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

***Dr. NizarJawadHadi **Dr.Jaleel Kareem Ahmed *** Ula Ali**

nizarjawad63@uobabylon.edu.iq

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 ofPoly vinyl alcoholis 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 100pulses 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 increaseswith the pulses increasing. The viscosity and surface tension increase as thenumber 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.

الخلاصة:- هذا البحث يحقق في تأثير عدد النبضات على التصرف الريولوجي والتركيبي لمحلول PVAالنانوي للفضة . في تقنيه القشط الليزري البوليمر وعدد مناسب لضربات الليزر استخدم لتنظيم تكوين دقائق الفضة النانوية . ١غم من PVA اذيب في الماء اللايوني المقطر عند ٨٠م باستخدام الخلاط الميكانيكي . قطعه نقيه من الفضة تغطس في محلول الماء – .PVA ليزر ل ٢٠,٤٠,٦٠,٨٠,١٠٠ نبضه سلطت عند ٦٠٠ ملي جول ،٨ نانو ثانيه ، ٥٣٢ نانو متر . طيف الامتصاص لمحلول دقائق الفضة النانوية تم قياسه باستخدام UV-VIS . المواصفات التركيبية للمحلول النانوي تم فحصها باستخدام مجهر القوى الذرية . التصرف الريولوجي فحص باستخدام جهاز Cone –on –plate لقياس اللزوجة وجهاز فحص الشد السطحي

اضهرت النتائج بان اعلى قمه لامتصاص الرنيني تحدث عند ٤٠٠ نانو متر والتي تدل على وجود الفضة النانوية . نتائج مجهر القوى الذرية اضهرت بان التباعديه ازدادت مع زياده عدد النبضات . اللزوجة والشد السطحي يزداد مع زياده عدد النبضات . تطابق جيد تم ملاحظته ما بين نتائج اللزوجة والتركيب . حجم دقائق صغير وتباعديه قليله ممكنه تم تحقيقها عند عدد النبضات القليلة.

KEYWORDS: **-number of pulses, laser ablation, silver nanoparticle (SNP), viscosity and morphology.**

List of Abbreviations

AFM	**atomic force microscopy**
PVA	**poly vinyl alcohol**
LA	**laser ablation**
DDDW	**double distilled deionized water**
SNP_S	**silver nanoparticles**
SPE	**Surface Plasmon Extinction**
NP_S	**nanoparticles**

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 laserbeam. 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 andpulses [P.V.Kazakevich et al, 2006]. When the number of laser pulses increases, theconcentration of the particles ejected in solution increases, whereas the ejection ratedecreases. The degree of the reduction must depend on the concentrations of thenanoparticles. 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

benefits of its use lie in its properties: non-toxicity, water-solubility, biocompatibility, biodegradability and excellent mechanical properties. [AbdulrahmanKhalaf Ali, 2010]prepared silver and gold nanoparticlesSolutions by pulsed laser ablationof a piece of silver and gold plate placed on the bottom of quartz vessel containing 1ml 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 FalahNoori,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 nanosolusion 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 600.1g of powder PVAdissolved in 50 ml of double distilleddeionized water DDDWat 80 ºC 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. Ablationiscarried out with laser operating at 532nm at 600mJ pulse energy. The number of laser shots applied for the metal target 20, 40, 60, 80, and 100pulses and pulse duration 8nanosecond.

CHARACTERIZATION:-

UV – VisDouble Beam Spectrophotometer:

SHIM ADZU spectrophotometer UV-1800is 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 micaand 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 0.8^0 .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.

RESULTSANDDISCUSSION:-

UV – VisSpectrophotometer:

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_s increases with the pulsesincreasing. The peak intensity of 100 pulses is higher than that of 20 pulses.

Morphology:

The surface morphology of 20 and 100 pulse of SNP-PVAnanosolution was tested. One drop of the colloidal suspension was dried out on a glass substrate. **Fig.2**A. Bshows SNPs 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 uniformsolution 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. 3indicates 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 SNP_S 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 SNP_s 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 thelaser 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 SNP_s. In the images of AFM the homogeneous, uniform solution and high stability of SNP_s 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 .Theresults 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 istested. The applied method is simple, safe and gives high stability. The polymer used isbiodegradable 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 SNP_s 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 SNP_s 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

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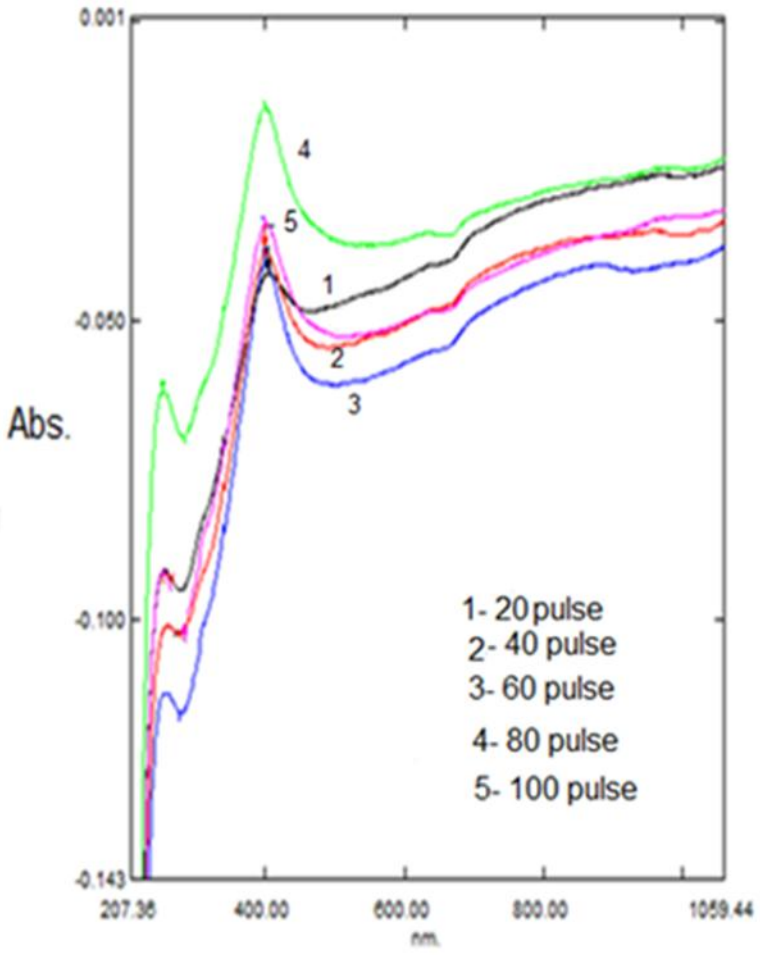

Fig.1: The Absorption spectra of the Plasmon band of SNP_s – PVA solution at different pulses

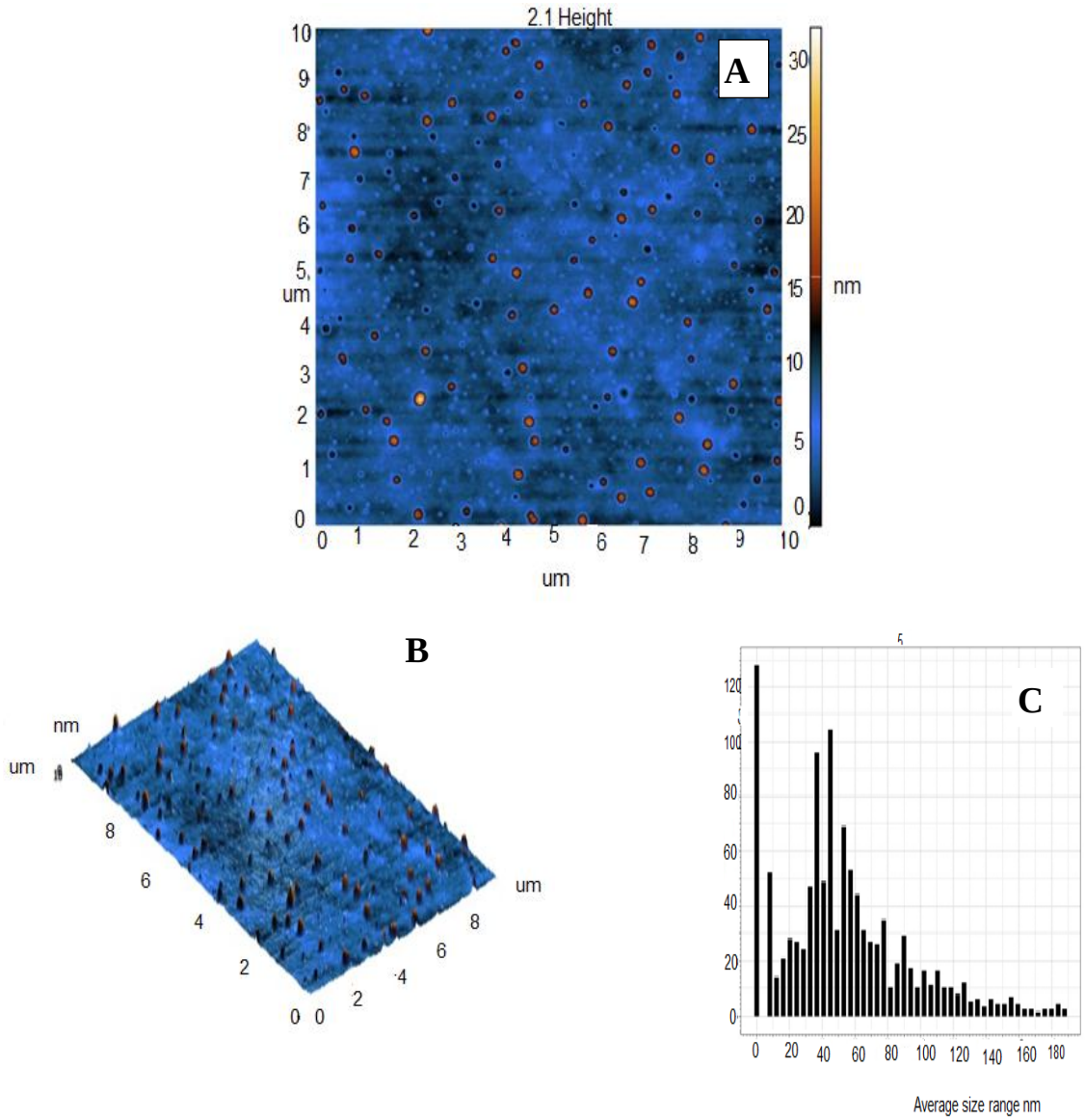

Fig. (2): Topography of the SNP-PVA solution at 20pulse (A) 2-D particles size (B) 3-D particle size (C) Particle size distribution.

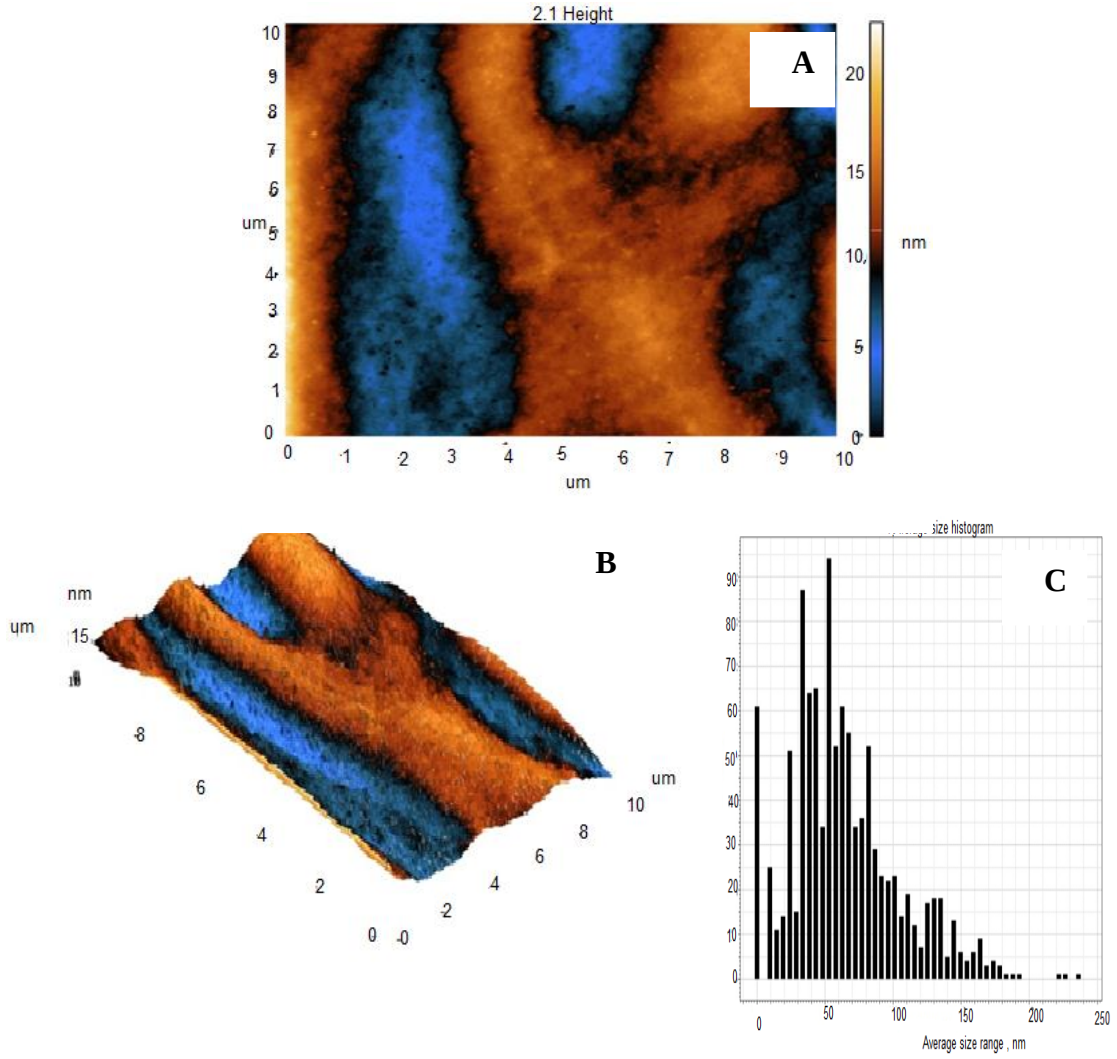

Fig.(3): Topography of SNP- PVA solution at 100pulse (A) 2-D particles size (B) 3-D particles size(C) particle size distribution

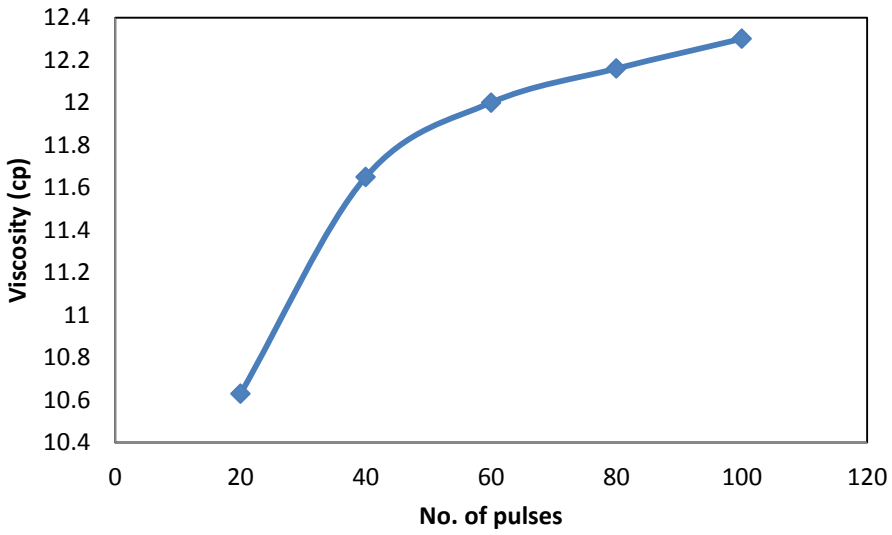

Fig .4: viscosity behavior of SNP-PVA solution at different pulses

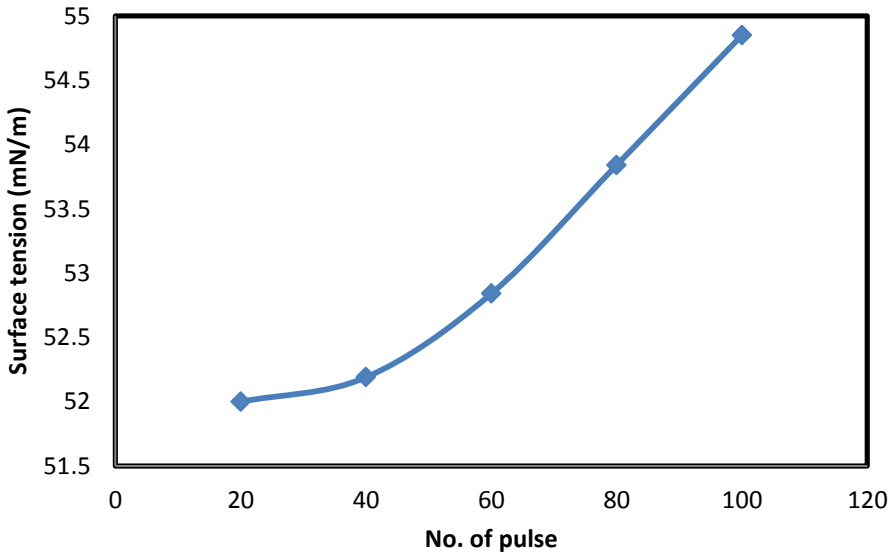

Fig.5: Surface tension behavior of SNP-PVAsolutionat different number of pulses

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