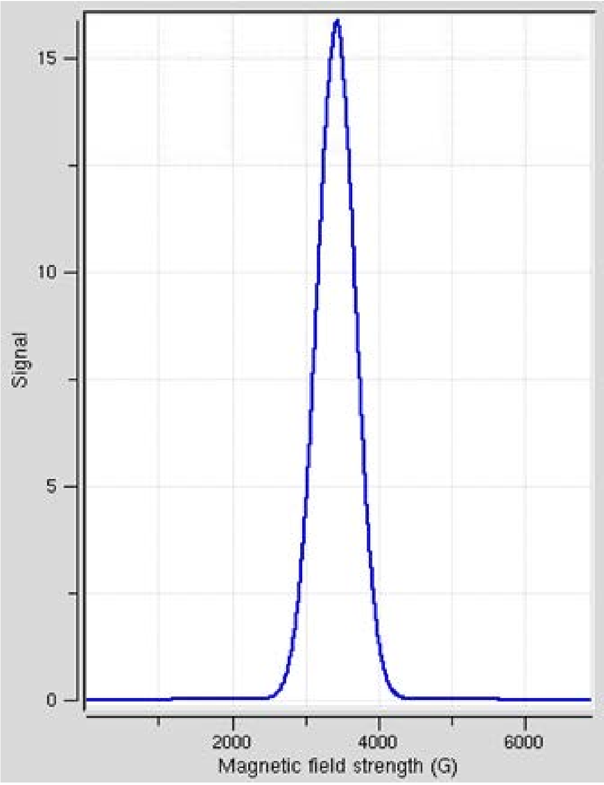
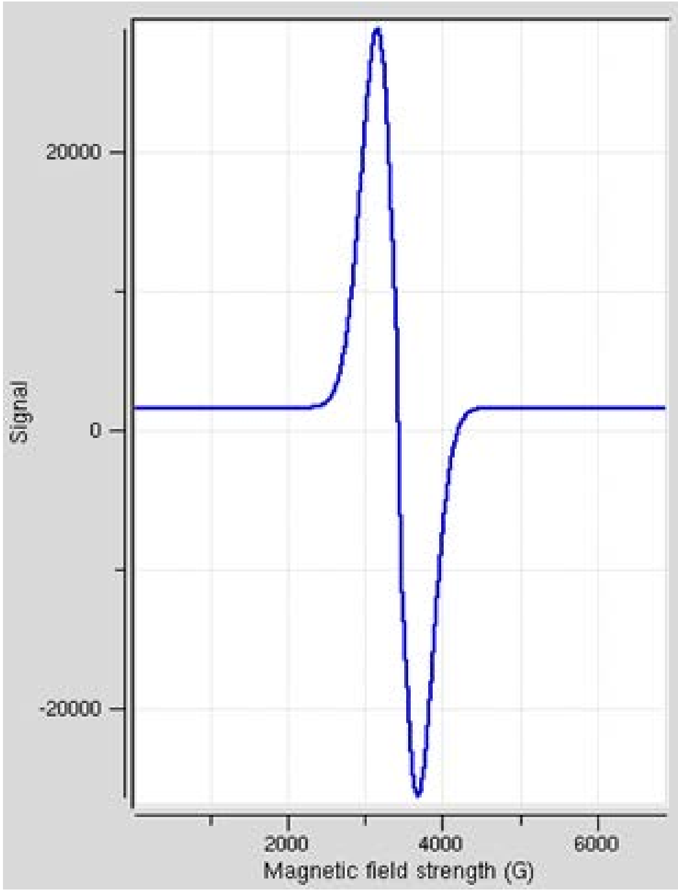


Table 2. Simulation Notes for Electron Magnetic Resonance for 100k

Sl No	Simulation Specifications	Value
1	Effective anisotropy field (Oersted)	250
2	Size of magnetic nanoparticles	3nm
3	Temperature	100K

Figure 5. Illustrates first derivative spectra of EMR-Absorption curve for temperature of 100K.



Observations

1. In figure 4, Highest Magnetic Resonance spectra were 15.8853 @ 3430.1G.
2. In figure 5, highest first derivative spectra of EMR-Absorption curve was 28804.1 @ 3155.01G.
3. In figure 5, lowest first derivative spectra of EMR-Absorption curve was -26188.5 @ 3679.41G.

Electron Magnetic Resonance for Temperature of 200K

Simulation Results for Electron Magnetic Resonance for temperature of 200K.

Table 3. Simulation Notes for Electron Magnetic Resonance for 200k

Sl No	Simulation Specifications	Value
1	Effective anisotropy field (Oersted)	250
2	Size of magnetic nanoparticles	3nm
3	Temperature	200K

Figure 6. Illustrates EMR Absorption Spectra for Temperature of 200K

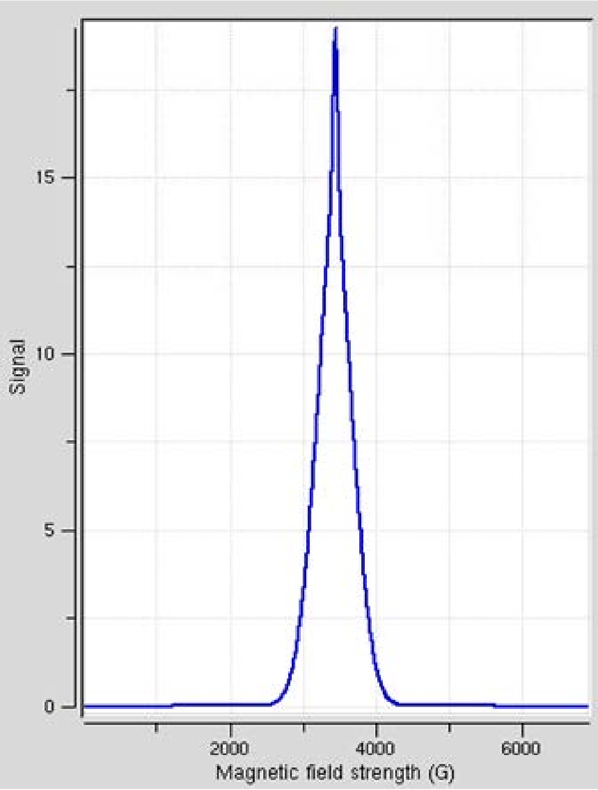
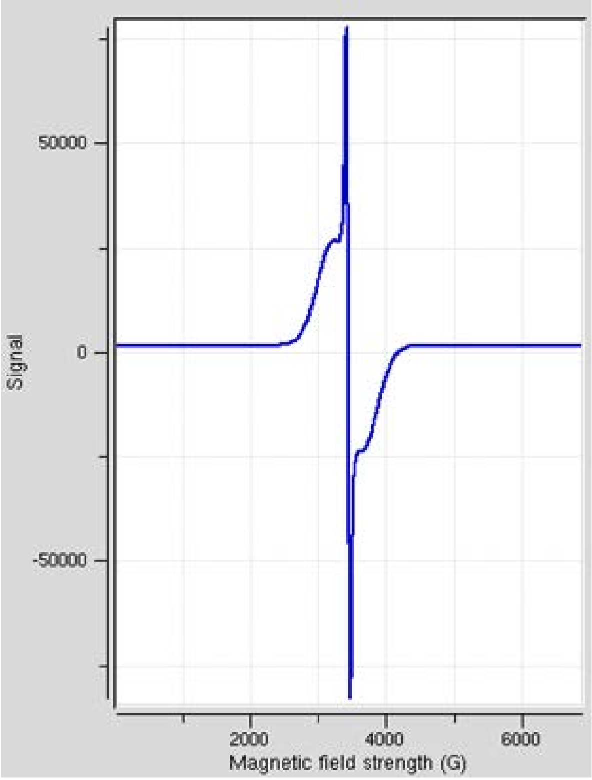


Figure 7. Illustrates First Derivative Spectra of EMR-Absorption Curve for Temperature of 200K



Observations

1. In figure 6, Highest Magnetic Resonance spectra were 19.2769 @ 3438.7G.

2. In figure 7, Highest first derivative spectra of EMR-Absorption curve was 77863.6 @ 3412.91G.

3. In figure 7, Lowest first derivative spectra of EMR-Absorption curve was -82540.03 @ 3464.49G.

Electron Magnetic Resonance for Temperature of 300K

Simulation Results, observations, and table for Electron Magnetic Resonance for the temperature of 300K.

Figure 8. Illustrates EMR Absorption Spectra for Temperature of 300K

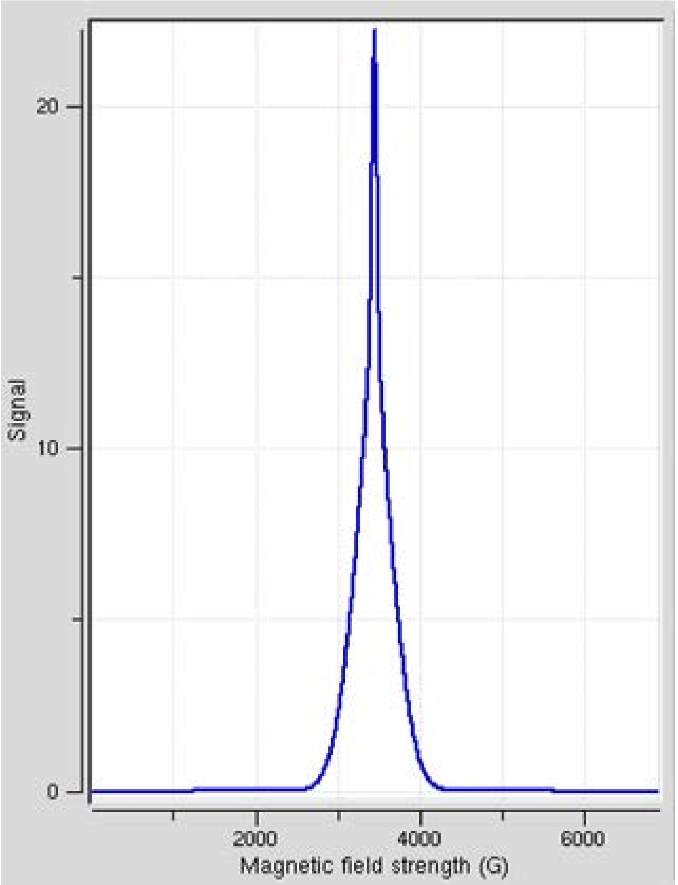
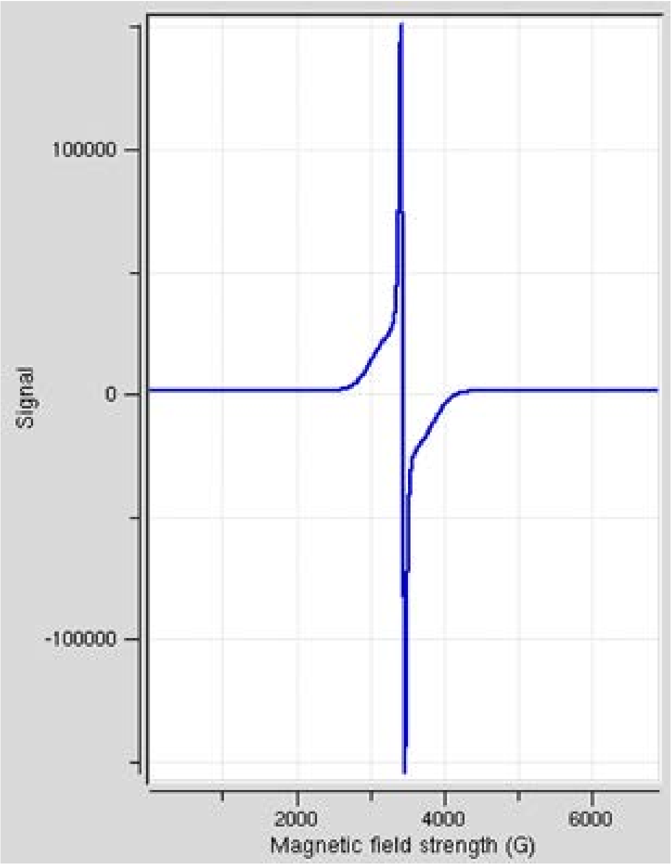


Table 4. Simulation Notes for Electron Magnetic Resonance for 300k

Sl No	Simulation Specifications	Value
1	Effective anisotropy field (Oersted)	250
2	Size of magnetic nanoparticles	3nm
3	Temperature	300K

Figure 9. Illustrates First Derivative Spectra of EMR-Absorption Curve for Temperature of 300K



Observations

1. In figure 8, Highest Magnetic Resonance spectra were 22.2289 @ 3438.7G.
2. In figure 9, the highest first derivative spectra of EMR-Absorption curve was 151441 @ 3412.91G.
3. In figure 9, the lowest first derivative spectra of EMR-Absorption curve was -153941 @ 3464.49G.

Electron Magnetic Resonance for Temperature of 400K

Simulation Results, observations and table for Electron Magnetic Resonance for the temperature of 400K.

Table 5. Simulation Notes for Electron Magnetic Resonance for 400k

Sl No	Simulation Specifications	Value
1	Effective anisotropy field (Oersted)	250
2	Size of magnetic nanoparticles	3nm
3	Temperature	400K

Figure 10. Illustrates EMR Absorption Spectra for Temperature of 400K

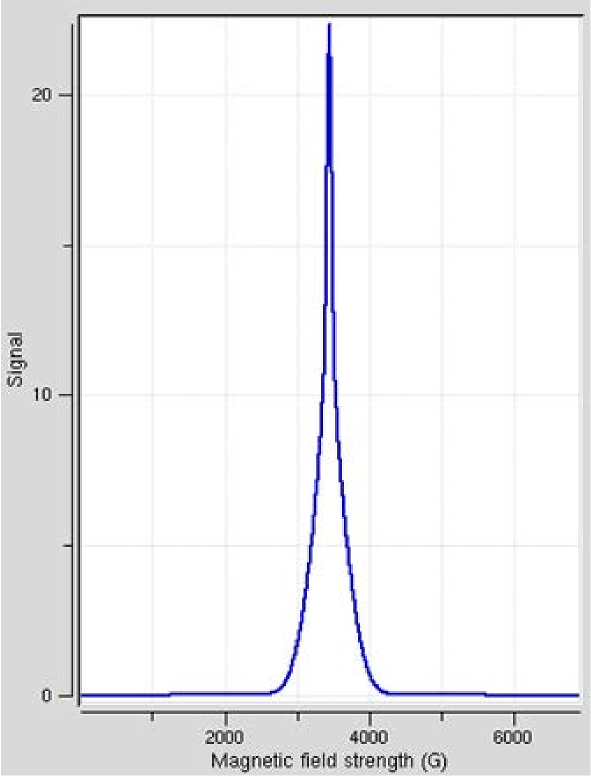
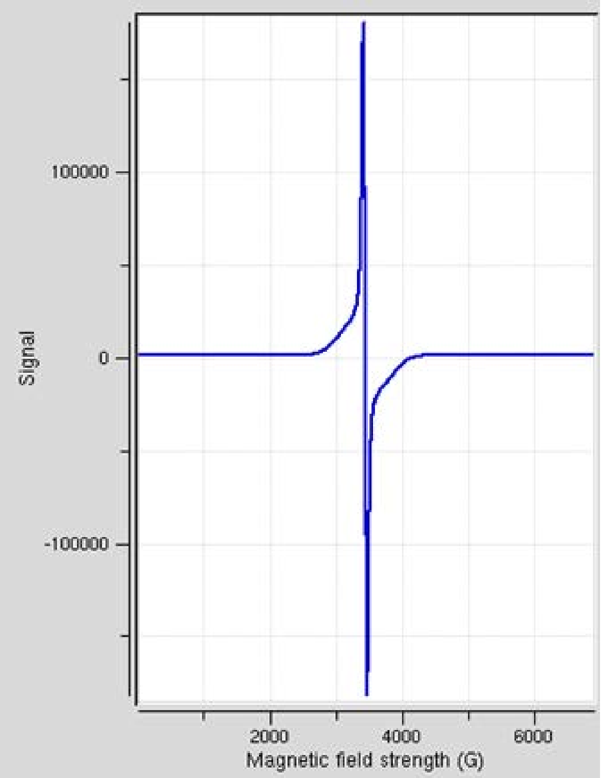


Figure 11. Illustrates First Derivative Spectra of EMR-Absorption Curve for Temperature of 400K



Observations

1. In figure 10, Highest Magnetic Resonance spectra were 22.3764 @ 3438.7G.

2. In figure 11, the highest first derivative spectra of EMR-Absorption curve was 181087 @ 3412.91G.

3. In figure 11, the lowest first derivative spectra of EMR-Absorption curve was -181135 @ 3464.49G.

RESULTS

What is claimed in this research article are

1. Characteristics of Electron Magnetic Resonance in nanoparticles are plotted for temperatures of 30K, 100K, 200K, 300K and 400K.

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In this research article, all the values are taken as default values which are documented in Tables. Results, graph, voltages, etc., vary for the change in the parameters and its values.

The author also wants to take note: whenever the temperature is increasing graphs are sharper and the signal is varying but Magnetic field strength (G) is constant for all the graphs even for a change in temperatures.

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CONFLICTS OF INTEREST

There is no conflicts of interest as per the Author's point of view.

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