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Synthesis, And Applications Of Copper Oxide Nanoparticles : An Overview

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Abstract : Nanoparticles are effective material for modern day technology. Copper oxide nanoparticles due to their vast applications prominently used in various fields. In the present review paper we have reported the synthesis of copper oxide nanoparticles by different methods. Apart for that we have discussed the various applications of the copper oxide nanoparticles in MRI, biological and solar cell applications.

Keywords: Copper Oxide nanoparticles, Solar Cell, E. Coli, S. Aureus

1. Introduction

Nanoparticles are widely used in various areas such as optical, mechanical, electrical and health care due to their small size and large surface to volume ratio. These particles are required for the technological revolution for modern day science and engineering [1-4]. Metal oxide nanoparticles are extensively used in magnetic, electrical, optical and many more research areas. Presence of unpaired electrons and small size the transition metal oxide nanoparticles are widely used for solar cell, photovoltaic cells, hypothermia, magnetic properties and many areas.

Copper oxide nanoparticles formed by Cu and oxygen, in which the central metal ion (Cu) binds with four oxygen molecules. These copper oxide nanoparticles have been widely used in various modern technologies such as solar cell, optical and catalysis. Due to their low band gap(1.5 eV) makes promising material for semiconductor. It's shows p-type semiconductor material and these band gap is also allows to forming photovoltaic cells (1.4 eV) [5]. This copper oxide nanoparticles are also used as an organic dye degradation material which are useful for prevented to water pollution. Copper oxide nanoparticles are widely used in catalytic reactions. Now the days copper oxide nanoparticles are also used in oil industry to remove the non desired products from oil [6].

Synthesis of copper oxide nanoparticles was various methods such as sol-gel, CVD, auto combustion, green synthesis and spray pyrolysis [7]. For the synthesis of copper oxide nanoparticles the main concern is that the particle size, toxicity and the stability of the nanoparticles. The less hazardous method, less chemical effect, more stability, and cost effective is the main concern of the synthesis of the copper oxide nanoparticles.

In this present paper, we provide an overview on the various synthetic methods of copper oxide nanoparticles. The role of copper oxide nanoparticles in various applications and the future aspects of this nanoparticles. In this paper we also reviewed the physical and chemical properties of the copper oxide nanoparticles such as volume effect, quantam size effect, and their surface effect.

2. Synthesis methods:

Copper oxide nanoparticles have been synthesized by various methods such as sol-gel, autocombuston, green method and sonochemical methods. Here in the present paper we have reported few synthesis methods of copper oxide nanoparticles.

2.1 Sol-gel Method

In this method copper nitrate dissolved in 30 ml deionized water. Then in the copper nitrate solution acetic acid was added dropwise and reaction was continue for one hour at 100°C. After one hr sodium hydroxide solution was added in the reaction mixture and again the reaction was continue for further one hr and then the black precipitate was obtained which was futher calcined under furnence at 450°C, then the copper oxide nanoparticles was obtained. This method was reported by Kayani et al [8].

2.2 Green method

In this method, copper oxide nanoparticles was synthesized by colloidal thermal method. In orbital shaker the mixture of copper chloride solution (1mM ,2 mM amd 3 mM) and gum karaya was taken and the reaction was stirred at 75°C at 250 rpm for 1 hour. After that the various size of copper oxide nanoparticles was obtained and this method was given by Padil et al [9].

The chemical free copper oxide nanoparticles was synthesized by Abboud et al. In this method for the synthesis of copper oxide nanoparticles, the extract of brown algae was taken. In the whole process no surfactant was also used and the biological properties of this materials was good [10].

2.3 Thermal Decomposition method

In this method, for the synthesis of copper oxide nanoparticles was followed by the thermal decomposition of copper salt in oxalic acid . In this reaction, it follows the mechano-physical mechanism after the calcination at 450°C, 10 nm copper oxide nanoparticles was obtained [11].

2.4 Sono-Chemical method

The copper salts dissolved in DI water and after that the solution posses under sonication for 30 min. After the calcination at 600°C, copper oxide nanoparticles was obtained. Reaction time and the particle size of the chemicals are depends on the sonication process and the time of calcination [12-14].

3 Applications

Copper oxide nanoparticles are widely used in various properties such as optical, electrical, biological and mechanical. Here we have been reported the various applications of copper oxide nanoparticles.

3.1 Biological activites

The copper oxide nanoparticles was plays an important role to prevent the fungal, bacterial and microbial attack on the yeast and molds. Copper oxide nanoparticles effectively take participate against the growth of bacteria such as Bacillus subtilis, Staphylococcus aureus, and Escherichia coli by using the diffusion method. E.coli and B. subtills shows susceptibility against the copper and silver nanoparticles. During the enhancement of the concentration of this nanoparticles the growth of the bacteria is going to inhibited and this studies was reported by Yoon et al. [15].

3.2 MRI studies

Now the days to find the tumor and other affected organ in our body the medical imaging is the important tool to detect that and cure that affected organ and tumor. Nanoparticles plays

an important role to visualize the pathological part and make the image and on the basis of that we easily cure the patient. Copper oxide nanoparticles also take participate in this type of studies by using MRI (magnetic resonance imaging). The size of the copper oxide nanoparticles less than 10 nm and the concentration range between 2.4 to 320 μg • mL^{-1} were required to scanned the affected organ. In this process the required magnetization is 9.4 T and the nanoparticles shorten the relaxation time T_1 and other side increased the ultra sound sonication speed. Which enhance the contrast to noise ratio of ultrasound attenuation. Hence the copper oxide nanoparticles is effective candidate for MRI technique [16].

3.3 Solar cell fabrication

Due to less than 2.0 eV band gap copper oxide nanoparticles is behaves ideal material for solar cell applications. When copper oxide nanoparticles should introduced in conducting polymer they shows good absorbant material for solar cell. When copper oxide nanoparticles was combined with P3HT/PC70BM polymer the solar cell efficiency enhances more than 20% respect to reference cell. When the reference cell was used that time the efficiency is 5.234 $mAcm^{-2}$ but when copper oxide nanoparticles was incorporated in that the time efficiency enhanced to 6.484 $mAcm^{-2}$. Only 0.6 mg copper oxide nanoparticles was used for this application. Hence copper oxide nanoparticles is a effective material for solar cell applications [17-19].

4. Conclusions

In the present manuscript we have reported the various method of the synthesis of copper oxide nanoparticles. The green synthesis method is the optimized method because in that no hazardous chemicals was used in that. Similarly the role of copper oxide nanoparticles was studied in various applications such as solar cell, biological and MRI technique, which makes this nanoparticles was superior material for modern day technology.

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