OPEN ACCESS
Scholars Bulletin
Abbreviated Key Title: Sch Bull
ISSN 2412-9771 (Print) | ISSN 2412-897X (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Subject Category: Chemistry

Recently Developed Methods for Synthesis of Nanoparticles, Recent Advances and Applications for Scientific Developments

Sajjad Ahmed[1], Ghulam Mudassir[2], Muhammad Faisal Yasin[2*], Khadija Aimun[2], Tayyaba Fizzah[3], Muhammad Shahzad Aziz[4], Irshad Khan[5], Tayyaba Mukhtar[6]

[1]Department of Physics, University of Wah, Wah Cantt, Pakistan
[2]Department of Chemistry, Government College University, Faisalabad, Pakistan
[3]Department of Chemistry, Khawaja Fareed University of Engineering and Information Technology, Rahim Yar Khan, Pakistan
[4]Department of Chemistry, Comsats University, Islamabad, Lahore Campus, Pakistan
[5]Department of Chemistry, University of Malakand Dir, Lower KPK, Pakistan
[6]Institute of Chemical Sciences, Bahauddin Zakariya University, Multan, Pakistan

DOI: 10.36348/sb.2021.v07i10.003 | **Received:** 22.08.2021 | **Accepted:** 01.10.2021 | **Published:** 09.10.2021

***Corresponding author:** Muhammad Faisal Yasin

Abstract

The texture and size of manufactured nanoparticles are influenced by the pH of solution media. Due to its wide applications in electronics, coatings, optical materials, and catalysis the alloy nanomaterials are of tremendous interest now days. Turkevich approach is a viable technique for chemical production of GNPs. Nanoparticles of certain materials can be made via "wet chemical methods", in which appropriate compound solutions are combined to make an insoluble compound of the desired substance. Nanowires created through lithography, for example, are not always smooth and can have a lot of impurities and structural flaws on their surface. The Polyol technique is a chemical approach for nanoparticle production. Non-aqueous liquid (polyol) is used as a reducing agent and solvent in this process. A colloidal solution of particles suspended in a liquid phase is known as a sol. The biological production of MNPs has always been advantageous. The reverse micelle approach can also be used to create nanoparticles with specific size and shapes. Chemical precursors are typically a combination of chlorides, metals and oxides that react during milling or heat treatment to generate a composites powder with ultrafine particles scattered in a stable salt matrix.

Keywords: Nanoelectronics, biomaterials, nanomedicine, consumer goods, methods.

INTRODUCTION

Metallica nanomaterials are made from metals using constructive or destructive processes. Pure metal nanomaterials are created by using the metal precursors. Due to plasma on resonance properties, metal nanomaterials optoelectrical capabilities. Facet, Shape, and size all influence the production of metal nanomaterials. Because of its unique characteristics and wide range of applications, ZnO (zinc oxide) is regarded as a magical material. The synthesis of zinc oxide nanoparticles was carried out by utilizing a precipitation approach with Zn (NO3)2.6H2O as a precursor and potassium carbonate as a precipitator [1-4].

The pH of a solution affects the creation of nanoparticles using green tech approaches. According to researchers, the texture and size of manufactured nanoparticles are influenced by the pH of solution media. Due to its wide applications in electronics, coatings, optical materials, and catalysis the alloy nanomaterials are of tremendous interest now days. The secretory cofactor NADH has a crucial role in defining the makeup of Au-Ag alloy nanomaterials, according to the production of bimetallic Au-Ag alloy by F. oxysporum [5-7].

In comparison to other methods, the Turkevich approach is a viable technique for chemical production of GNPs. In the Turkevich technique, Au3+ ions are reduced in an aqueous media by a mild reductant like citrate, tannic acid or ascorbic acid. GNPs of a tiny size and biocompatibility are created in this procedure [8, 9].

When compared to 0D nanomaterials, 1D nanomaterial has nanoscale size in both directions, with one dimension reaching centimeter length. They're employed for perfect systems; thus, they've got a lot of possible uses. They're also linked to optoelectronic, electronic and nanoscale aspects, as well as nanoelectronics [10-13].

Nanoparticles of certain materials can be made via "wet chemical methods", in which appropriate compound solutions are combined to make an insoluble compound of the desired substance. The size of particles in latter is controlled by adjusting the reagent concentrations and temperature of solution, as well as the inclusion of appropriate inert substances that impact the viscosity of liquids and rate of diffusion. The same general procedure can produce other nanostructures of the same substance, such as aerogels and other porous networks, by changing the parameters [14-17].

Top-down approaches

These techniques are naturally simple, relying on division or removal of bulk material or bulk production process reduction, to produce the desired structure with adequate attributes. The most significant flaw in the top-down method is the inaccuracy of surface structure. Nanowires created through lithography, for example, are not always smooth and can have a lot of impurities and structural flaws on their surface. Electron beam lithography, aerosol spray, atomic force manipulation, gas-phase condensation, high-energy wet ball milling, and other processes are examples of such techniques [18, 19].

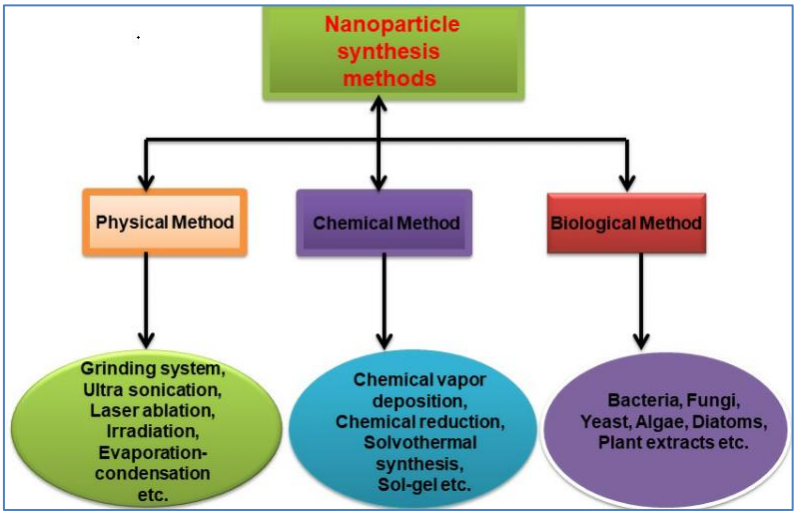

Fig-1: Shows the different methods used for synthesis if nanoparticles'

The Polyol technique is a chemical approach for nanoparticle production. Non-aqueous liquid (polyol) is used as a reducing agent and solvent in this process. The use of non-aqueous solvents in this approach has the benefit of agglomeration and reducing surface oxidation. This approach gives more control over the texture, shape and size of nanoparticles. The polyol approach can also be used to mass-produce nanoparticles [20-21].

Bionics, also known as biomimicry, is the study and creation of engineering systems and advanced technology using biological techniques and systems found naturally. One of method explored is bio-mineralization. The utilization of biomolecules for nanotechnology uses, such as viruses and lipid assemblies, is known as bio-nanotechnology. Nanocellulose has the potential to be used on a large scale [22].

Microemulsion methods can be used to make uniform and controlled-size silver NPs. The initial spatial separation of reactants (metal precursor and reducing agent) in two immiscible phases is the basis for the synthesis of NPs in two-phase aqueous organic systems [23].

Plant extracts, microorganisms, and enzymes are among the natural precursors found in the green sources. Fruit juices, which can act as reducers and coating agents are one of the most prevalent antioxidants source employed in the manufacture of silver nanomaterials. One example is the pomegranate, which has been the subject of numerous researches to determine its ingredients and attribute its attributes to its accessible components in the juice, mesocarp, aril, and shell as a great source of polyphenols [23, 24].

Delftia acidovorans, a bacterium, produced pure gold nanomaterials. Delftibactin is a non-ribosomal peptide that has been linked to the production of gold nanomaterials due to its ability to generate susceptibility to harmful gold ions. Due to the creation of AuNPs (innocuous gold nanoparticles) coupled to

delftibactin, the transition metal gold has no toxicity toward bacteria [25].

A colloidal solution of particles suspended in a liquid phase is known as a sol. A solid compound immersed in a solvent is called a gel. Because of its simplicity and the fact that most nanoparticles can be manufactured using this process, sol-gel is the most used bottom-up method. It is a wet-chemical method in which a chemical solution serves as a precursor for a distinct particle system. In the sol-gel process, chlorides and metal oxides are commonly utilized as precursors [8, 26].

A fungus has the ability to efficiently produce uniformly sized nanomaterials with well-defined shapes. For the creation of metallic nano-particles, a diversity of fungal internal enzymes like nitrate reductases and protein-complexes operate as reducing agents. Nanoscience has also advanced in other branches of science, such as computer study, engineering and biology. Computer science has developed to the point where a conventional computer can be reduced in size from a room to extremely efficient movable laptops because to advances in sciences and nanotechnology [5, 26, 27].

The biological production of MNPs has always been advantageous. Green synthesis method of MNPs utilizing plants and plant extracts is a more cost-effective, energy-efficient, and environmentally friendly approach that is devoid of hazardous contaminants, which is necessary in therapeutic uses. Microbes are considered promising bio-factories for MNPs production, and their specific physicochemical features make them a new generation antibacterial agent [15, 18].

For the bio-synthesis of AuNPs, green materials may act as both stabilising and reducing agents. In short, biomolecules derived from environmentally friendly or green materials convert gold (ii) ions to zero valent gold. The external surface of the Nanoparticles can then be covered by the agglomeration, resulting in NPs stability (controlled by biomolecules). In the solution phase, the LaMer model is commonly used to describe the growth and nucleation mechanism of metal-nanocrystals. Metal precursors are first reduced or decomposed into metal atoms, which then begin to collect into tiny clusters (i.e., nuclei) when their concentration reaches the point of supersaturation[21, 27].

The reverse micelle approach can also be used to create nanoparticles with specific size and shapes. Normal micelles form, as a result of an oil in water emulsion, with hydrophobic tails aiming at a core containing entrapped oil droplets. However, I In case of water in oil emulsion, reverse micelles are formed when the hydrophilic heads point towards a water-containing core. Nanotechnology may one day allow items to harvest energy from their surroundings. New nanoparticles and ideas are now being developed that have the ability to produce energy with high conversion efficiency from the movement, temperature fluctuations, light, glucose, and many other resources [25, 27].

Chemical precursors are typically a combination of chlorides, metals and oxides that react during milling or heat treatment to generate a composites powder with ultrafine particles scattered in a stable salt matrix. Nanotechnology is a viable approach for manipulating single atoms and molecules. It is described as the study and applications of structures ranging in size from 1 nm to 100 nm. To put that in perspective, it would take 800 nm particles lined up side by side to equal the breadth of a human hair. The goal of this essay is to promote nanotechnology as a future potent science and technology tool [28, 29].

Nanotechnology's future ramifications are now being debated among scientists. Nanotechnology has the potential to generate a wide range of new materials and structures with uses in nanoelectronics, energy production, biomaterials, nanomedicine, and consumer goods. Nanotechnology, on the other hand, generates many of the same challenges that any modern tech does, such as concern about nanoparticles' toxicity and impact on the environment, and also their possible implications on global economies and speculations about numerous apocalyptic scenarios. These issues have sparked a debate between advocate groups and the government about whether nanotechnology requires specific regulation [11, 30].

Nanotech goods, materials, and uses that are radically new, such as nanorobotics, are years away. Today, "nanotechnology" refers to basic research and innovation taking place in laboratories all around the world. Many respondents admitted nanotechnology will change the face of production and prosperity, as seen by the increase in public funding for nanotechnology research and innovation over the last year [31-35].

CONCLUSION

Many of the goods are well-defined as "nanotechnology-products" because these products comprised of nanomaterials in some procedure or other. For example, many of the antimicrobic coverings contains silver in the nano-scale form; foodstuffs and maquillages comprise nanomaterials and some goods are somewhat made up of complex ingredients comprising nanoparticles for example carbon nano-tubes.

REFERENCES

1. Mourdikoudis, S., & Liz-Marzán, L. M. (2013). Oleylamine in nanoparticle synthesis. *Chemistry of Materials*, *25*(9), 1465-1476.
2. Grzelczak, M., Pérez-Juste, J., Mulvaney, P., & Liz-Marzán, L. M. (2008). Shape control in gold nanoparticle synthesis. *Chemical Society Reviews*, *37*(9), 1783-1791.
3. Landfester, K. (2003). Miniemulsions for nanoparticle synthesis. *Colloid chemistry II*, 75-123.
4. Eastoe, J., Hollamby, M. J., & Hudson, L. (2006). Recent advances in nanoparticle synthesis with reversed micelles. *Advances in colloid and interface science*, *128*, 5-15.
5. Verma, H. N., Singh, P., & Chavan, R. M. (2014). Gold nanoparticle: synthesis and characterization. *Veterinary world*, *7*(2), 72.
6. Powar, N. S., Patel, V. J., Pagare, P. K., & Pandav, R. S. (2019). Cu nanoparticle: Synthesis, characterization and application. *Chemical Methodologies*, *3*(4), 457-480.
7. Yoshimura, Hideyuki. "Protein-assisted nanoparticle synthesis." *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 282 (2006): 464-470.
8. Srivastava, S., Usmani, Z., Atanasov, A. G., Singh, V. K., Singh, N. P., Abdel-Azeem, A. M., ... & Bhargava, A. (2021). Biological nanofactories: using living forms for metal nanoparticle synthesis. *Mini Reviews in Medicinal Chemistry*, *21*(2), 245-265.
9. Slocik, J. M., Naik, R. R., Stone, M. O., & Wright, D. W. (2005). Viral templates for gold nanoparticle synthesis. *Journal of Materials Chemistry*, *15*(7), 749-753.
10. Perala, S. R. K., & Kumar, S. (2013). On the mechanism of metal nanoparticle synthesis in the Brust–Schiffrin method. *Langmuir*, *29*(31), 9863-9873.
11. Malik, P., Shankar, R., Malik, V., Sharma, N., & Mukherjee, T. K. (2014). Green chemistry based benign routes for nanoparticle synthesis. *Journal of Nanoparticles*.
12. Pastoriza-Santos, I., & Liz-Marzán, L. M. (2009). N, N-dimethylformamide as a reaction medium for metal nanoparticle synthesis. *Advanced Functional Materials*, *19*(5), 679-688.
13. Geohegan, D. B., Puretzky, A. A., Duscher, G., & Pennycook, S. J. (1998). Time-resolved imaging of gas phase nanoparticle synthesis by laser ablation. *Applied Physics Letters*, *72*(23), 2987-2989.
14. Mialon, G., Gohin, M., Gacoin, T., & Boilot, J. P. (2008). High temperature strategy for oxide nanoparticle synthesis. *Acs Nano*, *2*(12), 2505-2512.
15. Sastry, M. (2003). Phase transfer protocols in nanoparticle synthesis. *Current Science*, 1735-1745.
16. Lo, C. H., Tsung, T. T., & Chen, L. C. (2005). Shape-controlled synthesis of Cu-based nanofluid using submerged arc nanoparticle synthesis system (SANSS). *Journal of Crystal Growth*, *277*(1-4), 636-642.
17. Saxena, J., Sharma, M. M., Gupta, S., & Singh, A. (2014). Emerging role of fungi in nanoparticle synthesis and their applications. *World J Pharm Sci*, *3*(9), 1586-1613.
18. Williamson, C. B., Nevers, D. R., Hanrath, T., & Robinson, R. D. (2015). Prodigious effects of concentration intensification on nanoparticle synthesis: a high-quality, scalable approach. *Journal of the American Chemical Society*, *137*(50), 15843-15851.
19. Suryanarayana, C. (2005). Nanoparticle synthesis. *Materials today*, *8*(11), 62.
20. Hung, L. H., Choi, K. M., Tseng, W. Y., Tan, Y. C., Shea, K. J., & Lee, A. P. (2006). Alternating droplet generation and controlled dynamic droplet fusion in microfluidic device for CdS nanoparticle synthesis. *Lab on a Chip*, *6*(2), 174-178.
21. Chen, S., & Kimura, K. (1999). Synthesis and characterization of carboxylate-modified gold nanoparticle powders dispersible in water. *Langmuir*, *15*(4), 1075-1082.
22. Hu, X., Wang, T., Qu, X., & Dong, S. (2006). In situ synthesis and characterization of multiwalled carbon nanotube/Au nanoparticle composite materials. *The Journal of Physical Chemistry B*, *110*(2), 853-857.
23. Han, P., Martens, W., Waclawik, E. R., Sarina, S., & Zhu, H. (2018). Metal nanoparticle photocatalysts: synthesis, characterization, and application. *Particle & Particle Systems Characterization*, *35*(6), 1700489.
24. Pati, P., McGinnis, S., & Vikesland, P. J. (2014). Life cycle assessment of “green” nanoparticle synthesis methods. *Environmental Engineering Science*, *31*(7), 410-420.
25. Lo, C. H., Tsung, T. T., & Lin, H. M. (2007). Preparation of silver nanofluid by the submerged arc nanoparticle synthesis system (SANSS). *Journal of Alloys and Compounds*, *434*, 659-662.
26. Mythili, R., Selvankumar, T., Kamala-Kannan, S., Sudhakar, C., Ameen, F., Al-Sabri, A., ... & Kim, H. (2018). Utilization of market vegetable waste for silver nanoparticle synthesis and its antibacterial activity. *Materials Letters*, *225*, 101-104.
27. Leong, G. J., Schulze, M. C., Strand, M. B., Maloney, D., Frisco, S. L., Dinh, H. N., ... & Richards, R. M. (2014). Shape-directed platinum nanoparticle synthesis: nanoscale design of novel

catalysts. *Applied Organometallic Chemistry*, *28*(1), 1-17.
28. Feng, X., Ren, Y., Hou, L., Tao, Y., Jiang, T., Li, W., & Jiang, H. (2019). Tri-fluid mixing in a microchannel for nanoparticle synthesis. *Lab on a Chip*, *19*(17), 2936-2946.
29. Rittler, A., Deng, L., Wlokas, I., & Kempf, A. M. (2017). Large eddy simulations of nanoparticle synthesis from flame spray pyrolysis. *Proceedings of the Combustion Institute*, *36*(1), 1077-1087.
30. Lane, M. K. M., & Zimmerman, J. B. (2019). Controlling metal oxide nanoparticle size and shape with supercritical fluid synthesis. *Green Chemistry*, *21*(14), 3769-3781.
31. Sarma, T. K., Chowdhury, D., Paul, A., & Chattopadhyay, A. (2002). Synthesis of Au nanoparticle–conductive polyaniline composite using H 2 O 2 as oxidising as well as reducing agent. *Chemical Communications*, (10), 1048-1049.
32. Sharma, G., Kumar, D., Kumar, A., Ala'a, H., Pathania, D., Naushad, M., & Mola, G. T. (2017). Revolution from monometallic to trimetallic nanoparticle composites, various synthesis methods and their applications: a review. *Materials Science and Engineering: C*, *71*, 1216-1230.
33. Porel, S., Singh, S., Harsha, S. S., Rao, D. N., & Radhakrishnan, T. P. (2005). Nanoparticle-embedded polymer: in situ synthesis, free-standing films with highly monodisperse silver nanoparticles and optical limiting. *Chemistry of Materials*, *17*(1), 9-12.
34. Song, C., Zhao, G., Zhang, P., & Rosi, N. L. (2010). Expeditious synthesis and assembly of sub-100 nm hollow spherical gold nanoparticle superstructures. *Journal of the American Chemical Society*, *132*(40), 14033-14035.
35. Tian, J., Liu, S., Zhang, Y., Li, H., Wang, L., Luo, Y., & Sun, X. (2012). Environmentally friendly, one-pot synthesis of Ag nanoparticle-decorated reduced graphene oxide composites and their application to photocurrent generation. *Inorganic chemistry*, *51*(8), 4742-4746.