THE EFFECT OF LASER PULSES ON MORPHOLOGY AND RHEOLOGICAL BEHAVIOR OF SILVER NANOAQUEOUS SOLUTION

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ABSTRACT: This paper investigates the effect of laser pulses on the morphology and rheological behavior of silver nanoparticles SNP-Poly vinyl alcoholPVA solution in laser ablation LA technique.

Polymer and suitable number of shots used to adjust the SNP formation. 1g of Poly vinyl alcohol is dissolved in double distilled and deionized water DDDW at 80°C using magnetic stirrer. Pure piece of silver immersed in the DDDW-PVA solution. Laser of 20, 40, 60, 80 and 100 pulses are applied at 600mJ, 8nspule duration and 532nm. Absorbance spectra of SNP solution were measured by UV-VIS spectrophotometer. The morphology properties of nanosolution are tested using atomic force microscopy AFM. The rheological behavior was investigated using cone-on-plate viscometer and surface tension device. The results show that the peak of Plasmon at 400nm indicated that the silver nanoparticle is present. AFM results show that the broadness increases with the pulses increasing. The viscosity and surface tension increase as the number of pulses increasing. A good confirming observed between structure and viscosity results. The small particle size and low range of broadness can be achieved at low number of pulses.

خلاصة: هذا البحث يحقق في تأثير عدد النيوبيات على التصرف الريولوجي والتركيبي لحلول PVA النانوية للفضة. في تقيقه، القشط الليزري البولير وعدد مناسب لضربات الليزر استخدم لتنظيم تكوين نقاط الفضائ النانوية. 1g من PVA اذب في الماء اللاييني المقدر عند 100مM باستخدام الخلاط الميكانيكي. قطعه نقيه من الفضائ تغطس في محلل الماء - PVA. ليزر ل PVA و applying 20, 40, 60, 80, 100, 100, 0.0325 و 100, 100, 0.04 100.006 تبضسه سللت عند 80 ملي جول، 80 نانو ثانية، 532 نانو متر. طيف الامتصاص لحلول نقاط الفضائ النانوية تم قياسه باستخدام UV-VIS الماهات. البذور النانوية بالتركيزة لحلول النانوية تم فحصها باستخدام محجر القوى الثرية، التصرف الريولوجي فحص باستخدام جهاز Cone-on-plate لقياس النزوعة وجهاز جهاز فحص الشد السطحي.
INTRODUCTION:

Laser ablation in solution is a simple and rapid technique. Recently, laser ablation method had been developed to prepare metal nanoparticles in solutions by the use of lasers having various performances [N.V.Tarasenko et al, 2006].

Laser ablation can be defined as the process of liberating particles from a solid (or liquid) surface by irradiating it with a laser beam. The characteristics of the metal nanoparticles formed and the ablation efficiency strongly depend upon many parameters such as the wavelength [T.Tsuji et al, 2001] of the laser impinging the metallic target [A.V.Kabashin and M.Menuier, 2003], the laser fluence [T.Tsuji et al, 2001], the effective liquid medium and pulses [P.V.Kazakevich et al, 2006]. When the number of laser pulses increases, the concentration of the particles ejected in solution increases, whereas the ejection rate decreases. The degree of the reduction must depend on the concentrations of the nanoparticles. Mostly silver has attracted much than others metals due to its unique properties which can be incorporated into antimicrobial applications, and to their surface Plasmon resonance related properties that are strongly useful for their biological applications [Hassan Korbekandi and siavashiravani, 2012]. Silver is a safe inorganic, nontoxic, antibacterial agent used for centuries and is capable of killing about 650 types of diseases caused by microbes [Brigger et al, 2002]. Poly vinyl alcohol (PVA) is a widely used synthetic polymer. The
The benefits of its use lie in its properties: non-toxicity, water-solubility, biocompatibility, biodegradability and excellent mechanical properties. [Abdulrahman Khalaf Ali, 2010] prepared silver and gold nanoparticles solutions by pulsed laser ablation of a piece of silver and gold plate placed on the bottom of quartz vessel containing 1 ml of ultra-pure DDDW. The number of pulses applied for the metal target ranged from 5 to 90 pulses. When an increase in laser shots results in an increase in the SPE intensity.

When an increase in laser shots result in an increase in the SPE intensity, the peak position remaining practically constant. The height and the width of the SPE peaks were found to be dependent upon the laser shots. [Maryam Falah Noori, 2012] study Effects of Laser Pulses on gold Nanoparticles immersed DDDW by Laser Ablation and found that when an increase in laser pulses results in an increase in the Absorbance intensity, while the peak position remaining practically constant, which around 525 nm. [Halimah Mohamed etal, 2014] synthesis silver nanoparticles in different concentrations of polyvinyl alcohol aqueous solution. The effects of PVA concentrations on the absorbance of the silver nanoparticles are studied. [Brajesh Kumar et al, 2014] a new method was applied to synthesize silver nanoparticles using starch under sonication. Colloidal silver nanoparticles solution exhibited an increase of absorption from 420 to 440 nm with increase starch quantity.

In this work the effect of laser pulses on rheological behavior and morphology of SNP-PVA nanosolution was investigated using laser ablation. The laser ablation is one-step method for Nano fluid production, safe preparing and give high stability of Nano particle in solution. Viscosity and surface tension were examined to be indicators for stability. The relation between morphology and rheological behavior also discussed.

**MATERIALS AND METHODS:-**

Silver target 99.99 % purity with dimension (20*5mm) is provided from China Company. Silver nanoparticles were synthesized by pulsed laser ablation of silver target in PVA biopolymer solutions at room temperature. The silver target washed and polished using paper grade 600.1 g of powder PVA dissolved in 50 ml of double distilled deionized water DDDW at 80 °C for 1/2 hour with agitation using magnetic stirrer, then the silver target was fixed at bottom vessel containing the solution of biopolymer and then the laser energy is applied. Ablation is carried out with laser operating at 532 nm at 600 mJ pulse energy. The number of laser shots applied for the metal target 20, 40, 60, 80, and 100 pulses and pulse duration 8 nanosecond.
CHARACTERIZATION:-

UV – VisDouble Beam Spectrophotometer:
SHIM ADZU spectrophotometer UV-1800 is used to checks the absorbance of the nanopolymer solutions.

AtomicForceMicroscopy (AFM):
The morphological studies of the Nano solution (SNP- PVA) were conducted by tapping mode AFM (AA3000) in Ministry of Science and Technology. The Nano solution were spread on preheated mica and expose to air to dry.

Cone– on- PlateViscometer:
The rheological measurements are performed with a con and plate geometry with the cone diameter 25mm and its angle of 0.8°. All experiments are conducted at a constant gap of 0.5mm and an initial stabilization period of 2 minutes is given for achieving the temperature equilibration.

Surface Tension:
Samples measurements obtained by using JZYW-200B Automatic Interface Tensiometer supply by BEING UNITED TEST CO., LTD.

RESULTS AND DISCUSSION:-
UV – Vis Spectrophotometer:
Fig. 1 shows the absorbance spectra of silver nanoparticles solutions. The Absorbance peaks in visible region are the characteristic metals NPs formation. The increasing of laser shots results in an increase of the absorbance intensity, while the peak position remaining practically constant around 400 nm. The concentration of SNP increases with the pulses increasing. The peak intensity of 100 pulses is higher than that of 20 pulses.

Morphology:
The surface morphology of 20 and 100 pulse of SNP-PV Ananosolution was tested. One drop of the colloidal suspension was dried out on a glass substrate. Fig. 2A. B shows SNP with average size of 83 nm. The shape of particles is spherical in general. The broadness of nanoparticles is clear and rises up to the 180 nm. The distribution of particles is approximately homogeneous. The laser
energy produce stable and uniform solution due to the electro statically charges. Nanoparticle produced by laser ablation generated electrostatic force which leads to repulsive force between particles. This force increases the stability and homogenousity of nanoparticles and this compatible with result of AFM, viscosity and surface tension.

**Fig. 3** indicates the SNPs distribution in the PVA solution at 100 pulses. The average particle size is about 94 nm. The difference in size between 20 and 100 pulses solution is because of concentration change of SNP. The SNPs increases up to the 250 nm due to the agglomeration. The range of the broadness of particles in 100 pulses solution is higher than that for 20 pulses solution due to at 100 pulses the number of particles evaporating increases while the condensation process efficiency decreases, due to the same quantity of solutions. The distribution of SNPs with 100 pulses is lower homogeneous and stability than that for 20 pulses solution.

**Viscosity and Surface Tension:**

**Fig. 4** shows the viscosity increases with the laser pulses increasing because the absorbance increases which means the concentration of SNP increasing. The increases of concentration produce agglomeration, which is proportion with the particle size and the viscosity.

The maximum change in viscosity is between 20 and 40 pulses. The low and high viscosity at 20 and 100 pulses solutions, justify the distribution of SNPs. In the images of AFM the homogeneous, uniform solution and high stability of SNPs produces lower viscosity and vice versa. The stability of silver nanosolution reduces with viscosity increasing.

**Fig. 5** shows the surface tension increases with the pulses number increasing for SNP-PVA solution. The results show that the surface tension increases because the Van der Waals force between the nano particles increases the surface free energy. Both viscosity and surface tension tests are used as indicator for stability of nanofluid and the homogeneous degree of nanoparticles distribution.

**CONCLUSIONS:**

In this study SNP-PVA nanosolution with different pulses synthesis by laser ablation technique is tested. The applied method is simple, safe and gives high stability. The polymer used is biodegradable and highly biocompatible. The results show that the absorbance peak around 400nm indicated silver nanoparticle is present. The viscosity and surface tension give an indication whether the nanosolution is stable or not. The increasing in SNPs concentration is due to the increasing of laser shots number in the solution. The increasing of viscosity and surface tension is
proportional with the agglomeration and inversely with the stability of solution. The AFM image illustrates the distribution and agglomeration of SNP₅ in solution. The confirming between the AFM photos and the viscosity and surface tension tests is clear. Therefore it can be used the easy rheological properties as indication for stability of SNP- PVA solution instead of AFM image. According to the viscosity and surface tension value and the SNP images, the 20 pulse solutionposse'shigher stability and lower nanoparticle size and broadness range

Fig.1: The Absorption spectra of the Plasmon band of SNP₅ – PVA solution at different pulses
Fig. (2): Topography of the SNP-PVA solution at 20 pulse (A) 2-D particles size (B) 3-D particle size (C) Particle size distribution.
Fig.(3): Topography of SNP- PVA solution at 100pulse (A) 2-D particles size (B) 3-D particles size(C) particle size distribution
**Fig. 4:** viscosity behavior of SNP-PVA solution at different pulses

**Fig. 5:** Surface tension behavior of SNP-PVA solution at different number of pulses
REFERENCES:


Hassan Korbekandi and Siavash Iravani (Silver Nano particle) 2012.


