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Synthesis of Cinnamon Nanoparticles in Methanol Medium by Laser Q-Switched Nd: YAG

Journal of Electrical Systems

Abstract: - Organic nanoparticles with diverse and non-toxic properties are useful for use in the medical field, where cinnamon nanoparticles are an example of bioactive organic materials, as they are working as anti-bacterial and anti-fungi. Starting with this idea we prepared it using the "pulsed laser ablation in liquid technique" (PLAL) using Q- Switched Nd:YAG pulse laser where we used different pulses (250, 500, 750, and 1000 Pulse/sec) with the constant ablation energy (500 mJ) FESEM, and Uv- Vis measurements were made and the results of FESEM were performed indicating obtaining the average sizes (17.06 nm) for the sample (750 Pulse /sec) and the average sizes (45.43 nm) of the sample (1000 Pulse /sec). The results of the Uv- Vis indicate two peaks within the wavelengths (240 nm, 324 nm) These particles can be well used in medical applications as an alternative to industrial drugs.

Keywords: Organic materials, Cinnamon, Nanoparticles, PLAL, and Methanol.

I. INTRODUCTION

Suitable to their unique structural, physical, optical, and chemical characteristics that cannot be seen in their bulk counterparts, organic nanomaterials have recently attracted increasing interest. [1] Cinnamon organic nanoparticles used as show components, herbal remedies, antimicrobials and cosmetics. [2] Such nanoparticles (NPs) have been produced using both top-down and bottom-up techniques over the years. Sputtering, chemical etching, mechanical milling, sol-gel, vapor deposition, and atomic or molecular condensation of spray pyrolysis are a few examples of these methods. The nanoscale structures created thru these methods, however, have many boundaries and Includes purity, morphology (shape and size), structure, costly and hazardous chemicals requirements, undesirable properties and custom morphology. [2,3] Due to its environmentally friendly characteristics and improved late, control, "pulsed laser ablation in liquid" (PLAL) technique earned intensive attention for the development of different nanoparticles with detailed morphology and structures. The nanoparticles developed using the PLAL technique have been shown to be absolutely free of unwanted impurities, free of harmful reactants and highly stable [4,5,6]. It should be noted that the use of stabilizers (capping agents) in biomedicine applications can be effective in adjusting the chemical reactivity of these NP surfaces [7]. Amongst the numerous nanostructures, CNPs have shown great potential for biomedical area, particularly as antibacterial agents. [1,7] The CNPs morphology generated by the PLAL approach may be better controlled by modifying for solvent structure and laser parameters (repetition rate, fluence, wavelength, and pulse duration). [8,9] In the PLAL method, the target material (cinnamon stick), which is submerged in methanol fluid, is irritated by a laser beam, causing a plasma that produces cavitation bubbles and a proper thermodynamic situation that imparts such a condition [10]. Two methods in particular may be used to explain how NPs form during the PLAL phase. first, the thermal evaporation process, which involves exposing the area between the surface of the target material and the laser beam to radiation to create plasma and vapor. NPs are subsequently released in the media through nucleation phases. [11] Second, the process of explosive ejection, where NPs are instantly ejected in the form of fragrances and boiling Nano sized dewdrops from the target material surface

[11,12].

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2. Materials and Methods

2.1 Synthesis of CNPs through PLAL method

"Cinnamon stick" was purchased from the local market (Baquba, Diyala, Iraq) with a high degree of purity and cut into a rectangular dimension (30mm X 20mm X 2mm). Methanol (CH_3OH) was used with a "high purity (96 ٪) as the medium" of growth of the excised particles with (PLAL) technique. After finishing the cutting process, we put it in a glass jar, doused it with acetone solvent, closed the bowl well, put it in the ultrasound bath for an hour, then wash it with distilled water three times. To get rid of organic pollutants a circular base attached to a motor was used to rotate the target by to avoid drilling and eradication from one place Spin (6 times per minute).The Laser of parameters using (Q-Switched Nd:YAG) with a wavelength of (1064nm) a repetition rate of (1Hz) , the duration of the pulse (10 ns) , the energy constant of each pulses (500 mJ) and the number of different pulses (250, 500, 750, 1000 pulse/sec) with a bundle of laser with a diameter (2mm) were ablation for (CNPs) from the solid target Topic in the glass container At the cinnamon target liquid interface as in fig.1, the laser-induced breakdown allowed the shaped plasma plume and cavitation bubble to be confined. [7] During the growing phase, the laser pulse contacted with the cinnamon surface, and the confined liquid traveling at a supersonic speed evaporated the substance. The target was then covered in a plasma plume, and a shock wave was created beneath the constrained liquid. [6] Whereas the highest cavitation bubble and the cinnamon target surface displayed a smooth vertical concentration curve for the major CNPs below 10 nm. [13] In the PLAL aided mechanism of development of CNPs the methanol media are represented.

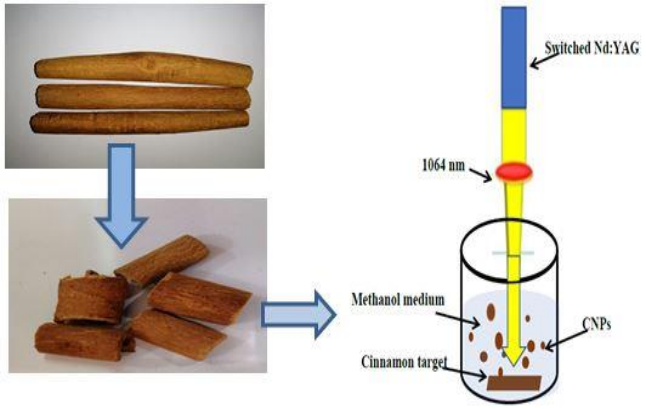

Figure 1. Illustrative diagram procedure of PLAL method.

3.Results and discussion

Figure: 2 (a) and (b) shows the FESEM image, style and size distribution of CNPs grown at the best Pulses laser 750 Pulse / sec with ablation energy constant of 500 mJ respectively. Figure 2(a) FESEM image depicts the CNPs' morphology, which was found to be mostly spherical in form, homogeneous, and with tiny particle diameters (ranging from 8.05 nm to 43.28 nm). The specific form of the CNPs was caused by the generated atoms that were contained by the pre-existing nuclei during the diffusion-controlled growth phase. Regarding figure 2(a), the size distribution of CNPs is shown in figure 2(b), and the average size was calculated to be (17.06 nm). The FESEM picture, style and size distribution of CNPs generated at the optimal laser pulse rate of 1000 pulses per second with an ablation energy constant of 500 mJ are shown in Figures 2(c) and (d), respectively. The morphology of the CNPs is depicted in the FESEM picture in figure 2(a), which was found to be mostly spherical in form, homogeneous, and particle diameter (ranging between 15.1 nm and 73.71 nm). Where the average size was determined to be (45.43 nm) This is in line with what the researcher (Salim et al) discovered. [12]

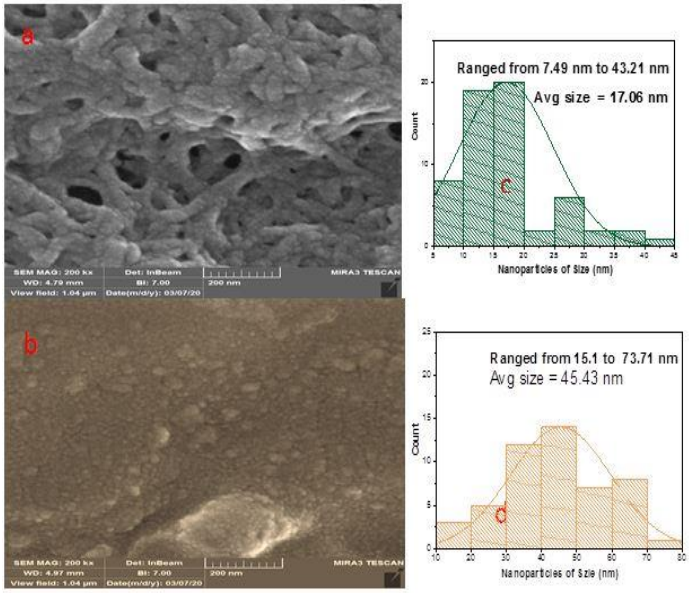

Figure 2. (a, b) FESEM image (c) Size distribution and gauss shape FESEM (a), (d) Size distribution and gauss shape (b)

Figure 3: This displays the absorption distribution in Uv-Vis of all synthesized samples (250,500,750, and 1000 pulse/sec) and ablation energy constant (500 mJ). The difference in CNP morphology and shapes was clearly demonstrated by the sharp shift in absorption peak locations and intensities. Table 1 demonstrates the absorption characteristics of the group of CNPs grown in methanol media. There is proof of two typical absorption bands corresponding to CNPs. [7] Two distinct absorption bands were obtained at 324 - 240 nm the first mild absorption peak showed a mild enlargement, independent of the growth environment, where the frequency of this weak peak was credited to the presence of the nucleated CNPs ring of benzoyl and cinnamoyl systemin [14]. This is consistent with the researcher's findings (Salim et al). [7] In addition, the absorption band in the range of (~240 nm) is considered to occur due to the excitation of protein residues of tryptophan and tyrosine. [15] intensity of the important absorption band, which is in the 297–325 nm region. This discovery was attributed to the CNPs' earlier reported quantum size effects [7,16]. Additionally, because the suspension was filtered away, the recovery of NPsat greater energy was smaller than with lower energy. The highest absorbance is obtained due to. The quantum size effects of CNPs at 324 nm [12,17] and by increasing the number of pulses, a higher absorption was obtained, as well as a gradual change in colour from colourless to brown Illustrated in fig. 2 Inset (1).

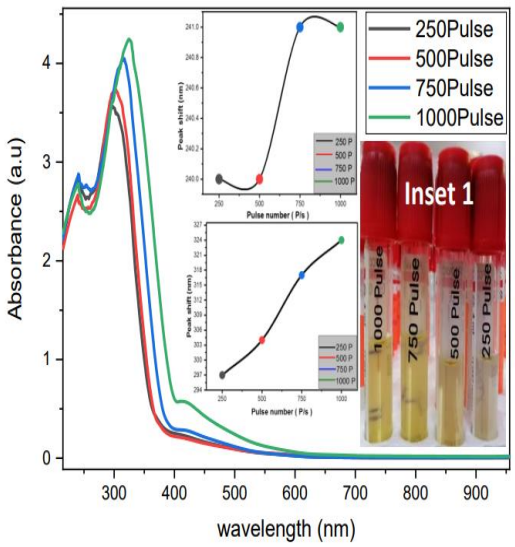

Figure 3. Absorbance as a function of wavelength by changing the number of pulses. Inset (1) Change the colour of the solution by increasing the number of pulses.

CNPs in methanol Pulses number (pulse/sec)	Peak shift 1(nm)	Peak shift 2(nm)	Abs 1 (a.u)	Abs 2 (a.u)
250	240	297	2.85	3.56
500	240	304	2.66	3.72
750	241	317	2.88	4.04
1000	241	324	2.77	4.24

Figure 4: The findings showed that the CNPs' chemical constituents had varied vibrational bond structures, and the purity of these associated NPs in the methanol liquid medium was demonstrated by various absorption bands with various wave numbers. The spectral intensity, width and shift of CNPs are found to be sensitive to the observed shift variation in intensity and all peaks as in table (2) towards low frequency clearly indicate a gradual shrinkage in the size of CNPs. Additionally, the presence of these absorption peaks confirms that the CNPs were surrounded by secondary plant metabolites, including terpenoids, flavonoids, glycosides, phenols, and tannins, that contain functional groups like ketone, carboxaldehyde, and others. [17]

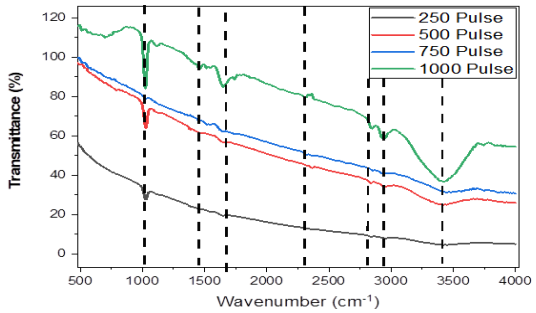

Figure 4. Ranges, peaks, and bond values for CNPs by changing the number of pulses.

Table 2. Ranges, peaks, and bond values for CNPs by changing the number of pulses.

Vibration modes	Vibrational band assignments	Wavenumber (cm^{-1})		
		CNPs in methanol	Pure methanol	Pure cinnamon
Halides, Alkyl, and alkynes	C-H bending	——	881.467	748.381
aliphatic amines	C-O stretching	1024.27 -1028.059	1045.412	1033.843
Alkane	C-OH stretch	-1454.32 1456.25	1384.896	1454.321
Aldehyde and carbonyl	C = O stretching	1647.2-1656.85	1647.21	1616.341
Aldehyde and alkyne	-C ≡ C- stretch	2312.653-2341.585	2364.723	2304.933

carbon hydroxyl	CH_3 stretch	2835.35-2856.57		
Alkane	CH_2 stretch	2926.01-2956.87	2974.23	2924.08
Hydroxyl	O-H stretching	3415.931-3446.79	3408.211	3404.362

ACKNOWLEDGMENT

The authors would like to thank the University of Diyala/College of Science/Department of Physics for the technical support to complete this work in their laboratories.

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