Study of Laser Energy Effects on the Light Properties

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Abstract

Laser is a device that emits light in the form of very thin pulses with specific wavelengths. The device is made up of a light collector or activator that is located inside the light intensity container. This substance strengthens the light source, which is created by an external source (not electricity or light). Various techniques and methods for the production of these nano-structures have been studied. The most traditional of these nano-structures are various types of shapes such as nano-rods, nano-needles, nano-pipes, nano-strand, as well as flower petal shapes monument-type structures have been created using traditional methods based on high temperatures or high vapor and chemical solutions. In this study we have shown that by changing the energy of a laser pulse or its wavelength, a collection of nanoparticles of ZnO can be produced by laser fracturing.

Keywords: *laser, laser energy, light properties, nanoparticles*.

Introduction

Nanoparticles are one of the topics that have attracted a lot of attention in technical and fundamental research. This is due to their physical characteristics and size. One of the most notable items in nanotechnology is zinc oxide (ZnO). These semi metal have many uses in light, energy conversion and medicine. The perceptual properties of zinc oxide, such as its crystallinity, electrical, chemical durability, low viscosity, antibacterial properties, antimicrobial and antimicrobial acids properties, have caused scientists to pay close attention to it over the years. Another advantage of this substance is that it can be made from chemical processes, which have a high luminosity energy (60meV). The substance has a bandwidth of 3,37eV at room temperature and is highly sensitive to toxic and flammable gases. ZnO is the richest substance in the family of nano-structures among semi metal materials in terms of structure or specific characteristics. (2, 1). Various methods have been studied to produce these nano-structures. The most traditional nano-structures with this genus come in a variety of shapes, such as nano-rods, nano-needles, nano-pipes, nano-strands, and monument or flower petals shapes as well as using traditional methods that have been developed with the help of high temperature heating techniques with chemical solutions. Among other things, the ultrasonic laser policy is one of the methods that has attracted a lot of attention for the creation of organic nanoparticles, and for the synthesis of organisms that are not soluble in water or shows resistance to dissolution in water is more appropriate. The most important feature of this method is that it can be used to create nanoparticles that are well crystalline and do not have side products. This method is very useful for synthesizing materials with nanoparticles such as solid matter in liquids. The primary benefit of this approach is the lower cost of fraying environmental equipment. More importantly, it has been shown that the size of the composite material can be adjusted to various parameters such as laser wavelength, effect, pulse duration, pH change of the solution, Increase the surface material and the temperature of the solution, changes it alternately. (3). Using the laser cutting method, we divided the production of ZnO nanoparticles and reports on its use into three groups. Much of this research is about the laser's environmental scrutiny over the properties of ZnO nanoparticles. In most of these cases, Nd-YAG lasers use a third harmonic to create ZnO nanoparticles. While we used the first and second harmonics of the wavelengths to produce ZnO. There are also very few reports on the effects of wavelengths and energy pulses for the production of these structures. (5). in this article, 470-1500 mJ of pulse energy is used for the first time to produce ZnO nanoparticles. We present here the results of experiments on the formation of ZnO nanoparticles, obtained from the method of laser fracturing in non-ionized water, which clearly shows the effects of laser pulse energy and wavelength on the structures, shapes and other characteristics of ZnO nanoparticles at room temperature and is a powerful model of laser energy. Also in this study we have shown that by changing the energy or wavelength of the laser pulse by the method of laser emission we can create a new collection of ZnO nanoparticles.

Experimental foundations

ZnO nanoparticles were formed using PLA with a 99.9% purity from a Zn sheet containing non-ionized water. A metal galvanized sheet is placed in an open glass cylindrical container filled with 25ml of deionized water. The water level on the target is 2cm.

The galvanized sheet has been cleaned with alcohol, estrogen and ionized water prior to testing by infrasound method. (7.6). The sheet is subjected to a 7min time interval using Nd-YAG laser pulses operating at a frequency of 10Hz and the pore hole is 6ns. ZnO nanoparticles using 1064nm wavelengths of the same laser wavelength, from 0.75j to 1.5j energy, and the Nd-YAG laser generated a 532nm wavelength (second harmonic) at 0.47j and 0.63j. The laser rays, measuring 532nm, 2.5mm and 1064nm, are focused on a galvanized model using a lens with a focal length of 85mm. The laser dot sizes at the target surface were 23,03um and 14,39um for 1064nm and 532nm wavelengths, respectively.

Table (1) shows the typical energy pulse using laser wavelength and PLA.

Example Number	1	2	3	4	5	6
Pulse Energy	0,47	0,63	0,75	1	1,25	1,5
Laser Wavelength	532		1064			

A variety of techniques have been used to appreciate these products. The crystalline structures of this sample are X-Ray (XRD) radius using refraction, using Cu-Kα (= 1,54060A) radius, using STOE-XRD refraction is obtained. These solutions are placed in Si layers and dried to measure XRD. The shapes of these structures are also examined by the SEM electron microscope. Other features of these structures are also examined at room temperature using PG instruments with a UV-vis sensory spectrometer. The particle size and distribution size are also measured by a DLS optical deviation device called MALVERN ZETASIZER 3000HS. TEM transmitting electron microscopes are also used by placing a drop of condensed solution in front of carbon-coated copper networks.

Similar structures

The Fracture rate

The fraction rate related to the energy density of the laser pulse is shown in the figure below.

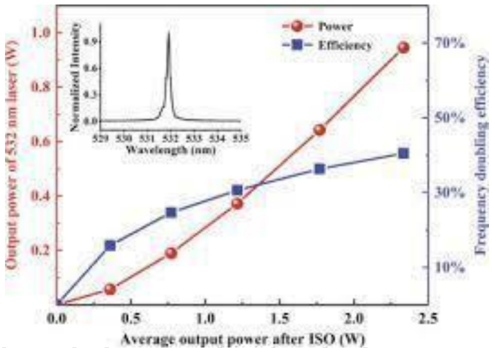

Figure 1: Instrument using PLA shows the laser wavelength and pulse energy of the produced sample (Djurisic, 2010.p: 204).

Unfortunately, the laser system is not powerful enough to generate a wavelength laser beam of 532nm with a density of more than 20J / cm2. In both cases the fracture rate of Zn with 1064nm is greater than the wavelength of 532nm. This shows that the photon energies are at a level that can cause a fracture. But a small amount of photon causes a low rate of fracture in a laser wavelength of 532nm. Another issue from the results of the above figure is that the linear procedure of the rate of fracture in nanoparticles of Zn is based on the energy density of the laser pulse. The mileage risk is about 0.67.

In this regard, we have to consider two parameters. One of which is the energy of the laser pulse. Our results show that the laser causes an increase in fracture rate with an increase in pulse. This is a clear result and has complete agreement with other reports. The second is the energy of laser photons. As the energy of the photons increases, while the pulse energy is constant, the fracture rate decreases. This may be due to the fact that the test of fracture rate in these conditions is largely based on the number of photons, not on the energy of the photons.

XRD research on nanoparticles of ZnO

The XRD spectra, as seen in the figure below, are derived from the X-ray refraction measurements of the dried concentrated material on the Si layers. The figure shows the flow of X-ray photons on the Si layer.

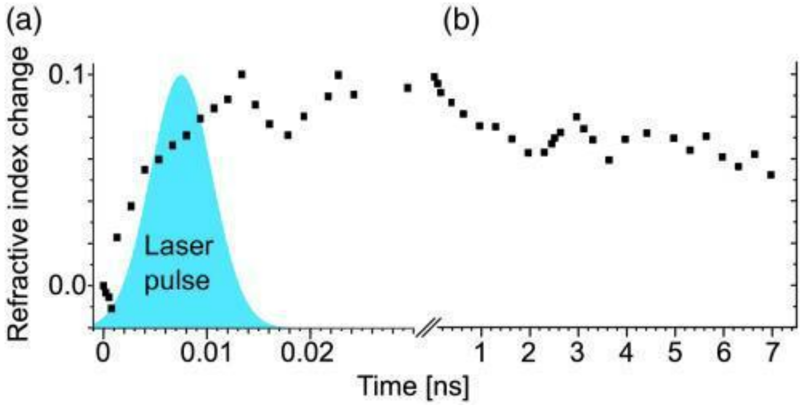

Figure: ratio of refraction rate to energy density of laser pulse (Djurisic, 2010.p: 206).

This spectrum of XRD clearly shows what shapes the crystalline structures in nanoparticles have, and shows different directions of zinc oxide. On the other hand, models developed in pure water show the refraction directions of nanoparticles of zinc oxide. The most important directions of zinc oxide are seen at 31, 8 ، 34, 5 ، 36, 3 ، 47, 6 ، 56, 7 and 63.1 degrees. In no spectrum are they observed in the directions created by 532nm. This must be due to the fact that very few nanoparticles are present in crystalline structures. XRD models of these nanoparticles formed by wavelengths of 1064nm in ionized water at room temperature show that the crystals are formed and have a hexagonal shape. We have obtained poly crystals of nanoparticles that have randomly changed the intensity of their directions for different models. In this section we can conclude that the atoms of Z and O are formed randomly during a series of fractures.

The average particle size of the nanoparticles of ZnO produced by a laser fracture is determined using the following equation, called the Scherer formula:

$$d = \frac{k.\lambda}{\beta.cos\theta}$$

In the final formula k is constant and 0.89 < < 1, is the radius wavelength and the refraction direction is half the radius of the absolute maximum and is the angle of refraction. The average size of the deviated particles of ZnO nanoparticles 002 is also calculated using the above formula. The grain size of the nanoparticles produced using a wavelength of 1064nm decreases with increasing the energy of the laser pulse. With the increase in the energy of the laser pulse, the reduction in grain size is in complete agreement with the latest reports from fazio and his colleagues.

Increasing the laser pulse reduces the adhesion of nanoparticles, which in turn leads to a reduction in the size of the particles in these models. This topic can be seen in the SEM micrographs.

The grain sizes calculated from other leaves randomly change in size to 13-40nm.

The above two network constants are called (a) and (c) for a single hexagonal cell, which can be derived from the XRD spectra from the models and calculated by the following equation:

$$\frac{1}{d^2} = \frac{4}{3}\left(\frac{h^2 + k^2 + hk}{a^2}\right) + \frac{l^2}{c^2}$$

That h, k and l are called Miller's indicators.

Nano particle sizes

The size distribution of the models is measured using DLS. This method is the most widely used method for measuring the size distribution of nanoparticles. The diagrams below show graphs related to the size distribution of the models. We have so far had no results from the nanoparticles produced with a wavelength of 532nm from the laser pulse. The reason for this may be that there are very few nanoparticles in deionized water. The low fracture rates clearly confirm that the number of particles on the models generated by the 532nm laser pulse is small. In this case the number of fractured particles for a 532nm laser pulse is small. Laser pulse nanoparticles produced using 1064nm wavelengths range from 30nm to 120nm. However, as specified in Figure 4, their sizes decrease as the energy of the laser pulse increases. Increasing the energy of the laser pulses leads to an increase in the potential energy of the fractured particle and this also leads to a reduction in the particle size. In other words, we have particles that have a higher temperature and are less likely to stick to each other. Based on the DLS results, the size distribution of the nanoparticles produced decreases as the pulse energy increases. We will have an innovative nanoparticle in high-energy laser pulses.

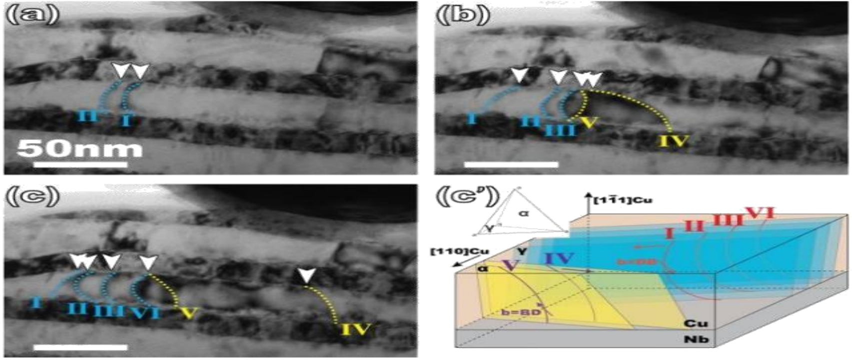

Figure: pulse fracture shows X-ray reflection from nanoparticles of ZnO by laser

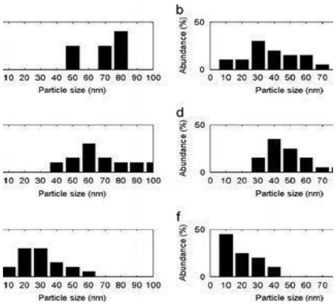

Figure: Displays the distribution sizes using the DLS method (Djurisic, 2010.p: 210).
Figure: Shows TEM micrographs from DLS nanoparticles (Djurisic, 2010.p: 214).

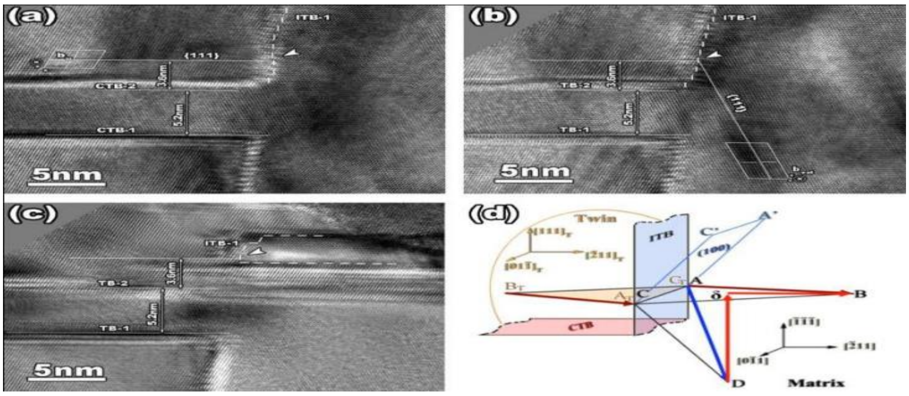

Figure (6) shows examples of size distribution (Djurisic, 2010.p: 216).

The figure above shows TEM images from nanoparticles at a scale of 100nm. As can be seen ZnO nanoparticles have spherical shapes in almost all models and the particle sizes and distribution depend on the energy and wavelength of the laser pulse. The above figure shows graphs of the particle size distribution of ZnO particles. It can be seen in these pictures that the size of the nanoparticles decreases with the increase of the energy of the laser pulse. Similar results can be seen in DLS sizes. The measured sizes of nanoparticles using the DLS method are larger than the sizes obtained using the TEM method. DLS measurement is characteristic of the hydrodynamic sizes of synthetic nanoparticles, which are significantly higher than the sizes reflected by TEM images.

The same results can be seen in the reports of Fazio and his colleagues. They have produced ZnO nanoparticles in water with a wavelength of 532nm and a pulse of 20-50mj from the process of laser fracture. Recently, Kim and his colleagues focused on the properties of laser wavelengths (325,532,1064nm) and the energy of 130mj / 50- pulse on the properties of nanoparticles in ZnO obtained using laser beam. The report states that the size and shape of the nanoparticles are influenced by the energy intensity of the wavelength of 1064nm and that the nanoparticles obtained with a fracture of 325nm were wire-shaped with a small diameter.

Conclusion

Probably the most important part of atomic physics is laser physics, by giving energy to the electrons of an atom we can take them to higher orbits. But this new space is not a stable place for electrons and the electrons prefer to return to their orbit by giving energy. This energy is released at a specific frequency in the form of a photon, that is, as a unit of energy. Others are made up of these photons. Therefore, if we perform this function simultaneously with a large number of atoms, we can create a frequency ray. In addition to being able to produce coherent radiation in a variety of ways with care. This is obviously the basis of the production of laser beams. The unique characteristics of the laser distinguish it from other pulses, such as are not seen in other sources. It is well known that the absorption edge decreases towards low wavelengths as a system, and the nanoparticle size also decreases. The perceptual and systemic change in the edge of absorption is due to the effect of quantum size. The effects of quantum limitations can be seen in the absorptive spectrum. Similar but larger changes are observed in the spectrum of the nanoparticles produced using the 532nm wavelength. Within the quantum range when the particle size gets smaller, the particle space band increases which causes the edge to absorb with shorter wavelengths.

References

1. Noel S, Hermann J, Itina T. Appl Surf Sci (2007)
2. Wagener Ph, Faramarzi Sh, Schwenke A, Rosenfeld R, Barcikowski S. Appl Surf Sci(2011)
3. Abdulmaleki A, Mallakpourb Sh, Borandeh S. Appl Surf Sci(2011)
4. Djurisic AB, Ng AMC, Chen XY. Prog Quantum Electron(2010)
5. He Ch, Sasaki T, Shimizu Y, Koshizaki N Appl Surf Sci (2008)
6. Patil LA, Bari AR Shinde MD, Deo V. Sens Actuators B(2010)
7. Mote VD, Purushotham Y, Dole BN.J Theor Appl Phys (2012)
8. Li B, Kawakami T, Hiramatsu M. Appl Surf Sci (2003)
9. Gondal MA, Drmosh QA, Yamani ZH, Salih TA. Appl Surf Sci (2009)
10. Ishikawa Y, Shimizu Y, Sasaki T, Koshizaki N.J Collinter face Sci (2010)
11. Solati E, Mashayekh M, Dorranian D. Appl Phys A (2013)
12. Drmosh QA, Gondal MA, Yamani ZH, Saleh TA. Appl Surf Sci(2010)
13. Zamiri R, Zakaria A, Abbastabar Ahangar H, Darroudi M, Khorsand Zak A, Drummen GPC.J Alloys Compd(2012)
14. He Ch, Sasaki T, Usui H, Shimizu Y, Koshizaki N.J Photobiol A(2007)
15. Fazio E, Mezzasalma AM, Mondio G, Neri F, Saija R. Appl Surf Sci (2013)
16. Zeng H, Cai W, Li Y Hu J, Liu P.J Phys Chem B(2005)
17. Suryanarayana C, Norton MG. X-ray diffraction practical approach. New York: Plenum Press; (1998)
18. Thiemann M, Marlow F, Hartikainen J, Weiss Linder m. J Phys Chem C
19. (2008)
20. Dorranian D, Solati E, Dejam L. Appl Phys A (2012)