



## Nano catalysis: Synthesis and properties

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### Abstract

The effect of catalyst on rate of chemical reaction is well known. Mainly two types of catalysis process are found; homogenous and heterogeneous catalysis. Catalysts are usually used so that chemical reactions can occur at temperatures and pressures low enough for producers to use economically priced equipment or to ensure that the rate of production of a desired product is greater than the rates of production of undesirable byproduct. Now-a-days the nano-catalysis has attracted the attention of scientists. Nano-particles are formed mainly by two methods; bottom up and top down technology. These nano-particles used as nano-catalyst in nano-catalysis process. The properties of nano-catalyst depends on the size of nano-particle and shape of particle. A variety of products like medicines, fine chemicals, polymers, fibres, fuels, lubricants, and a myriad of other value added products essential to humans, is feasible only due to presence of catalyst.

**Keywords:** catalysis, nano-particle synthesis, top-down and bottom-up technique, size and shape effect

### Introduction

Catalysis has been defined as the process by which chemical reaction rates are altered by the addition of a substance (the catalyst) that is not itself changed during the chemical reaction. Catalysts are usually used so that chemical reactions can occur at temperatures and pressures low enough for producers to use economically priced equipment or to ensure that the rate of production of a desired product is greater than the rates of production of undesirable byproduct. Catalyst is mainly of two types. One is homogenous catalyst and other is heterogeneous catalyst. Homogenous catalyst is that catalyst which remain in same phase as reacting substrates and heterogeneous catalysts are of different phase from reacting substrates. Actually catalyst is a substance that increases the rate of a chemical reaction without itself undergoing in any chemical reaction. Heterogeneous catalysis has received an amazing amount of attention, both from a scientific and an industrial perspective all over the world. The production of most industrially important chemicals involves catalysis. Similarly, most biochemically significant process is catalysed. Research on catalysis is a major field in applied science and involves many areas of chemistry, notably organometallic chemistry and material science. Catalysis is relevant to many aspects of environmental science for example, the catalytic converter into automobiles and the dynamics of the ozone hole.

A variety of products like medicines, fine chemicals, polymers, fibres, fuels, lubricants, and a myriad of other value added products essential to humans, is feasible only due to presence to catalyst. Because a large number of reaction take place only in presence of catalyst. Using catalyst the rate of reaction increases because of decrease in the activation energy as shown in figure.

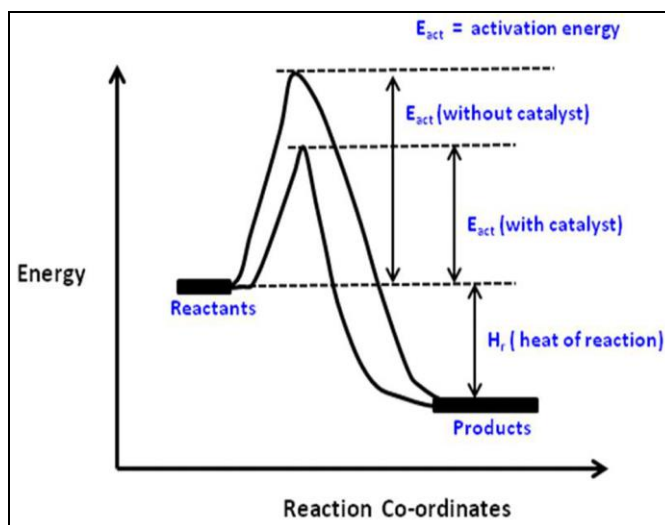


Fig 1

There comes some difficult in the catalysis process such as catalysts with long life and self-repairing capabilities, efficient conversion of biomass, unused by-products into useful raw materials. Now-a-days, the technology of Nano catalysis has attracted a lot of attention. Nano catalysis is a process in which catalysis process use products of nanotechnology as a catalyst which is called Nano catalyst. In this paper, the synthesis of Nano catalyst and the effect of size and shape on Nano catalysis process is discussed.

### Result and Discussion

#### Synthesis

Nanocatalyst composed of nanoparticles. Smaller than 100nm in at least one dimension. Porous compounds having pore

Diameter less than 100nm. Synthesis of stabilized nanoparticles (NPs) sized between 1-100 nm is the main task of the nanochemistry. Nanoparticles may be synthesized by various methods, the two main methods are; (i) top-down technologies and (ii) bottom-up technologies.

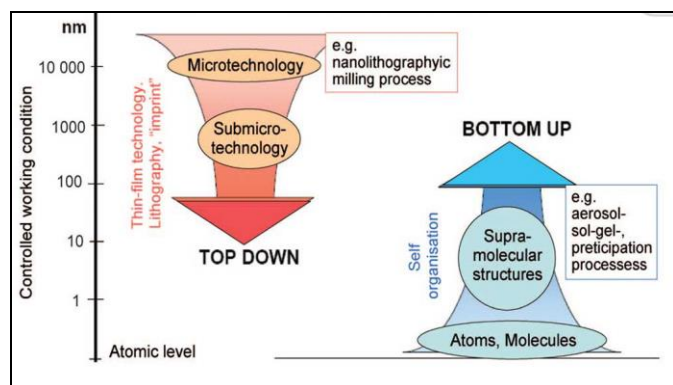


Fig 2

In top down method, destructive approach is used. Starting from larger molecule, which decomposed into smaller units

and then these units are converted into suitable NPs example of this method are grinding/milling, CVD, physical vapour deposition (PVD) and other decomposition techniques. This approach is used to synthesize coconutshell (CS) NPs. The milling method was employed for this purpose and the raw CS powders were finely milled for different interval of times, with the help of ceramic balls and a well-known planetary mill. In top down technique large scale production take place and there is no need of chemical purification. But it is an expensive technique and control over deposition parameter is difficult to achieve. In case of bottom-up synthesis, this approach is employed in reverse as NPs are formed from relatively simpler substances, therefore this approach is also called building up approach. Examples of this case are sedimentation and reduction techniques. It includes sol gel, green synthesis, spinning, and biochemical synthesis. The main advantages of this method is that nanotube, nano-cell, ultra-fine nanoparticles can be prepared. It is a cheaper technique and deposition parameter can be controlled. Difficult in large scale production and requirement of chemical purification of nanoparticle are its main disadvantages.

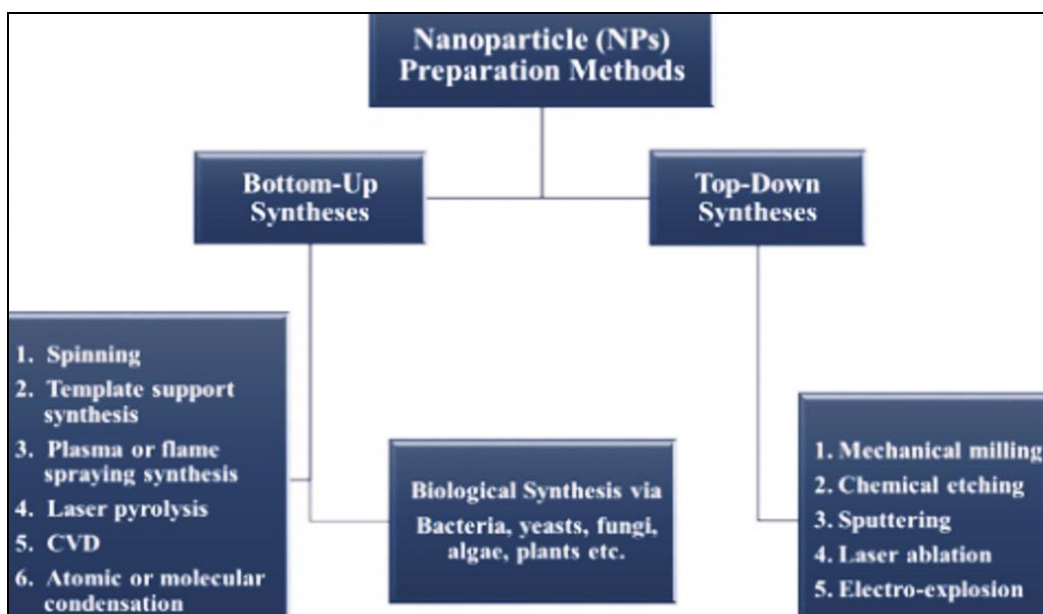


Fig 3

### Properties

Nanoparticles are important scientific tools that have been and are being explored in various biotechnological, pharmacological and pure technological uses. Nanoparticles are unique because of their large surface area. The nanoparticles are smaller but consist high adsorption capability. Absorption of solar radiation in photovoltaic cells is much higher in nanoparticles than it is in thin films of continuous sheets of bulk material. NPs of Zinc oxide particles shows superior UV blocking properties compared to its bulk substitute. Gold nanoparticles appear deep red to black in solution, which show that the NPs also often possess unexpected optical properties as they are small enough to confine their electrons and produce quantum effects.

### Factor effecting catalysis process

In materials, there is a strong chemical bonding between them, delocalization of electrons can be extensive and this extend of delocalization varies depending on the size of the system. Hence surface reactivity of the nanoparticles is highly size dependent. It is found that the size effect relationships are classified mainly into three primary groups:-positive size-sensitivity reactions, negative size-sensitive reactions, and size insensitive reactions. In positive size-sensitivity reaction, it is reported that are those reactions in which turnover frequency increases with decreasing particle size. The peototypical reactions for this group is methane activation. Here, dissociative bond cleavage via  $\sigma$ -bond activation is the rate limiting step and for which the turnover frequency decreases

with decrease in the particle size and the prototypical reaction for this group is dissociation of CO and N<sub>2</sub>, which require step-edge sites and contact with multiple atoms, formation or dissociation of  $\pi$ -bond is often the rate-limiting is negative size-sensitive reaction. In case of Size-insensitive reaction; there is no significant dependence of turnover frequency on the particle size. Size effect relationship is shown below in given figure.

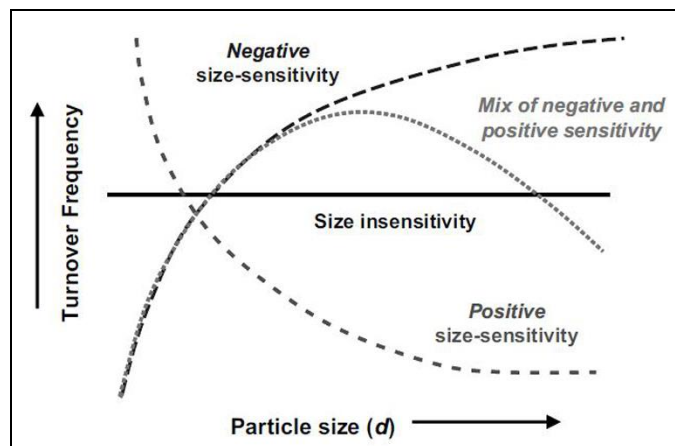


Fig 4

It has been reported that NPs with more and sharper edges and corners have higher efficiency. It is therefore seen the size of the nanoparticles effects the reaction rate, selectivity and deactivation. The arrangement of atoms on the surface strongly influences the adsorption of the reacting molecules and desorption of the products. Thus, the morphology of the catalyst particle determined by the exposed crystal planes could substantially alter the catalytic property as well. This is termed as morphology- dependent Nanocatalysts: an NP having an anisotropic shape can modify the performance of reaction by selectivity exposing specific crystal facets. It is also found that the atomic arrangement of atoms on a surface has a significant effect on catalyst behaviour. The adsorption site available for the adsorbates will differ because different adsorbates will have different affinity for each type of adsorption site which will in turn greatly effect on catalysis. Consequently, the presence or absence of a particular type of site can affect not only the reaction rates but also selectivity. However, not all of the reactions are structure sensitive and some are structure-sensitive only within a particular range of specific conditions. Most of the NPs adopt roughly spherical shapes often referred to as polyhedral or actahedra, inorder to minimize the surface energy.

### Conclusion

These nano-particles used as nano-catalyst in nano-catalysis process. The properties of nano-catalyst depends on the size of nano-particle and shape of particle. The size effect on nano-catalysts is classified mainly into three primary groups; positive size-sensitivity reactions, negative size-sensitive reactions, size insensitive reactions. NPs which consists larger number of sharper edges and corners shows higher efficiency. The effect of the size and shape of the nanoparticles can be seen on reaction rate, selectivity and deactivation. The bottom

up technique is a cheaper technique and deposition parameter can be controlled and in case of top down technique large scale production take place and there is no need of chemical purification.

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