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: Physics

Role of Different Technologies for Use of Nanoparticles, And Applications in Different Fields

Muhammad Raheel[1], Syeda Muskan Zahra Rizvi[1*], Saud Rafiq[2], Ijaz Ahmad[1], Syed Zulqurnain Mustafa[1], Muhammad Daud Rafique[2], Muhammad Kashif[1], Kaleemullah[3]

[1]Centre of Excellence in Solid State Physics, University of the Punjab, Lahore, Pakistan
[2]Institute of Physics, Government College University, Lahore, Pakistan
[3]Department of Physics, Ghazi University, Dera Ghazi Khan, Pakistan

DOI: 10.36348/sb.2021.v07i12.001 | **Received:** 23.10.2021 | **Accepted:** 29.11.2021 | **Published:** 13.12.2021

***Corresponding author:** Syeda Muskan Zahra Rizvi

Abstract

Nanotechnology as multidisciplinary branch helpful in designing of variety of semiconductor such as transistors, switches depending upon the nature of particular materials composed of nanoparticles. X-ray diffraction is also used for measuring the different properties of nanoparticles also used for characterization of nanosacle materials. Silver and gold nanoparticles formulations can be easily accessed through the different methods such as lithographic and vacuum deposition of metal, but expensive techniques. There are many other techniques for instrumental manufacturing leads to accurate determination of thickness, roughness, and density of nanoparticles. X-ray reflectometry determines layer thickness, roughness, and density while on the other hand; high-resolution diffraction can measure the lattices properties and dimensions of nanoparticles. LEDs, different types of diodes, solar cells synthesized based on nancapsules and quantum computing. Photovoltaic cells can be synthesized through nanotechnology by employing high quality materials due to thermal and mechanical properties. Nanotechnology in electronics in designing of electronics devices by increase the shelf life of memory chips.

Keywords: Nanoparticles, Size of transistors, integrated circuits, nanocapsules, X-ray diffraction.

INTRODUCTION

There are different techniques used for detection of nanoparticles on the basis of size and other characteristics features. Advances in physical and chemical techniques leads to discovery of innovative nanoparticles with emerging applications in the fields of x-ray diffraction, electronics, electrical conductivity and measurements of heat capacities of different of different objects. One of such kind technique is the powder X-ray diffraction that is used for studying the crystals based properties of nanoparticles [1-3]. X-ray diffraction used for actual structure deviates from the ideal one, owing to internal stresses and defects during the synthesis of nana based materials. Anisotropic peak broadening related to crystallite shape, defects, and microstrain occurs frequently in nanomaterials and can significantly complicate the analysis. Therefore, more accurate analysis of different nanoparticles can performed in order to measure their characteristics that distinguish them from other materials due to compact surface, mechanical based properties and high conductivity [4, 5].

Role of emerging technologies

X-ray diffraction is also used for measuring the different properties of nanoparticles also used for characterization of nanosacle materials. It measures the size of nanoparticles by detection of crystal based properties of nanoparticles under investigation. It also provides the important information that is complementary to various microscopic and spectroscopic methods, such as phase identification, sample purity, crystallite size, and, in some cases, morphology [6, 7]. X-ray diffraction has become the value technique that critically used for measuring the phase properties of different particles under different conditions. This technology can be employed for discovery of nanoparticles that could be used for studying the crystallographic measurements. These possess different information values, reliabilities of results obtained, and calculation laboriousness.

Selecting one of these methods for the analysis of different objects. Accuracy of delivery of nanoparticles through X-ray diffraction more preciseable than those traditional techniques that are costly [8-10].

There are several approaches X-ray diffraction for analysis of nanoscale materials with mechanical properties. For determination of structure of different nanoparticles or nanoscale materials, width and shape of reflection yield information about the substructure of the materials sizes of crystallites, microstrain of a lattice, dislocation structures. These features of X-ray diffraction leads to synthesize the different nanoparticles with applications in heat transfer, mechanical based thermoregulators, electronic devices used for physical operations. X-ray diffraction as most important technique for optical measurements of nanosacle object[11-13].

Silver and gold nanoparticles formulations can be easily accessed through the different methods such as lithographic and vacuum deposition of metal, but expensive techniques. The high cost in these methods leads too much consumption of energy also required for preparation of nanoparticles and characterization. One of the suitable, simplest and low-cost methods is co-precipitation method which can be used in wide range of materials. In this study explaining the formation of silver nanoparticles through silver nitrate ions. The complex formed by silver nanoparticles can be immobilized through physical methods in order to enhance the catalytic performance of newly synthetized nanoparticles [14-16].

There are many factors influenced on formulations and characterization of novel nanoparticles. The common factor in nanotechnology is the lateral dimension of the accurate measurement of atomic and molecular distances within structures ranging from semiconductor devices to nano-powders. There are many other techniques advances in their instrumental manufacturing leads to accurate determination of thickness, roughness, and density of nanoparticles. X-ray reflectometry determines layer thickness, roughness, and density while on the other hand, high-resolution diffraction can measure the lattices properties and dimensions of nanoparticles [17-19].

Scattering of light as important for synthesis of nanoparticles in order to employ the optical properties. Modifications in different nanoparticles leads to synthesize the industrial based compounds with scattering properties. A regular array of scatterers produces a regular array of spherical waves. In the majority of directions, these waves cancel each other out through destructive interference. The most promising nanoparticles in the nanotechnology are the sliver nanoparticles with size range between 1-100 nm [16, 21]. These nanoparticles are extensively studied in physical studies in order to elucidate the size and shape depending optical, electrical, and magnetic properties. They are ideally important in industrial manufacturing of composite fibers, cryogenic superconducting materials, cosmetic products, and electronic components [20-23].

Applications in Physics and materials sciences

Nanoparticles can employ in semiconductors technology through the combinations of semiconductor quantum dots. This approach leads to higher light absorption in particular in the infrared spectral region of the photo current at higher temperatures. Different types of nanoparticles can synthesized through the nanotechnology by incorporation of semiconductor materials during processing. Semiconductor based nanoparticles possess the magnetic properties with excellent electrical conductivity due to which they are used in different appliances and engineering works. Zinc oxide is a distinctive electronic and photonic n-type semiconductor with a wide direct band gap of 3.37 eV and can be easily synthesized at room temperature but under different concentrations of nanomaterial employed used in their synthesis[24, 25].

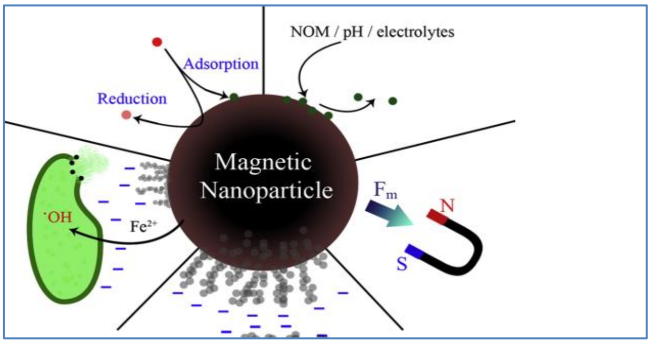

Fig-1: Shows the important properties of magnetic nanoparticles

Nanotechnology playing important role in designing of variety of semiconductor such as transistors, switches depending upon the nature of particular materials composed of nanoparticles. Nanocrystals based semiconductors formulations can be used for different industrial processes [1, 16, 19].

Different types of semiconductor with combinations of nanocrystals are commonly used as probes for labeling owing to their intense, tunable fluorescence. Semiconductors with recent advances in the field of physical sciences leads to synthesize emerging materials with high quality, thermal resistance and optical properties. Semiconductor nanomaterial's have interesting physical and chemical properties and useful functionalities, when compared with their conventional bulk counterparts and molecular materials [25, 26].

Advances in semiconductor technology have been made in order to increase the demand of nanomaterials that employed used for their synthesis. Semiconductor based NPs are composed of semiconductor materials at nanoscale high surface area, and quantum size effects. They are used LEDs, different types of diodes, solar cells synthesized based on nancapsules and quantum computing [31, 34]. These properties make the significant value in semiconductor marketplace by replacing the traditionally used semiconductors. Some of the semiconductors that high cost due to large time required in their preparation are not reliable. Therefore, semiconductors based on nanoparticle as dominate in electronics [27, 28].

Photovoltaic cells can be synthesized through nanotechnology by employing high quality materials due to thermal and mechanical properties. The photovoltaic cells that synthesized through nanotechnology approach possess the photofunctional materials, nanoscale architectures usually exhibit unique optical and electronic properties. These materials become the more popular and their demand increasing due to their efficient production, low cost and high compact materials used to design to structural formation [21, 27, 29]. It based on demand of clean electricity production based on renewable energy sources. Photovoltaic technology also employed the crystalline nature silicon to address the troubleshooting in proper supply of electricity. The largest share of the actual PV electricity supply is still based on crystalline silicon wafer solar cells. There is need to design such kind of cells that supply electricity with low cost and maximum production both industrial and commercial level [29, 30].

Electronic and photonic information technology and renewable energy alternatives, such as solar energy, fuel cells and batteries, have now reached an advanced stage in their development. Many of the electronic based devices are synthesized through the applications of nanotechnology due to feature sizes of the latest generations of electronic devices are approaching atomic dimensions, circuit speeds are now being limited by interconnect bottlenecks[1, 16, 17]. This approach leads to discovery of new materials that can be incorporate to microelectronics prior to use for different purposes. One of such kind of example is the alternative technologies to silicon based chip with combinations of various parts through nanotechnology. This silicon-nanotechnology approach helpful to design the novel materials by replacing the traditional materials used for industrial purposes [31, 32].

Table-1: Shows the recent advances, role of nanotechnology in different measurements

Recent Advances	Potential Role	Measurement/ Typical analysis	Reference
Nanotechnology	Electronics, as different parts can be implanted via silver and gold nanoparticles formulations can be easily accessed through the different methods such as lithographic and vacuum deposition of metal.	Electrical conductivity and measurements of heat capacities of different of different objects	[1,2,3,16]
X-ray diffraction	For measuring the different properties of nanoparticles also used for characterization of nanosacle materials.	It measures the size of nanoparticles by detection of crystal based properties of nanoparticles under investigation.	[6,7]
X-ray reflectometry and high-resolution diffraction	Determines layer thickness, roughness, and density	That can measure the lattices properties and dimensions of nanoparticles	[16,17,18]
Semiconductor based NPs	That comprised of materials at nanoscale high surface area, and quantum size effects.	Dominate in electronics as photovoltaic cells can be synthesized through nanotechnology by employing high quality materials due to thermal and mechanical properties.	[27,28]
Sensitizing dyes	That are used to increase the range and location of the wavelengths.	These dyes can be absorbed and favorable to sunlight. These advances leads to synthesize the variety of novel materials focusing on application in the electronics appliances	[27,28]

Different types of voltaic cells can be designed through nanomaterials prior to them for particular applications. For example, through the advances in nanotechnology, proof-of-concept photovoltaic cells comprising of small perfect crystals, rather than large, perfect silicon crystals [11, 15]. As traditionally used photovoltaic cells are not effective for industrial purposes due to high cost and troubleshooting problems. Nanowhiskers have been designed for experimented as new antireflective coating. This coating as a proof layer and acting as barrier for passing of different materials and water molecules [33, 34].

Sensitizing dyes are also used to increase the range and location of the wavelengths. These dyes can be absorbed and favorable to sunlight. These advances lead to synthesize the variety of novel materials focusing on application in the electronics appliances [9, 11, 13]. Traditionally used solar power generation systems possess the poor intermittent development. And can cause serious environmental factors. Traditionally used solar power generation systems possess the poor intermittent development. And can cause serious environmental factors. Most nanoparticles composed of carbon that designed for industrial applications. Some of the most commonly used nanomaterials for electronic and electrical equipment are carbon nanotubes and quantum dots and, in the case of surface coatings, nanoparticles of silver. These nanoparticle are environment friendly, have low costs and compatible to the industrials operations [1, 7, 9]. Therefore, these are not used for industrial and other purposes and replaced by nanotechnology based materials that are environment friendly, have low cost. One of the ideal nanotechnology based materials is silicon for the solar cell under the areas of p-n junctions. They generate current and voltage when light falls to the material source by creating the electric field. This electric field can be used for the movements of electrons [1, 7].

CONCLUSION

Nanotechnology in electronics in designing of electronics devices by increase the shelf life of memory chips and it reduces the size of transistors that used in integrated circuits. Traditionally used solar power generation systems possess the poor intermittent development and can cause serious environmental factors.

REFERENCES

1. Kricka, L. J. (2001). Microchips, microarrays, biochips and nanochips: personal laboratories for the 21st century. *Clinica Chimica Acta*, *307*(1-2), 219-223.
2. Endo, Tatsuro, Kagan Kerman, Naoki Nagatani, Ha Minh Hiepa, Do-Kyun Kim, Yuji Yonezawa, Koichi Nakano, and Eiichi Tamiya. "Multiple label-free detection of antigen− antibody reaction using localized surface plasmon resonance-based core− shell structured nanoparticle layer nanochip." *Analytical chemistry* 78, no. 18 (2006): 6465-6475.
3. Sabeeh, H., Aadil, M., Zulfiqar, S., Rasheed, A., Al-Khalli, N. F., Agboola, P. O., & Shakir, I. (2021). Hydrothermal synthesis of CuS nanochips and their nanohybrids with CNTs for electrochemical energy storage applications. *Ceramics International*, *47*(10), 13613-13621.
4. George, S., & Lee, H. K. (2009). Direct electrochemistry and electrocatalysis of hemoglobin in nafion/carbon nanochip film on glassy carbon electrode. *The Journal of Physical Chemistry B*, *113*(47), 15445-15454.
5. Sosa, I. O., Noguez, C., & Barrera, R. G. (2003). Optical properties of metal nanoparticles with arbitrary shapes. *The Journal of Physical Chemistry B*, *107*(26), 6269-6275.
6. Evanoff Jr, D. D., & Chumanov, G. (2005). Synthesis and optical properties of silver nanoparticles and arrays. *ChemPhysChem*, *6*(7), 1221-1231.
7. Nehl, C. L., Liao, H., & Hafner, J. H. (2006). Optical properties of star-shaped gold nanoparticles. *Nano letters*, *6*(4), 683-688.
8. Khurgin, J. B., & Sun, G. (2009). Enhancement of optical properties of nanoscaled objects by metal nanoparticles. *JOSA B*, *26*(12), B83-B95.
9. Hao, F., & Nordlander, P. (2007). Efficient dielectric functions for FDTD simulation of the optical properties of silver and gold nanoparticles. *Chemical Physics Letters*, *446*(1-3), 115-118.
10. Rehman, S., Mumtaz, A., & Hasanain, S. K. (2011). Size effects on the magnetic and optical properties of CuO nanoparticles. *Journal of Nanoparticle Research*, *13*(6), 2497-2507.
11. Stamplecoskie, K. G., & Scaiano, J. C. (2010). Light emitting diode irradiation can control the morphology and optical properties of silver nanoparticles. *Journal of the American Chemical Society*, *132*(6), 1825-1827.
12. Guo, L., Yang, S., Yang, C., Yu, P., Wang, J., Ge, W., & Wong, G. K. (2000). Highly monodisperse polymer-capped ZnO nanoparticles: preparation and optical properties. *Applied physics letters*, *76*(20), 2901-2903.
13. Temple, T. L., & Bagnall, D. M. (2011). Optical properties of gold and aluminium nanoparticles for silicon solar cell applications. *Journal of applied physics*, *109*(8), 084343.
14. Sathya, M., & Pushpanathan, K. (2018). Synthesis and optical properties of Pb doped ZnO nanoparticles. *Applied Surface Science*, *449*, 346-357.
15. Catchpole, K. R., & Polman, A. (2008). Design principles for particle plasmon enhanced solar cells. *Applied Physics Letters*, *93*(19), 191113.
16. Scholl, J. A., Koh, A. L., & Dionne, J. A. (2012). Quantum plasmon resonances of individual

metallic nanoparticles. *Nature*, *483*(7390), 421-427.
17. Pensa, E., Gargiulo, J., Lauri, A., Schlücker, S., Cortés, E., & Maier, S. A. (2019). Spectral screening of the energy of hot holes over a particle plasmon resonance. *Nano letters*, *19*(3), 1867-1874.
18. Wei, Q. H., Su, K. H., Durant, S., & Zhang, X. (2004). Plasmon resonance of finite one-dimensional Au nanoparticle chains. *Nano letters*, *4*(6), 1067-1071.
19. Hu, M., Ghoshal, A., Marquez, M., & Kik, P. G. (2010). Single particle spectroscopy study of metal-film-induced tuning of silver nanoparticle plasmon resonances. *The Journal of Physical Chemistry C*, *114*(16), 7509-7514.
20. Suh, J. Y., Donev, E. U., Ferrara, D. W., Tetz, K. A., Feldman, L. C., & Haglund Jr, R. F. (2008). Modulation of the gold particle–plasmon resonance by the metal–semiconductor transition of vanadium dioxide. *Journal of Optics A: Pure and Applied Optics*, *10*(5), 055202.
21. Kodama, R. H. (1999). Magnetic nanoparticles. *Journal of magnetism and magnetic materials*, *200*(1-3), 359-372.
22. Šafařík, I., & Šafaříková, M. (2002). Magnetic nanoparticles and biosciences. *Nanostructured materials*, 1-23.
23. Fang, C., & Zhang, M. (2009). Multifunctional magnetic nanoparticles for medical imaging applications. *Journal of materials chemistry*, *19*(35), 6258-6266.
24. Tsakalakos, L. (2010). *Nanotechnology for photovoltaics*. CRC press.
25. Manna, T. K., & Mahajan, S. M. (2007, May). Nanotechnology in the development of photovoltaic cells. In *2007 International Conference on Clean Electrical Power* (pp. 379-386). IEEE.
26. Gharzi, M., Arabhosseini, A., Gholami, Z., & Rahmati, M. H. (2020). Progressive cooling technologies of photovoltaic and concentrated photovoltaic modules: A review of fundamentals, thermal aspects, nanotechnology utilization and enhancing performance. *Solar Energy*, *211*, 117-146.
27. Duraisamy, S., Suppan, T., Mohanta, K., Krishnamoorthy, M., & Priyadarshini, B. G. (2020). Novel synthesis of Cu2CoSnS4-carbon quantum dots nano-composites potential light absorber for hybrid photovoltaics. *Nanotechnology*, *31*(23), 235401.
28. Ghasemi, M., Zhang, L., Yun, J. H., Hao, M., He, D., Chen, P., & Wang, L. (2020). Dual‐Ion‐Diffusion Induced Degradation in Lead‐Free Cs2AgBiBr6 Double Perovskite Solar Cells. *Advanced Functional Materials*, *30*(42), 2002342.
29. Arifin, Z., Tjahjana, D. D. D. P., Hadi, S., Rachmanto, R. A., Setyohandoko, G., & Sutanto, B. (2020). Numerical and experimental investigation of air cooling for photovoltaic panels using aluminum heat sinks. *International Journal of Photoenergy*, *2020*.
30. Xiong, Y., Booth, R. E., Kim, T., Ye, L., Liu, Y., Dong, Q., ... & Ade, H. (2020). Novel Bimodal Silver Nanowire Network as Top Electrodes for Reproducible and High‐Efficiency Semitransparent Organic Photovoltaics. *Solar RRL*, *4*(10), 2000328.
31. Lamnatou, C., Notton, G., Chemisana, D., & Cristofari, C. (2020). Storage systems for building-integrated photovoltaic (BIPV) and building-integrated photovoltaic/thermal (BIPVT) installations: Environmental profile and other aspects. *Science of the Total Environment*, *699*, 134269.
32. Bhattacharya, S., & John, S. (2020). Photonic crystal light trapping: Beyond 30% conversion efficiency for silicon photovoltaics. *APL Photonics*, *5*(2), 020902.
33. Dong, H., Xu, F., Sun, Z., Wu, X., Zhang, Q., Zhai, Y., & Sun, L. (2019). In situ interface engineering for probing the limit of quantum dot photovoltaic devices. *Nature nanotechnology*, *14*(10), 950-956.