National Journal of Multidisciplinary Research and Development
ISSN: 2455-9040
Impact Factor: RJIF 5.22
www.nationaljournals.com
Volume 3; Issue 1; January 2018; Page No. 1365-1367

Application of nano catalysis: A review

Mandeep
University of Delhi, Delhi, India

Abstract
The process which take place with help of catalyst is called catalysis. Type of catalysis depends on the nature of catalyst such as homogenous catalysis, heterogenous catalysis, enzymatic catalysis and nano-catalysis. A variety of products like medicines, fine chemicals, polymers, fibers, fuels, lubricants, and a myriad of other value added products essential to humans, is feasible only due to presence to catalyst. Nano catalysis has long become a vital part of Nano science. Nanoparticle can substitute conventional material and serve as active and stable heterogeneous catalysts or as support material for various catalytic groups. Due to their small sizes, catalytic active nanoparticles have higher surface area and increased exposed active sites, and thereby improved contact areas with reactants, akin to those of homogeneous catalytic systems. The application of nano-catalyst is reported in various field such as biodiesel production, drug delivery, and photo catalysis. Coupling reaction, hydrogenation reaction, nano toxicology, solar cell, waste water treatment etc.

Keywords: Nano-catalysis and its application

Introduction

A catalyst is defined as a substance that increases the rate of a chemical reaction without itself undergoing any permanent change. The process which take place with help of catalyst is called catalysis. Type of catalysis depends on the nature of catalyst such as homogenous catalysis, heterogenous catalysis, and enzymatic catalysis. When a reaction is carried out without catalyst, very large activation energy (E) must be required for the reaction. But in the presence of a catalyst, molecules create a transitional state with a catalytic surface to reduce potential energy. Hence a catalyst without involving in reaction increases the rate of reaction. Petroleum and energy production, chemicals and polymer production, food industry and pollution control are four major sectors of the world economy and all involves the catalytic process. Hence, we can say that the science and technology of catalysis is of great significance as it affects our daily life. Activation energy is decreased by using catalysis in chemical reaction as shown in figure.

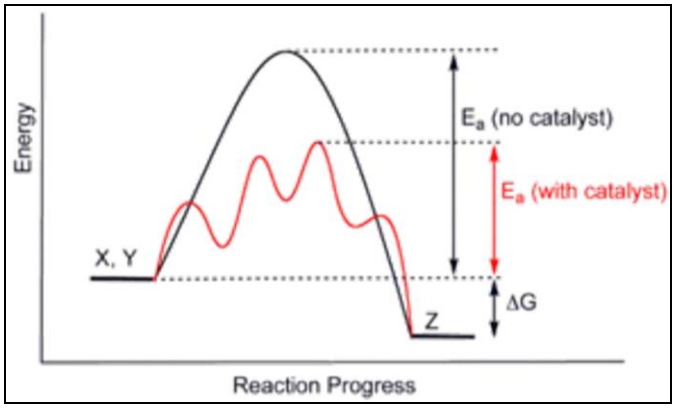

Fig 1

Nano catalysis has long become a vital part of Nano science. Nanoparticle can substitute conventional material and serve as active and stable heterogeneous catalysts or as support material for various catalytic groups. Due to their small sizes, catalytic active nanoparticles have higher surface area and increased exposed active sites, and thereby improved contact areas with reactants, akin to those of homogeneous catalytic systems. At the same time nano structures catalyst can behave as heterogenous catalysts thus, they can also be easily separated from reaction mixture. It is reported that Nanoparticles (NPs) find application in every field such as electronics, medicine and maquillages. Nanoparticles are synthesis by two ways, as shown in figure

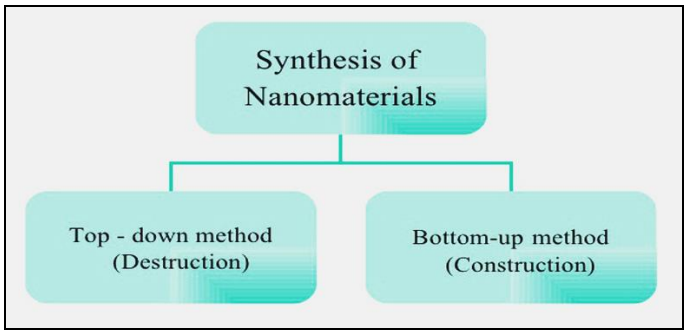

Fig 2

They are now growing in the field of catalysis because their optical, electrical, mechanical and chemical properties are a function of their size, composition and structural order. This leads to new improved catalytic properties. These materials is a new class above the classical homogeneous and heterogeneous catalysts. Nano catalysis can be considered as part of "green" science as well, because Nano catalysis often

allows conducting chemical transformations in an environmentally friendly manner.

In era of nanotechnology where size of every object is going to smaller and smaller with their enhanced properties; catalysts of nano size are also used in several chemical processes and beneficial for human being. In this paper all literature data on application of Nano catalyst reported within the last few years is reported.

Applications

With the decrease of petroleum reserves, biodiesel, defined as the monoalkyl esters of fatty acids, has been the focus of a considerable amount of recent research as an alternative renewable fuel. More and more biodiesel is being used in many country. The trans esterification reaction of oil and alcohol with homogeneous catalyst is used for preparation of biodiesel. If the homogeneous catalyst is used for this purpose it shows many difficult like isolation problem, large quantity water requirement, huge quantity of wastes etc. Heterogeneous catalytic methods also faces the problem like mass transfer resistant, time consuming and inefficient. They have become the focus of recent research. Nano catalyst doesn't faces such type of problem because of high specific surface and high catalysis activities. The high specific surface area and large pore size are favorable for contact between catalyst and substrates, which effectively improved efficiency of transesterification.

Many different types of drug delivery systems are currently available. In the nanomaterials science, carbon nanotubes (CNT) have emerged as a new alternative and efficient tool for transporting and translocating therapeutic molecules. CNT mainly of two type single wall carbon nano tube and multi walled carbon nano tubes. The main important feature of CNT is that it can be functionalised with bioactive peptides, proteins, nucleic acids and drugs, and used to deliver their cargos to cells and organs. CNT is not immunogenic because functionalised CNT display low toxicity. It is found that CNTs may be suitable for bio-applications in bio recognition and drug delivery systems.

The treatment of industrial waste waters for removing organic pollutants by heterogeneous photocatalysis has developed as an advanced technique. Recently, metal NPs were reported as effective photo catalysts under ambient temperature with visible light illumination. The widespread use of nanomaterial like semiconductor metal oxides increases the possibility due to their excellent properties such as Ferro electricity, high temperature stability, superconductivity, semi conductivity, ferromagnetism, piezoelectricity and catalytic activity. NPs such as WS2, CdS, ZnO, SnO2,TiO2, AgS, ZrO2, MOS2, ZnS, WO3, and SrTiO3 have been identified as photo catalysts for the degradation of numerous synthetic dyes and organic contaminants. It is reported that TiO2 is regarded as the most efficient and environmentally benign photo catalyst and has been most widely used for photo degradation of various pollutants. TiO2 photo catalysts can also be used to kill bacteria, as has been carried out with E. coli suspensions.

In last few years the Nano catalyst has attract attention in the field of biology. It is found that the activity of the biocatalyst was investigated for the esterification and also tested as an enantioselective catalyst in the kinetic resolution of racemic 2-pentylamine. The ee obtained in the resolution was 97-99%. Another such example is magnetically immobilized lipase, which was used to produce biodiesel fuels from soybean oil. Magnetic Fe3O4 NPs treated with (3-aminopropyl) triethoxysilane were used as immobilization material. Lipase was covalently bound to the amino-functionalized MNPs by using glutaraldehyde as a coupling reagent with the activity recovery up to 70% and the enzyme binding efficiency of 84%. Similar immobilization of lipase on magnetic Nano composites (hierarchically ordered porous functionalized magnetic Nano composites) has been observed. The resulting nano biocatalysts has been utilized for hydrolysis reaction. The present progress of nano bio catalysis has demonstrated the advantages of nano bio catalytic approaches and their bright future as a fusion of nanotechnology and bio catalysis.

Some of the nanoparticles shows nano-toxicology. It is found that Silver nanoparticles (Ag-np) are being used increasingly in wound dressings, catheters, and various household products due to their antimicrobial activity. The toxicity was evaluated using changes in cell morphology, cell viability, metabolic activity, and oxidative stress. Ag-np reduced ATP content of the cell caused damage to mitochondria and increased production of reactive oxygen species (ROS) in a dose-dependent manner. DNA damage, as measured by single cell gel electrophoresis (SCGE) and cytokinesis blocked micronucleus assay (CBMN), was also dose-dependent and more prominent in the cancer cells. The nanoparticle treatment caused cell cycle arrest in G2/M phase possibly due to repair of damaged DNA.

It is reported that nanoparticles are used as thin film solar cell. There are advantages of multiple reflections, the effective optical path for absorption is much larger than the actual film thickness, the light generated electrons and holes need to travel over a much shorter path and thus recombination losses are greatly reduced. As a result, the absorber layer thickness in nanostructured solar cells can be into nanometer from micrometer. In particular nano-structured CdS, CdTe and TiO2 are of interest as window and absorber layers in thin film solar cells used the self-assembly process to fabricate a variety of nano-structured films including CdTe and CdS on coated glass substrates. TiO_2 also used in photocatalytic splitting of water on a TiO2 electrode. The high surface area brought about by small particle size is beneficial to most TiO2-based devices, as it facilitates reaction/interaction between the devices and interacting media, which mainly occurs on the surface and depends on the surface area. Nanoparticles also used in some chemical reactions such as alcohol oxidation, hydrogenation etc.

Conclusion

The high surface area and high number of mesopores in ordered mesoporous carbons and carbon gels allow high diffusivity and good reactant flux. The high specific surface area and large pore size of nano-catalyst are favorable for contact between catalyst and substrates, which effectively improved efficiency of transesterification and used in preparation of biodiesel. The functionalized CNTs with bioactive peptides, proteins, nucleic acids and drugs are used to drug delivery. NPs such as WS2, CdS, ZnO, SnO2,TiO2, AgS, ZrO2, MOS2, ZnS, WO3, and SrTiO3 have been

identified as photo catalysts for the degradation of numerous synthetic dyes and organic contaminants. Some of the nanoparticles shows nano-toxicology. It is found that Silver nanoparticles (Ag-np) are being used increasingly in wound dressings, catheters, and various household products due to their antimicrobial activity.

References

1. Sun CQ. Size dependence of nanostructures: Impact of bond order deficiency. Prog. Solid State Chem. 2007; 35(1):1-159.
2. Astruc D. Nanoparticles and Catalysis (ed. D. Astruc), Wiley-VCH Verlag GmbH, Weinheim, Germany, 2008, 1.
3. Thomas JM. Colloidal metals: past, present and future. Pure & Appl. Chem. 1988; 60(10):1517-1528.
4. Thomas JM. The advantages of exploring the interface between heterogeneous and homogeneous catalysis. Chem. Cat. Chem. 2010; 2:127-132.
5. Cole-Hamilton D. Homogeneous catalysis - new approaches to catalyst separation, recovery, and recycling. Science. 2003; 299(5613):1702-1706.
6. Chen CY, Yang P, Lee YS, Lin KF. Fabrication of electrocatalyst layers for direct methanol fuel cells. Journal of Power Sources. 2005; 141:24e9.
7. Chung CG, Kim L, Sung YW, Lee J, Chung JS. Degradation mechanism of electrocatalyst during long-term operation of PEMFC. International Journal of Hydrogen Energy. 2009; 34:8974e81.
8. Alcaide F, A ´lvarez G, Miguel O, La ´zaro MJ, Moliner R, Lo ´pezCudero A, *et al*. Pt supported on carbon nanofibers as electrocatalyst for low temperature polymer electrolyte membrane fuel cells. Electrochemistry Communications. 2009; 11:1081e4.
9. Calvillo L, La ´zaro MJ, Garcı´a-Bordeje´ E, Moliner R, Cabot PL, Esparbe´ I, *et al*. Platinum supported on functionalized ordered mesoporous carbon as electrocatalyst for direct methanol fuel cells. Journal of Power Sources. 2007; 169:59e64.
10. Chena W, Suna G, Liang Z, Mao Q, Li H, Wang G, *et al*. The stability of a PtRu/C electrocatalyst at anode potentials in a direct methanol fuel cell. Journal of Power Sources. 2006; 160:933e9.
11. Jafria RI, Sujathaa N, Rajalakshmib N, Ramaprabhu S. AueMnO2/MWNT and AueZnO/MWNT as oxygen reduction reaction electrocatalyst for polymer electrolyte membrane fuel cell. International Journal of Hydrogen Energy. 2009; 34:6371e6.
12. Wang CH, Du HY, Tsai YT, Chen CP, Huang CJ, Chen LC, *et al*. High performance of low electrocatalysts loading on CNT directly grown on carbon cloth for DMFC. Journal of Power Sources. 2007; 171:55e62.
13. Pereza H, Morin A, Akroura L, Cremona C, Baret B, Haccoun J, *et al*. Evidence for high performances of low Pt loading electrodes based on capped platinum electrocatalyst and carbon nanotubes in fuel cell devices. Electrochimica Acta, 2009.
14. Park J, Joo J, Kwon SG, Jang Y, Hyeon T. Synthesis of monodisperse spherical nanocrystals. Angew. Chem. Int. Ed. 2007; 46:4630-4660.
15. Tao AR, Habas S, Yang P. Shape control of colloidal metal nanocrystals. Small. 2008; 4:310-325.
16. Ahmadi TS, Wang ZL, Green TC, Henglein A, El-Sayed MA. Shape-controlled synthesis of colloidal platinum nanoparticles. Science. 1996; 272:1924-1926.
17. Sun Y, Xia Y. Shape-controlled synthesis of gold and silver nanoparticles. Science. 2002; 298:2176-2179.
18. Song H, *et al*. Hydrothermal growth of mesoporous SBA-15 silica in the presence of PVP-stabilized Pt nanoparticles: Synthesis, characterization, and catalytic properties. J Am. Chem. Soc. 2006; 128:3027-3037.
19. Narayanan R, El-Sayed MA. Shape-dependent catalytic activity of platinum nanoparticles in colloidal solution. Nano Lett. 2004; 4:1343-1348.