Study the characteristics of nanomaterials prepared by Arc discharge method using rotating disk electrode

A Thesis

Presented to the Graduate School
Faculty of Science, Alexandria University
In Partial fulfillment of the
Requirements for the Degree

Of

Doctor of Philosophy of Science

In

Physics

By

Mostafa mohamed mohamed El sayed

M.Sc. in physics (2013)

2018

SUMMARY

Nanotechnology has reached the status of the 21st century's leading science and technology based on fundamental and applied research during the last two decades. A valuable benefit of nanotechnology is to connect the gap between the atomic, molecular fundamental sciences and microstructural scale of engineering. To prepare these nanomaterials, novel synthesis procedures have been developed that can be described as physical, biological and chemical methods. In physical methods, the simplest one technique for synthesizing Nano-metal particles is arcing discharge method that overcomes of the toxicity of the chemical preparation, oxidizing Nano-metals.

The present works have several aims as follow;1) Design and fabricate rotating arc discharge tube, as well as the electrode circuit and software, operates the discharge to control the gaps between the electrodes,2) Study the effect of rotational speed of the target, its shape and the dielectric medium as an optional factors on preparation silver nanoparticles by developed arc discharge technique to improve the quality and quantity of produced nanoparticles, 3) The preparation of silver nanoparticles, zinc nanoparticles and silver carbon nanotubes with optimum conditions by using the rotating target arc discharge, 4) The use of silver carbon nanotubes and zinc nanoparticles as nano-adsorbents. Conducting batch adsorption experiments as a function of content time, solution pH, dye concentration, and the adsorbent dosage. The Langmuir, Freundlich, and Temkin models were utilized for analysis of the adsorption equilibrium. Finally, Kinetic models were tested for the previous nano-materials to identify the potential adsorption process mechanisms and 5) Using different size silver nanoparticle prepared by rotational electrode at different speeds to investigate the genetic alterations, bacterial resistance and changes in cellular membrane properties of Klebsiella pneumonia as a result of adding silver nanoparticles with different particle sizes.

In summary, a facile and cheap approach for the fabrication of spherical silver nanoparticles has been demonstrated via arc discharge method at different speeds and shapes of cathode when using two different dielectric medium. Silver nanoparticles are dependent on the electrode shape, dielectric media, and rotational speed. Cylindrical cathode shape at higher rotational speed 950 rpm submerged in deionized water is recommended.

According to the optimum condition studied thorough the preparation of silver nanoparticles, now it is easy to prepare zinc nanoparticles and silver carbon nanotubes by using these conditions (rotating speed 950 rpm, cylindrical shape cathode, and deionized medium). The present work is divided into two parts the first part gives the details of the preparation of the nano sample and the effect of rotation cathode speed, shape of the cathode and the dielectric collecting medium on the characteristics of the samples as mentioned in the previous sections while the second one explains the applications of these prepared samples to purify water from dyes contaminate as well the control of bacterial growth.

The prepared nano-adsorbents have a great effect on methylene blue removal from aqueous solution. Correlation coefficients indicated the following order to fit isotherms for silver carbon nanotube: Freundlich > Langmuir > Temkin. On the other hand, for zinc oxide nanoparticles, the following adjustment founded to fit isotherms was: Langmuir > Temkin> Freundlich. Kinetic studies showed that the adsorption of Methylene blue onto

silver carbon nanotube followed Elovich kinetic model, and the rate of adsorption is controlled by the intraparticle diffusion model. Adsorption of Methylene blue on zinc oxide nanoparticles followed the pseudo-second-order kinetic model, and the rate of adsorption is controlled by the liquid film diffusion model. Silver nanoparticles act as bactericidal and bacteriostatic on Klebsiella pneumonia. The smallest particle size nanoparticles having the most powerful antibacterial effect on Klebsiella pneumonia

The rotation of the silver electrode distributes arc discharges uniformly and generates stable plasma using microcontroller system. The rotational force accelerates silver clusters and prevents it from condensation on cathode surface which intrinsic factor in minimizing particle size of silver nanoparticles, also condense distribution in low particle size region. The rotational disk electrodes gliding rotatory arc discharge process is a persistent process of the steady discharge and it is expected to perform high-quality mass production. Optimum percentage removal (84%) of Methylene blue dye on silver carbon nanotubes was obtained at a contact time of 90 min, initial dye concentration of 40 ppm, and adsorbent dosage of 0.1 gm/ 100ml. In case of zinc oxide nanoparticles, optimum removal of Methylene blue dye (63%) occurred at 120 min, initial dye concentration of 40 ppm, and adsorbent dosage of 0.1 gm/ 100ml. The antibacterial properties of silver nanoparticles increased with a surface area of the sample and by controlling silver size, bacteriostatic (inhibition of bacterial growth) or bactericidal (killing of inoculated bacteria) activities can be obtained and modulated. The silver particle size can be controlled using different synthesis method. In this way, it is possible to control the silver releasing rate using rotating electrode arc discharge method.