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Investigate the scattering of electromagnetic waves from lanthanide nanoparticles by changing the size and shape of nanoparticles

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ABSTRACT

The aim of this study was to evaluate the effect of change in particle size and shape of nano lanthanides and its effect on the distribution of electromagnetic waves. In this study, we investigated lanthanide nanoparticles for the scattering of electromagnetic waves in excitation factors such as the electronic properties of nanoparticles, the size and shape of nanoparticles, the temperature properties around nanoparticles and dielectric nanoparticles. In this study, lanthanide nanoparticles with CST software were used to simulate the scattering of electromagnetic waves. In this project, using the classical electromagnetic theory, the scattering of small dielectric particles in relation to this cross section of electromagnetic waves was investigated and the changes for different parameters were evaluated. Also, the rotation measured the cross-section of small particles by changing the parameters. Lanthanide nanoparticles in the 60 GHz to 120 GHz band were used to study the scattering of electromagnetic waves. The results showed that the yield of lanthanide particle nanometers was more than five nanometers in diameter and more than ten nanometers. We have shown that with the angular scattering of electromagnetic waves, lanthanide nanoparticles are more oval and more than a spherical shape.

1-Introduction

In the last decade, many efforts have been made to produce new materials, nanostructured materials. Nanoparticles have been shown to have unique properties due to their small size and high specific surface area. Similarly, these materials are due to their large internal surface area and small pore size. There are many applications [1] Nanotechnology holds a promising potential for developing biomedical nanoplatforms in cancer therapy [2].

Lanthanides are elements 58 to 71 of the periodic table. They are part of the elements of inner transition. It should be noted that the chemical properties of these elements are also characteristic of lanthanum, this group of elements, rare earth elements refers to "rare earth elements".

Lanthanides have good ability due to their half-life and duration of radiation and scattering of electromagnetic waves. Lanthanide metals are shiny and have a significant chemical reaction. An important feature of Negligee is that by changing the size of lanthanide nanoparticles, the nanoparticles scatter different levels of electromagnetic waves.

Particle size and distribution, effect on density, mechanical properties, sheets of electrical and thermal materials. Electromagnetic waves, electromagnetic wave range (infrared) up to 1013 Hz (ultraviolet) range 3 to 30,000 Hz or 1017 nm. The relationship between frequency and wavelength is C = λv while C is the velocity of electromagnetic waves in a vacuum [3].

Wave Properties and Particles Electromagnetic waves can be thought of as an energy package or photon that all photons of electromagnetic radiation have a specific wavelength and a certain amount of energy. The intensity of electromagnetic radiation at a certain wavelength is equal to the number of photons per unit area per unit time.

Electromagnetic waves are used as a source of electromagnetic radiation when the particle size of lanthanides changes. Electromagnetic waves are used as a source of electromagnetic radiation. Compared to white, which contains a wide range of electromagnetic wavelengths, electromagnetic radiation is four to counteract the scattering phenomenon. Absorption, reflection, and refraction occur when the magnitude of each of these phenomena is equal to the wavelength of the waves. It depends on the electromagnetic and optical properties of the material[4].

Medintz [5] showed that the fluctuations of electromagnetic wave propagation can be measured using a suitable detector. The oscillations of the scattered electromagnetic waves in the solvent depend directly on the propagation speed, and by knowing the viscosity of the environment, the intensity of the vibrations is used to determine the sample size. The diameter measured in this way is labeled as the hydrodynamic diameter of the particles in the sample and indicates how fluid it is.

The diameter obtained by this method is measured by the circular transfer coefficient of the particle. The diffusion coefficient of particle size, surface structure, depends on the concentration and type of ions in the environment.

Zrazhevskiy et al. [6] do not consider it to be fixed in the action of lanthanide particles and move continuously with Brownian motion. One of the characteristics of small, fast and large particle brown motion is slow motion. Because lanthanide nanoparticles are constantly moving, the pattern created by the motion appears to amplify the light and dark areas. Particle size is calculated using oscillations.

The relationship between particle size and velocity in the Stoke-Einstein brown lanthanide defined by the equation. This equation: [7]

$$d(H) = \frac{kT}{3\pi\eta D} \quad \ldots\ldots(1)$$

The hydrodynamic diameter of particles dH, K is the Boltzmann constant, η the viscosity of the solvent depends on temperature, pressure and density and related systems, T is the absolute temperature and D is the diffusion coefficient [7]

Mader and Kele[8] showed that the magnetic anisotropy properties of nanoparticles are directly affected by supra-magnetic nanoparticles. The magnetic moment of nanoparticles is low at easy crystal axis (EA) magnetic anisotropy energy. Spherical magnetic particles are the magnetic anisotropy of the crystal magnetic anisotropy of the whole.

This anisotropy is a barrier to changing the direction of magnetic waves. When the particle size is reduced by the size of the provinces, EA is equal to the thermal activation energy (KBT). Despite the small barrier, the anisotropy of energy versus thermal activation energy or magnetic nanoparticles is easily differentiated by an external magnetic field.[9].

Despite the small anisotropy, the energy barrier due to thermal activation or magnetic nanoparticles is easily carried out by changes in the external magnetic field. If the thermal energy is greater than EA, all directions and magnetic moment are inhomogeneous in many respects. Basically, the general behavior of magnetic nanoparticles, such as atoms, is super-magnetic. Although nanoparticles have little magnetism, each particle acts like a magnetic atom, but it has a high magnetic moment. Such behavior is called super-magnetic. The paper super-magnetic nanoparticles change rapidly for magnetism rather than specific direction. Nanoparticles inhibit the energy of magnetic anisotropy. Temperature always exceeds the energy of heat activation, called the blocking temperature.

2-The method (method of study)

Consultant lanthanide nanoparticles with a diameter greater than 10 nm, the dielectric constant equal to the amount of bulk material does not depend on the size. Thus it is observed that the dependence of the large optical spectrum of the nanoparticle size on the particle size can only be controlled by the external effects of electromagnetic radiation.

Researchers are looking for the fact that the interaction of nanoparticles based on size with electromagnetic waves with excitable wavelength λ d can be analytical, semi-analytical and numerical. Of course, the hypothesis that has always been considered in this analysis is that d «λ is a particle size much smaller than the wavelength. The electromagnetic field of a harmonic oscillation phase is assumed to be a constant volume particle.

In lanthanide nanoparticles for scattering electromagnetic waves in local surface excitation and affecting their properties under the following conditions:

Electronic properties of nanoparticles

Size and shape of nanoparticles

Temperature properties of nanoparticles

Surrounding dielectric nanoparticles

It should be noted that with the distance from the surface of metal nanoparticles, the intensity of the electromagnetic field (especially the electric field strength) decreases exponentially.

Nano-sized electromagnetic field is generated locally and improves compression. Slight changes in the volume of the surrounding nanoelectric, on the effect of intensifying the surface of the plasmon, so that these changes in the scattered light, the wavelength of light absorbed or change. Changes can be measured using optical specifications.

Lanthanide nanoparticles are able to limit light to a very small volume around them, ie below the scattering limit. This causes highly localized and enhanced electromagnetic fields in the so-called "hot spots" of plasmon nanoparticles.

These hotspots are useful for measuring as well as enhancing surface processes. Because any object that is in the hot spot, it affects the light resonance of the system by connecting to the local field.[10].

Particle measurements can only be obtained using scattering spectroscopy, from plasmonic nanoparticles efficiently scattering light and can be easily seen under a dark field microscope.

Development of a fabrication method for creating plasmonic nanoantenna structures By placing a desired nanoparticle (eg a lanthanide nanoparticle) at a hot spot, the optical resonance of the system can be altered by connecting to a local field. The role of the size and shape of lanthanide nanoparticles has also been discussed, which can be effective in Localized surface Plasmon resonance (LSPR).

Scattering and absorption of light in metal nanoparticles

Adsorption is when light is absorbed into matter, and scattering occurs when light is forced to deviate from a direct path due to the non-uniformity and inhomogeneity of the nanoparticle affected by electromagnetic waves.

The propagation of electromagnetic waves through a scattered source can follow these two mechanisms under certain conditions. The sum of adsorption and dispersion leads to the cross-sectional area of the dispersion.

The German physicist Gustav Mai (1908) proposed an exact solution of Maxwell's equations for a wave affected by the input of electromagnetic waves interacting with a spherical particle of variable size and composition.

However, a baseline model is useful for understanding how materials in and around LSPR particles affect lanthanide. When a particle of size a is smaller than the wavelength of light, a << λ can create a so-called quasi-static approximation to solve Maxwell equations. Approximate means that an electromagnetic field is occurring in interaction with a particle at a constant particle volume. For a spherical nanoparticle in the quasi-static range, the sections for scattering, scattering, and adsorption can be described as follows:

$$C_{ext} = 4\pi k a^3 \cdot Im\left\{\frac{\varepsilon_p - \varepsilon_m}{\varepsilon_p + 2\varepsilon_m}\right\} \quad ....(2)$$

$$C_{sca} = \frac{8\pi}{3} k^4 \cdot a^6 \left|\frac{\varepsilon_p - \varepsilon_m}{\varepsilon_p + 2\varepsilon_m}\right|^2 \quad ....(3)$$

$$C_{abs} = C_{ext} - C_{sca} \quad ....(4)$$

Where k is the number of waves (k = 2 / / λ), a is the radius of the particle, εm is the dielectric function of the surroundings, and εp is the dielectric function of the metal nanoparticle. As can be seen from the equation, the scattering scale is considered as the particle volume (a3) and the scaling scale is considered as the square particle volume (a3). It is also known that particle scattering and adsorption are affected by the dielectric functions of both the particle and its surroundings. As can be seen from the following equation, the maximum in the scattering and scattering section must be done with the following conditions[11].

$$\varepsilon_p + 2\varepsilon_m = 0 \quad ....(5)$$

Which is the resonance mode for lanthanide LSPR

If a state is assumed to summarize a dielectric algorithm of a metal as predicted, the simplest approximation is used to describe the optical properties of metals, assuming that all the electrons in the structure are displaced.

$$\varepsilon_p = 1 - \frac{\omega_p^2}{\omega^2 + i\gamma\omega} \quad ....(6)$$

Where ωp is the lanthanide frequency of a metal, for example the following frequency, where each metal is equal to the external disturbance frequency.

The combination of the last two equations for the lanthanide LSPR frequency is then expressed.[12]

$$\omega_{max} = \frac{\omega_p}{\sqrt{2\varepsilon_m + 1}} \quad ......(7)$$

The above equation can be rewritten in terms of wavelength

$$\lambda_{max} = \lambda_p\sqrt{2\varepsilon_m + 1} \quad ......(8)$$

Where λp is the wavelength corresponding to the lanthanide frequency of the bulk metal. It is clear that the position of the lanthanide LSPR wavelength depends on the dielectric performance of the environment as well as changes in the lanthanide frequency (or, in other words, the electron density) of the particle. This is the fundamental effect known by the nano lanthanide sensor.

3-Methods and tools for data collection

According to the research methodology applied in this study in order to gather information from many sources: books, articles and research results published in electronic spaces.

At Nano-particle dispersion of electromagnetic waves, nanoparticles of different shapes and sizes lanthanides, geometry plays an important role. To describe the shape and size of randomized lanthanide nanoparticles using a set of parameters on a wide range of frequency, always remains as a challenge. However, if the geometric shapes and various sizes randomly generated lanthanide nanoparticles is not correct, the results even through accurate mathematical solutions to these problems will not lead to the correct answer. The Nano-particle model simulations by taking into account all scenarios, describing the geometry of nanoparticles is required

In general, almost all nanoparticle sizes or sizes are moderate to high, the effective size by the height (rms) controlled. The amount of which is approximately the wavelength of the frequency. Here, with respect to the operating frequency is 60 GHz, the amount of about five millimeters. There is different kind of sizes larger scale level, which in this kind of level as they slowly change. Here we are just the first of which will affect the distribution of millimeter wave, we're dealing.

Lanthanide nanoparticles of different shapes and sizes with the height of one-dimensional random

z = F (X)……….(9)

It is considered to be a Gaussian random process. Gaussian processes described completely by the correlation function

$\langle f(x_1) f(x_2) \rangle = h^2 C(x_1, x_2)$ ....(10)

In the C and h respectively represent the relationship of the correlation function and are effective height. If the height of the statistics we are immutable.

Then, we

$C(x_1, x_2) = C(x_1 - x_2)$ ......(11)

Fourier power $h^2 C(x)$ spectrum density $W(k_x)$ resulted. The power spectral density level of a limited size L and cause the height function F (x) can be considered as $f(x) = f(x+L)$ a periodic function of size L that. Fourier series for F (x) as follows: [5]

$$f(x) = \frac{1}{L}\sum_{n=-\infty}^{\infty} b_n e^{(\frac{i2\pi nx}{L})}$$ ....(12)

$k_x = \frac{2\pi}{L}$, $b_n = 2\pi L W(k_x)$ Regarded…(13)

Lanthanide nanoparticles of different shapes and sizes to model the stochastic correlation function normally two types of nanoparticles with different sizes are used for modeling:

Gaussian correlation function

$$C(x) = \exp(\frac{-x^2}{L_x^2})$$ ......(14)

And exponential correlation function is shown below.

$$C(x) = \exp\left(\frac{-|x|}{L_x}\right)$$ .....(15)

In the above equation, Lx is the correlation length in the X direction.

Power spectral density corresponding Gaussian correlation function is as follows:

$$W(k_x) = \frac{h^2 L_x}{2\sqrt{\pi}} \exp(\frac{-k_x^2 L_x^2}{4})$$ ......(16)

And for exponential correlation function

$$W(k_x) = \frac{h^2}{\pi(1 + k_x^2 L_x^2)}$$ ......(17)

In this study, the size distribution of nanoparticles in simulated Gaussian random statistical correlation function can be modeled. Charts nanoparticles with different sizes were measured and their correlation functions can be achieved in this regard will be discussed in the next chapter.

In this study, to be able to study the dispersion of electromagnetic waves lanthanide nanoparticles by changing the particle size and shape of the nanoparticles, the frequency band 60 GHz to 120 GHz for the research study.

Table 1: Frequency band lanthanide particle diameter of Nano-particles

The nanoparticles shape	Lanthanides particle diameter	Frequency band
circular	30 nm	60GHz to 120 GHz frequency band, C-nm spherical
	40 nm	
	60 nm	
	80 nm	
	100 nm	
Oval	30 nm	
	40 nm	
	60 nm	
	80 nm	
	100 nm	
Angled	30 nm	
	40 nm	
	60 nm	
	80 nm	
	100	

4- results and discussion

Electromagnetic radiation particles and review process

Electromagnetic wave interacts with the particles

Determines particle size by using the communication function

Speed of particles moving an important role in the relationship between communication and function of particle size. If large particles are measured, the intensity of electromagnetic wave spread slowly and slowly swings. However, if the particles are small particles to be measured, they move faster and spread rapidly oscillating electromagnetic wave intensity.

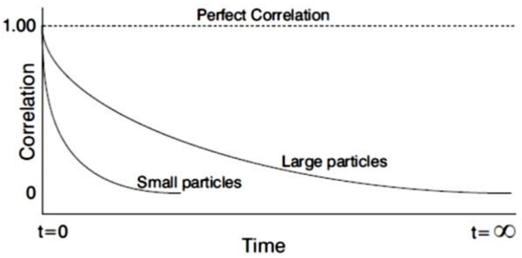

Fig. 1: shows the relationship between communication functions for large and small particles show.

Shape1- curve communication functions for large and small

As can be seen, the rate of loss of communication function, depend on size. Speed function decline, the smaller particles faster than large particles.

In this study, taking into account the software CST, by entering the properties of the particle lanthanides have discussed the research work. The lanthanides include electronic properties of Nano-particle properties of the particle, the size and shape of the nanoparticles, thermal properties of nanoparticles and dielectric nanoparticles are surrounded.

On the other hand, taking into account the frequency band 60 GHz to 120 GHz and thirty nanometers to hundreds of nanometers and the lanthanides particle diameter circular shapes, oval and angular particles, achieved the following results.

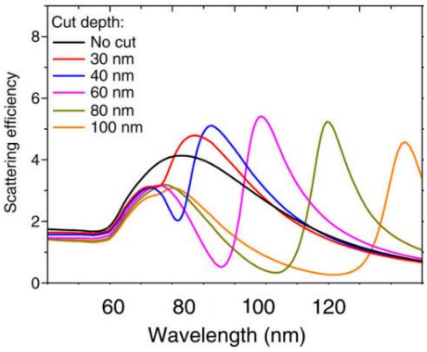

Fig. 2: 60 GHz to 120 GHz frequency band, as well as lanthanides particle diameter of thirty nanometers to hundreds of nanometers.

Evaluation and interpretation of the results show that the frequency band ranging from 60 GHz to 120 GHz, sixty and eighty nanometers and forty-nm particle diameter lanthanide the highest dispersion of electromagnetic waves are lanthanide nanoparticles.

Now, with regard to the determine the lowest and highest rates of wave scattering, at a later stage to examine the effect of particle diameter of sixty, eighty, forty-nm paid

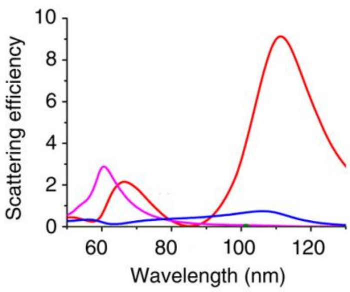

Fig. 3: 60 GHz to 120 GHz frequency band of thirty nanometers to hundreds of nanometers lanthanide Venice particle diameter and shape of the nanoparticles in the form of circular

Evaluation and interpretation of the results show that the frequency band ranging from 60 GHz to 120 GHz and oval-shaped nanoparticles, shown in this frequency range, particles with a diameter of sixty has been most distribution of waves. Efficiency of the particle diameter distribution of lanthanides in one step and the next step is to twenty percent to ninety percent

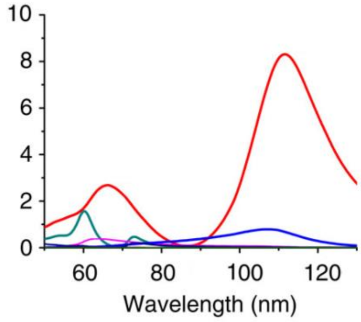

Fig. 4: 60 GHz to 120 GHz frequency band of thirty nanometers to hundreds of nanometers lanthanide Venice particle diameter and shape of the nanoparticles in the form of circular

Evaluation and interpretation of the results show that the frequency band ranging from 60 GHz to 120 GHz and form a circle nanoparticles, It has been shown that in this frequency range, particles with a diameter of sixty has been most distribution of waves. The particle diameter distribution of lanthanides in a stage performance to twenty-five percent to eighty-five percent in the next step.

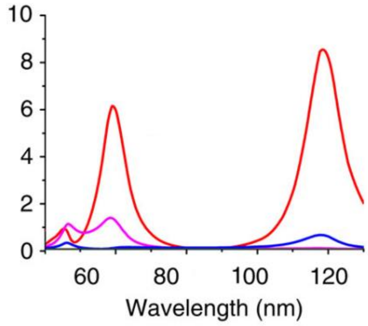

Fig. 5: 60 GHz to 120 GHz frequency band of thirty nanometers to hundreds of nanometers lanthanide Venice particle diameter and shape of the nanoparticles at an angle

Evaluation and interpretation of the results show that the frequency band ranging from 60 GHz to 120 GHz and shape of the nanoparticles at an angle, It has been shown that in this frequency range, particles with a diameter of sixty has been most distribution of waves. The particle diameter distribution efficiency lanthanides and three percent are at one stage and the next stage thumbs up to ninety percent.

Dependence of lanthanide LSPR on the shape, size and material of nanoparticles

Impact of lanthanide nanoparticle shape

Particle shapes other than a sphere can be used effectively to regulate lanthanide LSPR over a wide range of wavelengths. Today, with the advancement of nanotechnology, nanoparticles are produced in different shapes and sizes, and their optical properties must be calculated using various theoretical tools (other than May theory). Theoretical modeling of nanoparticles with arbitrary shapes and sizes improves better understanding and improvement of current lanthanide LSPR assay programs (as well as other nanophotonic impulses). There are several techniques that allow you to calculate the shapes and sizes of different particles. Examples of bipolar discrete approximation (DDA), finite time difference amplitude (FDTD), T matrix method, multiple multiplex method and modified long wavelength approximation (MLWA)

The DDA method is the basis of many papers that analyze different particle shapes and their advantages for lanthanide LSPR assays. For example, Jane (2018) calculated the optical properties of Au nanoparticles in the form of nanospores, nanomaterials and nanomaterials for biological and biomedical imaging applications.

In another paper by Hao et al. [13] the effect of shape on Ag nanoparticles was considered by comparing a triangular prism, a rod and an enclosed element filament. Other forms that have been studied.

Impact of lanthanide nanoparticle size

If the condition a << λ is no longer valid, for example the particle size comparable to the wavelength of light has the following effects: 1) the excitation field becomes non-uniform inside the particles; 2) The depolarization fields of the given volume elements of the induced wave flux experience change when they propagate across the particle. Both effects lead to the phenomenon of lagging behind the optical field.

The lag phenomenon leads to a decrease in the field of moderate depolarization within the nanoparticles (emergence to redshift of the LSPR lanthanide resonance with increasing particle size) and the appearance of a higher order-induced multipolar charge distribution in addition to a dipole. The latter mode (quadrupolar, octapolar, etc.) is increasingly increasing as particle size as well as with asymmetric particle shapes.

Another effect of this is due to the increase in particle size, the expansion of LSPR lanthanide resonance (shorter lifespan), which is caused by the loss of bipolar energy of radiation through photon emission (light scattering). The radial energy loss is proportional to the square of the induced depolarization moment, which is proportional to the particle size. It assumes that as the particle size increases, the radiative plasmon degradation channel begins.

The effects associated with increasing particle size typically result in the conversion of lanthanide LSPR to longer wavelengths and occur in a wide range of lanthanide LSPR peaks.

5- Conclusion

In this study, we were examined the scattering of electromagnetic waves by changing the particle size of the lanthanide nanoparticles and the nanoparticles. We have shown that stimulation of the lanthanide nanoparticles to scatter electromagnetic radiation factors are such as the electronic properties of Nano particles, Nano-particle size and shape, surrounding temperature properties of nanoparticles and dielectric nanoparticles. In this study, in order to simulate the dispersion of electromagnetic waves lanthanide nanoparticles were used with the software CST. In this project, we use the classical theory of electromagnetic scattering cross section of small dielectric particles were dealing with electromagnetic waves. The cross-sectional area changes for different parameters were evaluated. Also, swing by changing the parameters were measured scattering cross section of small particles. To study the dispersion of electromagnetic waves lanthanide nanoparticles, from 60 GHz to 120 GHz frequency band used.

In this study, the researchers examined the scattering of electromagnetic waves by changing the particle size of the lanthanide nanoparticles and the nanoparticles. Lanthanide nanoparticles to scatter electromagnetic radiation at stimulating factors such as the electronic properties of Nano particles, Nano size and shape particle temperature properties of nanoparticles and dielectric nanoparticles surrounding the case involved

Evaluation and interpretation of the results shows that nanoparticles form within the frequency band and at an angle, as shown in this frequency range, particles with a diameter of sixty has been most distribution of waves. We show that, the particle diameter distribution efficiency lanthanides and three percent at one stage and the next stage thumbs up to ninety percent.

Have demonstrated that, with angular scattering of electromagnetic waves from the lanthanide nanoparticles more of an oval shape and it has been more than circular shape.

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[13] L Hao, W Liu, K Liu, K Shan, C Wang, C Xi, J Liu, Q Fan… - Marine drugs, (2019)- mdpi.com In recent years, the wide application of exopolysaccharides (EPSs) in food, cosmetics, medicine, and other fields has drawn tremendous attention. In this study, an EPS produced by Pseudoalteromonas agarivorans **Hao 2018** was isolated and purified, and its …

التحقيق في تشتت الموجات الكهرومغناطيسية من جزيئات اللانثانيدات النانوية عن طريق تغيير حجم وشكل الجسيمات النانوية

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الملخص

الهدف من هذه الدراسة هو تقييم تأثير التغير في حجم وشكل الجسيمات النانوية اللانثانيدية وتأثيرها على توزيع الموجات الكهرومغناطيسية. في هذه الدراسة ، درسنا جسيمات اللانثانيد النانوية لتشتت الموجات الكهرومغناطيسية في عوامل الإثارة مثل الخصائص الإلكترونية للجسيمات النانوية، وحجم وشكل الجسيمات النانوية ، وخصائص درجة الحرارة حول الجسيمات النانوية والجسيمات النانوية العازلة للكهرباء. في هذه الدراسة ، تم استخدام جزيئات اللانثانيد النانوية مع برنامج CST لمحاكاة تشتت الموجات الكهرومغناطيسية. في هذا المشروع، وباستخدام النظرية الكهرومغناطيسية الكلاسيكية ، تم دراسة تشتت الجزيئات الصغيرة العازلة فيما يتعلق بهذا المقطع العرضي للموجات الكهرومغناطيسية ، كما تم تقييم التغيرات في المتغيرات المختلفة. أيضًا، قام الدوران بقياس المقطع العرضي للجسيمات الصغيرة عن طريق تغيير المعلمات. تم استخدام جزيئات اللانثانيد النانوية في النطاق 60 جيجاهرتز إلى 120 جيجاهرتز لدراسة تشتت الموجات الكهرومغناطيسية. وأظهرت النتائج أن ناتج نانومتر جسيمات اللانثانيد كان أكثر من خمسة نانومتر في القطر وأكثر من عشرة نانومتر. لقد أظهرنا أنه مع التشتت الزاوي للموجات الكهرومغناطيسية، تكون جسيمات اللانثانيد النانوية أكثر بيضاوية وأكثر من مجرد شكل كروي.

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