SYNTHESIS OF SiO2 NANOPARTICLES USING SOL-GEL PROCESS

[1]Prof. J. S. Pachbhai, [2]N. P. Satange, [3]N. M. Bagde, [4]A. M. Nimje, [5]S. S. Sevatkar, [6]S. I. Harinkhede

[1]Assistant Professor, College of Engineering and Management, Nagpur-441501, Maharashtra, India.
[2,3,4,5,6]UG. Scholar, Department of Mechanical Engineering, J D College of Engineering and Management, Nagpur-441501, Maharashtra India.

Abstract : Nanotechnology is a huge and recently developed innovation and has been added as another subject to the growing specialists. In this the significant spotlight is on readiness of nanoparticles and its use with the current known innovation, gadgets and hardware. There are different techniques known to make nanoparticles like, sol-gel strategy, and so forth. The primary target of this examination is to incorporate Silicon dioxide nano-particles utilizing sol gel strategy and utilizing a Tetraethyl Orthosilicate as a synthetic arrangement. Refined water, Ammonia, Acetic corrosive and Ethanol were utilized as the impetus and hydrolyzing specialist. Numerous boundaries were read and perceived for the maturing and calcination. The maturing season of the Silicon dioxide nano-particles was for 2 hours at 400-500^{0}C. At that point, they are calcinated for 4 to 6 hours at the temperature scope of 600-700^{0}C. after that we got silicon dioxide nano-particles was portrayed utilized FESEM and nanoparticles size analyzer. The outcome demonstrated that the silicon dioxide nanoparticles were effectively integrated by utilizing sol gel technique with ideal boundary of 700^{0}C of calcination temperature and 2 hours of maturing time. The average size of silicon dioxide nanoparticles was in the range of 400 to 500 nm.

I. INTRODUCTION

Nanotechnology is an immense and recently advanced innovation and has been included as another subject Nanotechnology is a significant field of current examination managing plan, union, and control of molecule structures going from around 1-100 nm. Nanoparticles (NPs) have wide scope of utilizations in territories, for example, medical care, makeup, food and feed, natural wellbeing, mechanics, optics, biomedical sciences, compound businesses, gadgets, space ventures, drug-quality conveyance, vitality science, optoelectronics, catalysis, single electron semiconductors, light producers, nonlinear optical gadgets, and photograph electrochemical applications.

Nanobiotechnology is a quickly developing logical field of creating and building gadgets. A significant zone of exploration in nanobiotechnology is the union of NPs with various synthetic pieces, sizes and morphologies, and controlled differences. Nanobiotechnology has turned up as a basic division of contemporary nanotechnology and unfastened novel age in the fields of material science getting worldwide consideration because of its abundant applications. It is a multidisciplinary approach coming about because of the investigational utilization of NPs in organic frameworks including the controls of science, natural chemistry, science, building, physical science and medication. Besides, the nano bio-innovation additionally fills in as a basic strategy in the improvement of perfect, nontoxic, and eco-accommodating strategies for the union and assembly of metal NPs having the inborn capacity to diminish metals by explicit metabolic pathways.

These days, there is a developing need to create eco-accommodating cycles, which don't utilize harmful synthetics in the amalgamation conventions. Green combination approaches incorporate blended valence polyoxometalates, polysaccharides, Tollens, natural, and light technique which have favorable circumstances over traditional strategies including synthetic specialists related with ecological poisonousness. Determination of dissolvable medium and choice of eco-accommodating nontoxic lessening and settling operators are the most significant issues which must be considered in green union of NPs.

II. LITERATURE SURVEY

[1] Silver and gold nanoparticles were combined by the sol–gel measure in SiO_2, TiO_2, and ZrO_2 dainty movies. An adaptable strategy, in light of the utilization of coordination science, is introduced for settling Ag_1 and Au31 particles in sol–gel frameworks. Different ligands of the metal particles were tried, and for every framework it was conceivable to locate an appropriate ligand fit for balancing out the metal particles and forestalling gold precipitation onto the film surface. Slender movies were set up by turn covering onto glass or intertwined silica substrates and afterward heat-treated at different temperatures in air or H2 climate for nucleating the metal nanoparticles. The Ag molecule size was around 10 nm subsequent to warming the SiO_2 film at 600°C and the TiO_2 and ZrO_2 films at 500°C. After warmth treatment at 500°C, the Au molecule size was 13 and 17 nm in the TiO_2 and ZrO_2 films, separately. The movies were described by UV–vis optical ingestion spectroscopy and X-beam diffraction, for contemplating the nucleation and the development of the metal nanoparticles. The outcomes are talked about with respect to the inserting lattice, the temperature, and the environment of the warmth treatment, and it is inferred that crystallization of TiO_2 and ZrO_2 movies may impede the development of Ag and Au particles.

[2] As of late, data innovation is developing quickly, for example, specialized gadgets. Notwithstanding, there are as yet numerous inadequacies, for instance, private data spills brought about by the spillage of electromagnetic waves utilized. A covering of electromagnetic materials or development composite of electromagnetic material with different materials, for

example, SiO_2 is expected to defeat these issues. For such needs, it is important to contemplate the production of SiO_2 which is basic, modest, and viable. In this examination, production of SiO_2 by sol-gel technique utilized an answer of sodium silicate (Na_2SiO_3) as forerunners and H_2SO_4 as an impetus. The boundaries tried in this trial is the impact of sintering temperature on the properties of the subsequent SiO_2. The reason for this examination was to get a formless SiO_2 powder, which is in nano-sized and has a high surface region. The portrayal of arranged examples were performed by utilizing a X-beam Diffraction (XRD), Fourier Transmission Infra-Red (FTIR), Scanning electron microscopy-vitality dispersive spectrometer (SEM-EDS), Transmission Electron Microscopy (TEM), and Surface Area Analyzer (SAA). In light of the exploratory outcomes, the SiO_2 nebulous structure was acquired with a molecule size of 15-20 nm, the surface territory of 298 m2/g, and sintering temperature of 100 °C.

[3] Silica nanoparticles have gotten a concentrated consideration of academic network because of its expansive applications in industry. The optical properties of silica nanoparticles can be accomplished concerning surface imperfection identified with enormous surface/volume proportion as indicated by the applications. In this paper, silica nanoparticles were blended from tetraethyl orthosilicate (TEOS) as an antecedent and PVP as a surfactant by utilizing sol-gel technique. By XRD estimation, a wide pinnacle of unadulterated nebulous nature is watched while FTIR investigation demonstrated hygroscopic nature of particles. TEM estimation has likewise affirmed the shapeless structure of arranged SiO_2 nanoparticles with their average diameter-25 nm. The compositional proportion of silicon and oxygen is examined by EDX and discovered to be acceptable.

[4] Silica nanoparticles were set up by ultrasound-helped and customary solgel strategy. The union systems were planned and advanced by the Taguchi exploratory plan technique. Molar groupings of TEOS, H2O, NH_4OH, and response temperature were picked as principle factors. The outcomes indicated that the molar convergence of alkali is the principle factor which influences the molecule size of the silica nanoparticles. The compound structure, size, and morphology of the item were examined by X-beam diffraction, Fourier change infrared spectroscopy, laser light dispersing, and checking electron microscopy. By the ideal states of the ultrasound-helped sol-gel strategy, silica nanoparticles with a normal molecule size of 13 nm were readied.

[5] Sol-gel technique is the easiest strategy and can control the molecule size and morphology through precise checking of response boundaries. The target of this exploration is to combine silica nanostructures by sol-gel technique and to describe the incorporated silica nanostructures. Silica nanoparticles were combined through the sol-gel strategy utilizing Tetraethyl orthosilicate as an antecedent. The acidic corrosive and refined water were utilized as the impetus and the hydrolysing operator. Fluctuated boundaries of the examination were the maturing time in the scope of 2 to 6 h and the calcination temperature in the scope of 600–700 ◦C. The acquired silica nano powder was described utilizing FESEM, and Nano-Particle Size Analyzer. The outcomes show that the silica nanospheres were effectively incorporated by utilizing sol-gel technique with the ideal boundaries of 700 ◦C of calcination temperature and 2 h of maturing time. The normal size of silica nanoparticles was in the scope of 79.68 nm to 87.35 nm.

[6] Utilization of silica nanoparticles as fillers in the arrangement of nanocomposite of polymers has drawn a lot of consideration, because of the expanded interest for new materials with improved warm, mechanical, physical, and synthetic properties. Ongoing advancements in the union of monodispersed, restricted size dispersion of nanoparticles by sol-gel strategy give huge lift to improvement of silica-polymer nanocomposites. This paper is composed by underlining on the blend of silica nanoparticles, portrayal on size-subordinate properties, and surface alteration for the readiness of homogeneous nanocomposites, by and large by sol-gel method. The impact of nano silica on the properties of different kinds of silica-polymer composites is likewise summed up.

III. RESEARCH METHODOLOGY

1) MATERIALS AND CHEMICALS USED-

For the preparation of nanoparticles, we used following chemicals

1. Tertraethyl orthosilicate (TEOS)- It is aa synthetic compound with the recipe Si(OC2H5). It is a fluid that debases in water. It is an ethyl ester of orthosilicic corrosive. It is most common alkoxide of silicon. It is chiefly utilized as a crosslinking specialist in silicon polymers and as an antecedent to silicon dioxide in the semiconductor business. TEOS is likewise utilized as silica hotspot for combination of certain zeolites.
2. Distilled water- Refined water will be water that has been bubbled into fume and dense go into fluid in a different holder. Debasements in the first water that don't bubble underneath or close to the breaking point of water stay in the first compartment. Accordingly, refined water is one sort of filtered water.
3. Ethanol- It is likewise called as ethyl liquor, grain liquor, spirits. It is a natural concoction intensify, a straightforward liquor with a synthetic equation C2H6O. Ethanol is an unstable, combustible, dreary fluid with a slight trademark scent.
4. Acetic acid- It is additionally called as Ethanoic corrosive, the most significant of the carboxylic acids. A weaken arrangement of acidic corrosive produces by maturation and oxidation of common sugars is called as vinegar.
5. Ammonia- It is a compound of nitrogen and hydrogen with a chemical formula NH3. A stable binary hydride, and a simplest pnictogen hybride, ammonia is a colourless gas with a characteristic smell.

2) APPARATUS USED

1. Conical flask (250 ml)
2. Fork
3. Magnetic stirrer

4. Measuring tube
5. Muffle furnace
6. Watson filter paper
7. Mortar
8. Funnel
9. Tong etc.

3) PREPARATION PROCESS

Right off the bat, clean all the mechanical assembly cautiously and clean it with care. Wash them all with refined water. At that point take 125ml ethanol in the cone like carafe and include 25 ml refined water with it. Blend it well for almost 15 minutes by hand or by shaking or with the assistance of attractive stirrer at 400C at 600rpm. At that point include 12ml Tetraethyl Orthosilicate in a similar conelike carafe and proceed with the blending cycle for around 2 hours. From that point onward, add 30 ml corrosive to it and set the temperature at 400C at 1000 to 1100 rpm for next 4 hours.

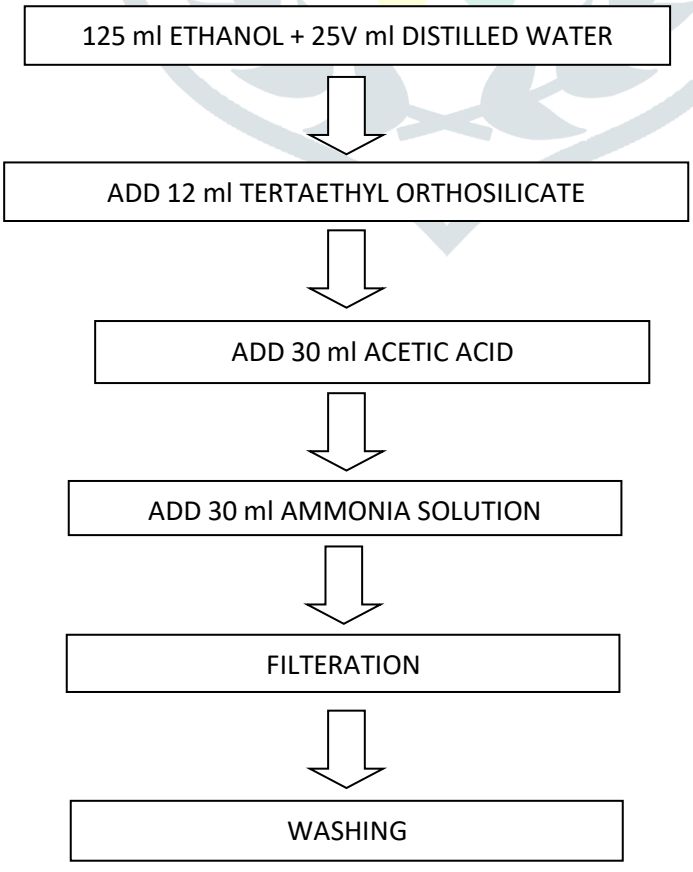
After the competition of that mixing process, add 30 ml ammonia liquid solution in the flask at the temperature of 60^0C at 1400 to 1600rpm. The solution in the flask will start to form a thick gelatinous fluid. This will indicate that the reaction is started and gone well. Continue the mixing process for 1 hour. Then set the temperature of the stirrer at 30^0C and at 1100 rpm and continue the mixing process for 8 to 9 hours till it becomes a thick gel like fluid.

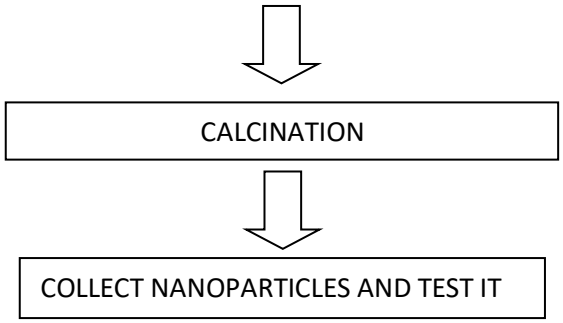
As the thick gel is formed, it indicated that the reaction is completed. Now collect that in a glass which is cleaned and cover it with a watmon paper. Now hydrolysis is required to remove excess water and chemicals from that solution. For this, filtration is required and can be done by using circular filter paper of fine grade. Put a filter paper on the glass conical funnel and put this setup in the tripod stand and collect the remaining fluid in another flask.

After the filtration is completed, collect a solid gel sediment in a clean glass flask. Now the washing of that gel solution is required. Take a warm water in a bog vessel and a minute pored fibre net. Take a gel solution in it and wash it with hand. Also wear rubber gloves. After washing. Collect the gel solution in a silica crucible and put it in a muffle furnace at 100^0C for 1 hour. After that take it out from the furnace.

Now, calcination of that thick gel solution is required to form granules like structure. For this, take a spatula and collect a small portion of that solution is a silica crucible. And put it in the furnace at 600^0C for 2 hours. Check it frequently because sometimes, due to the presence of ammonia it bursts. After 2hours, take out the crucible from the furnace cool it at room temperature. Collect the granules in the mortar and crush it as fine as possible.

Now collect fine sized nanoparticles and put it in the muffle furnace for 4 to 5 hrs for calcination. It will remove all the moistures and all the other chemicals from it and SiO2 nanoparticles will be formed. Now remove it from the furnace and do the testing of it.





IV. TESTING AND RESULT:

For the testing of nanoparticles, nanoparticles were tested at Sophisticated Analytical Instrument facility lab. IIT MADRAS. Following figures represents the SEM micrograph and particles size distribution of SiO2 nanoparticles obtained. The photo graph of the SiO2 nanoparticles indicates the uniform distribution of their sizes and their spherical shape. The composition of SiO2 nanoparticles was qualitatively analysed by EDS and these nanoparticles are clearly composed Si and O elements. No other elements were present in the SiO2 nanoparticles.

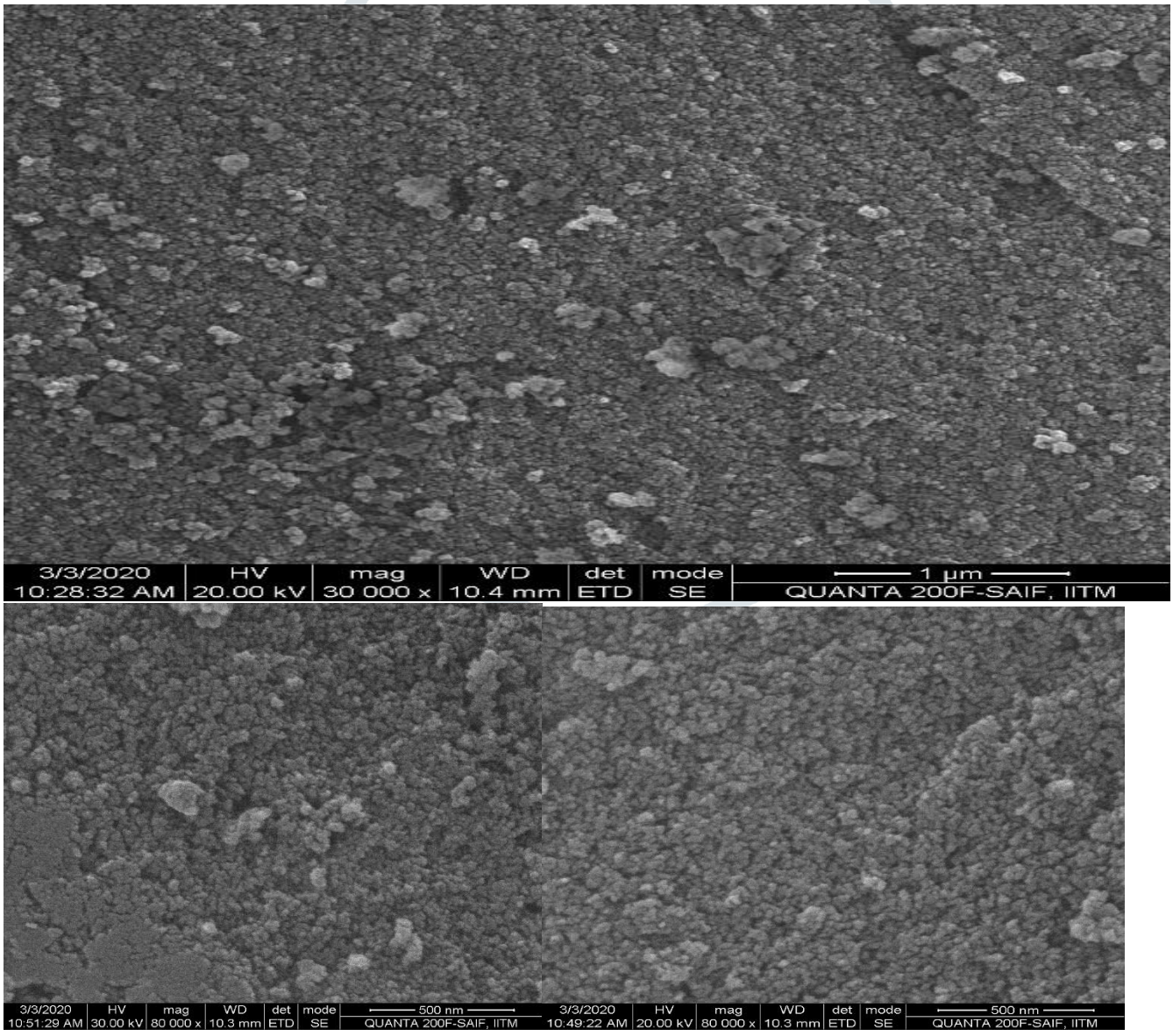


Figure : SEM TESTING IMAGES, SAIF, IIT, MADRAS.

Therefore, SiO2 nanoparticles can be effectively synthesized through sol-gel method.

V. CONCLUSION:

This study and research mainly focuses on the preparation of nanoparticles. SiO2 nanoparticles were prepared with the use of sol-gel method as CMP slurries. It could produce higher chemical purity and ultrafine particles with a narrow size distribution. SEM results reveal that CMP with these SiO2 slurries yielded surfaces of high quality.

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REFERENCES

[1] Mauro Epifani, Cinzia Giannini, Leander Tapfer, and Lorenzo Vasanelli, Sol–Gel Synthesis and Characterization of Ag and Au Nanoparticles in SiO2, TiO2, and ZrO2 Thin Films. Journal of the American Ceramic Society—Epifani et al. Vol. 83, No. 10

[2] Bharat H. Patel and P. N. Patel. Synthesis and Application of Nanosized SiO2 to Textiles: a Review, Article in International Dyer · May 2012

[3] S Wardiyati, W A Adi and Deswita, Synthesis and Characterization of Microwave Absorber SiO2 by Sol-Gel Methode, IOP Conf. Series: Materials Science and Engineering 202 (2017) 012059 doi:10.1088/1757-899X/202/1/012059

[4] M. J. Kao, F. C. Hsu, and D. X. Peng, Synthesis and Characterization of SiO2 Nanoparticles and Their Efficacy in Chemical Mechanical Polishing Steel Substrate, Hindawi Publishing Corporation Advances in Materials Science and Engineering Volume 2014, Article ID 691967.

[5] Ruchi Nandanwar, Purnima Singh and Fozia Z. Haque, Synthesis and Characterization of SiO2 Nanoparticles by Sol-Gel Process and Its Degradation of Methylene Blue, American Chemical Science Journal 5(1): 1-10, 2015, Article no.ACSj.2015.001 ISSN: 2249-0205.

[6] R. S. Dubeya , Y. B. R. D. Rajesh and M. A. Morec, Synthesis and Characterization of SiO2 Nanoparticles via Sol-gel Method for Industrial Applications, Materials Today: Proceedings 2 (2015) 3575 – 3579