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DESIGN AND CONSTRUCTION OF DIGITAL LASER COMBUSTION INSTRUMENT AND SYNTHESIS OF SILVER NANOPARTICLES (AgNPs)

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Abstract

The present work focus to the design and development of digital combustion instrument for synthesis of nanoparticles by laser combustion method. This instrument is capable of controlling the synthesis just by giving digital i/p (input), we can prepare more sample of linearly varying different physical variables with digital accuracy and it consume less time and power, sample prepared with this instrument can also be further characterized by Transmission Electron Microscope (TEM). The shape evolution and size of the formed silver nanoparticles was studied using transmission electron microscope. The captured images shown the formed particle were spherical in shape, surface morphology, and diameter in the AgNPs its range from 10 to 20 nm.

Keywords

Digital Laser Instrument, Silver Nitrate ($AgNO_3$), Hydrogels, Deionized Water (DI) and Transmission Electron Microscope (TEM)

1. Introduction

Recent years many researchers across the globe have put more effort on synthesis of nanoparticle in different method, during the synthesis process researchers need to concentrate on two factors one is to maintaining the system to control over both physical parameters and chemical parameters and another one is preparation of sample in such a way that it should be helpful for further characterization. Currently some researchers use analog method for synthesis part by manually controlling both physical and chemical parameters after that they go for digital analysis by using so many softwares but in the entire process there are chances of miss communication between analogy synthesis and digital analysis. In our work we have tried to fill the gap between synthesis part and analysis part by introducing new method called digital synthesis method. In this method we are able to prepare more sample with linearly varying physical parameter by consuming less power consumption and very less chemical within a small time and it proved helpful to further characterization so for that we are designed both software and hardware. In this work we have replaced a tradition combustion chamber for preparation of nanoparticle by introducing new digital combustion chamber and it is controlled by microcontroller just by writing a program in an arduino environment and it works as back hand, the software which we have developed by using visual studio acts as the lead. For combustion it requires a high temperature and for that we are using high power laser source and again it is control by an arduino microcontroller and laser driver.

1.1. Software requirements for developing instruments

- Arduino software
- Visual basics
- Autocad13

1.2. Hardware requirements

- 2 LG DVD drivers
- Arduino UNO microcontroller
- Motor driver
- 1watt LASER
- LASER driver
- 12v power supply
- Laser water cooler
- Water pump

1.3. System requirements

- Operating system windows7, windows8, windows10
- RAM 2GB
- Hard disk 32GB
- Processor 1.92GH_z

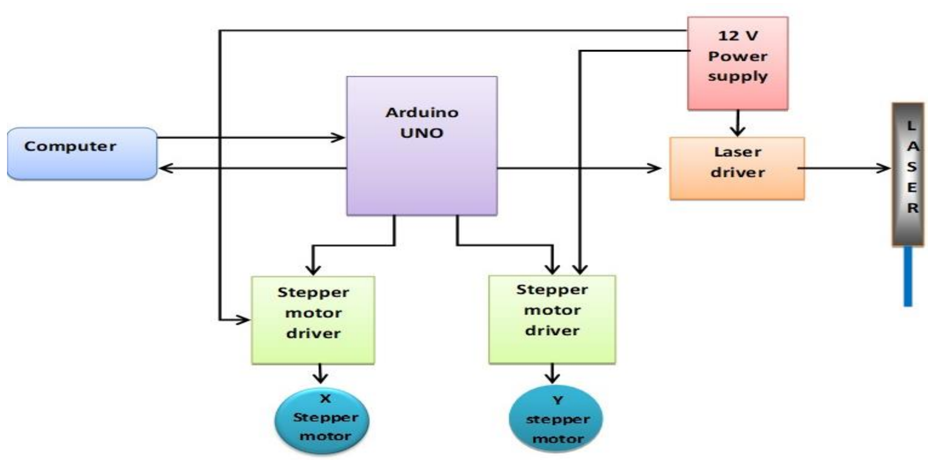

Figure 1: *Block diagram digital combustion instrument*

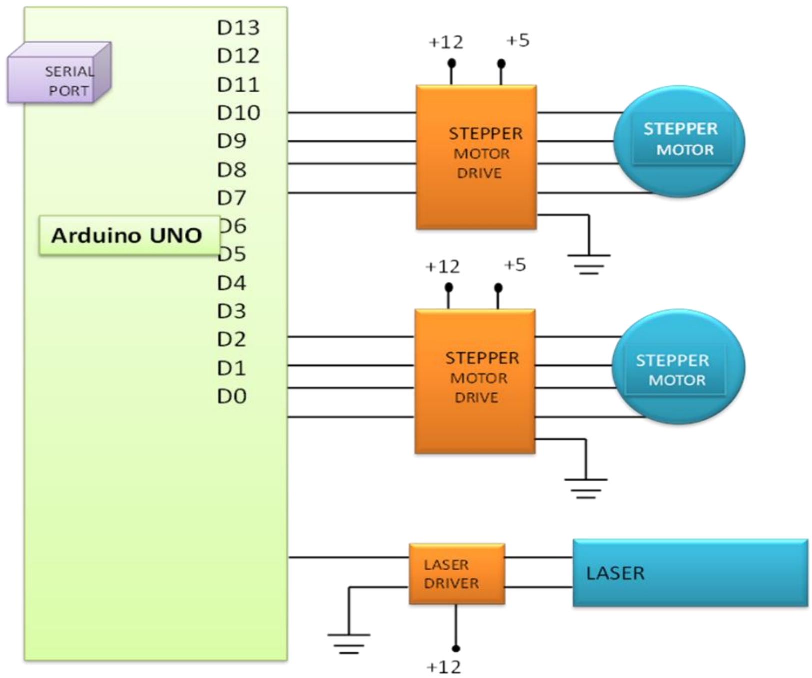

Figure 2: *Circuit diagram of digital combustion instrument*

1.4. Working of digital combustion instrument

This instrument is just plug and play, it is powered by ac power source of 50 Hz, 250 volts then it is connected to computer installed with the driver software and digital combustion software, place a sample which you want to burn in the sample holder, in digital combustion software first choose the mode of operation weather it should be continuous or pulsed. Continuous means laser is kept on continuously during complete synthesis while pulsed means laser will be turning on and off continuously with desired frequency then we should select the area to be burned just by giving step length to both x- axis and y- axis then if you want to burn different sample with linearly varying of physical parameter give sample length and breadth then select time delay then click send data then press start button engrave. After all these inputs the laser will start to move in zigzag motion. If you give increment time delay it increments the time delay for next sample like that it increases continuously for different sample if we choose pulsed mode then we should give on time and off time and number of pulse and it starts to burn the sample just by giving pulsed laser light. Here one cycle of on and off of the laser light is considered as one pulse, if we give increment on time or off time so it increments the on time and off time for next sample likewise it continuously increases for next samples in the same way increment pulse also.

1.4.1.Hardware construction

Body of the digital combustion chamber is designed in auto cad 2013 software and it is made out of stain less steel of1.6 mm gauge it has four way of ventilation for better combustion and it has two stepper motor these motors are taken from DVD driver, these two stepper motor for two dimensional linear motion control it has 135 micron step length, one stepper motor is connected to laser source and another one is connected to sample holder, both are moving exactly perpendicular each other these stepper motor connected to arduino UNO through motor driver and laser is also powered by laser driver and controlled by arduino UNO through TTL connection, both stepper motor and laser driver are powered by 12 volt power supply, for laser cooling we have introduced water cooling system which has one inlet and one outlet for water circulation.

1.4.2. Software construction

1.4.3. Arduino

We have choosed arduino as a microcontroller because over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge. Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than 1000/- Rs. The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. It's conveniently based on the Processing programming environment; program in that environment will be familiar with how the Arduino IDE works. We write program in such a way that to get a freedom to move in both X and Y axis and we introduce new concept called increment of physical parameter for different sample burning, we put more option for user to prepare more sample with less chemical and linearly varying physical parameter like increment time delay and increment laser on and off time and increment pulse. During the execution it need variable values so that we write a program in such a way that it takes the value from serial port and assign to variable following flowchart shows that how assigned variable are executing in arduino board

2. Experimental

Preparation of GG-g-P (AAM-co-AMPS)-Ag nanohydrogel: Briefly, 0.5g of dry hydrogels were equilibrated in double distilled water for 48 h and the swollen hydrogel species were transferred in to a beaker containing 50 ml of $AgNO_3$ (10 mM) aqueous solution and then allowed to Laser irradiation for 24 h (B. L. Rao.et.al. and S. Asha. et.al). During this Laser Irradiation stage, the Ag^+ ions are being exchanged from solution to the GG-g-P (AAM-co-AMPS) hydrogel networks. The Ag^+ ions loaded GG-g-P (AAM-co-AMPS) hydrogels were wiped off using tissue paper and transferred in to a beaker containing 50 ml of TCS (10 mM) solution. The beaker was left in the refrigerator (4 ˚C) for 8 h in order to reduce the Ag^+ ions into AgO nano particles. The obtained hydrogel AgO nano particles was used for further studies (K. Vimala.et.al. and X. X. Feng.et.al). The morphology of the GG-g-P (AMPS-c-AAM) and GG-g-P (AMPS-c-AAM)-Ag nano hydrogels were performed using transmission electron microscopy (TEM) which was performed at using JEOL JEM2010 operated at an accelerating voltage of 200 keV.

3. Results and Discussions

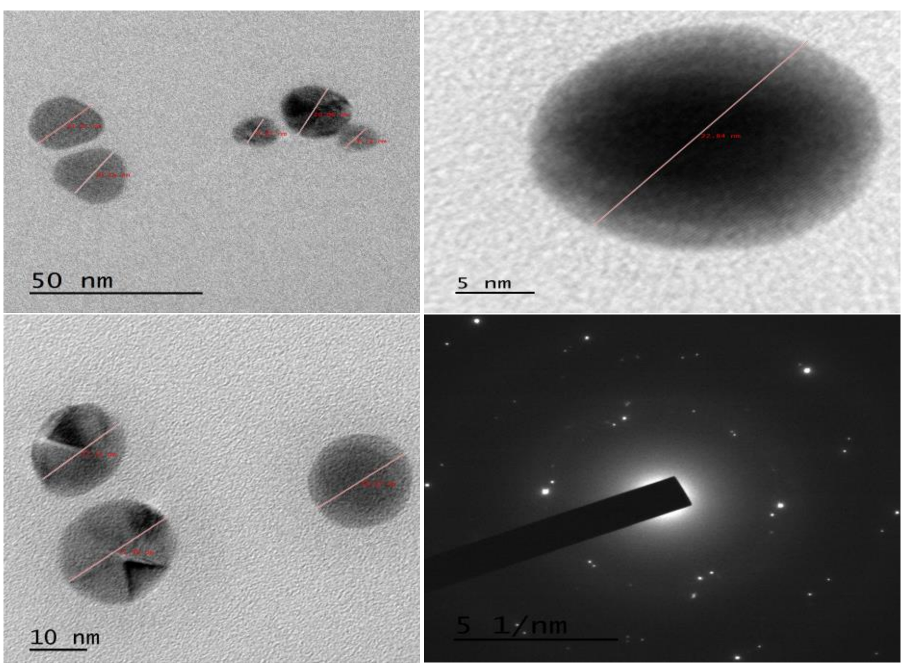

Figure 3: *TEM image of silver nano particles synthesised by laser combustion method*

TEM image demonstrates a highly uniform distribution of silver nanoparticles as shown in Figure 3. (H. Zhang et.al. and M. A. Martinez-Rodrigueza.et.al.). It is confirmed that the silver nanoparticles formed in the cross-linked network are spherical in shape and smooth edges (R. Madhukumar et.al.), highly dispersed in nature, low nanometre in size morphology of AgNPs were carried out by using TEM image. The average size of the AgNPS was found to be 10-20 nm as shown in fig. 3 (C. S. Shivanada.et.al and M. Gowda. et.al.). Moreover, the selected area electron diffraction (SAED) pattern of silver nanoparticles is clearly visible as three diffraction rings from the selected area of the TEM image and they are definitely attributed to the FCC structure of silver nanoparticles.(M. Nilanjal et.al. and R. Madhukumar et.al.)

4. Conclusion

We successfully design and developed advanced combustion instrument called digital combustion instrument, from this instrument we can able to prepare a more sample of linearly varying physical parameter with less time and less chemical and it helpful to further characterization TEM. The synthesized Ag nanoparticles were spherical in shape and their morphology was confirmed by TEM images. From this investigation, it was found that the increasing the Laser irradiation hours increasing the rate of reduction and decreases the particle size, and thus the size of the Ag nanoparticles can be tuned by controlling the Laser irradiation.

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