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Synthesis of Co_3O_4 nanoparticles for sensing toxic gas at room temperature

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ABSTRACT

Over the past few decades, there has been an increasing demand for inexpensive, accurate, portable and reliable gas sensors which can be used to detect combustible, flammable and toxic gases, and oxygen depletion. Typically, gases of interest include CO, NO, NO_2, NH_3, SO_2, CO_2, CH_4 and other hydrocarbons. These gases can be harmful to human health if present beyond a certain concentration. Among various metal oxide semiconductors, p-type Cobalt oxide semiconductors are excellent materials for fabricating highly sensitive and selective gas sensors of high-performance. In this study, a novel and low cost chemical route has been developed to synthesize Co_3O_4 nanostructures. The efficiency of Co_3O_4 nanomaterials is improved by means of introducing n-type dopants. The synthesized nanomaterials were characterized by different characterization techniques like UV double beam spectrophotometry, X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray analysis (EDAX). The Cobalt oxide nanoparticles are observed to have a good response and sensitivity to ammonia gas at room temperature.

Selection and peer-review under responsibility of the scientific committee of the 2nd International conference on Advanced Materials – Materials for a Better Living.

1. Introduction

Over the previous decades the study of the applications of nanoscale materials has attracted much attention [1–4]. The transition-metal oxides with varied morphologies have attracted intensive interest in many fields.

Among the p-type oxide semiconductors, Co_3O_4 is a promising material. Various morphologies of Co_3O_4, including nanobelts, nanosheets, nanorods, nanowires, nanotubes, microspheres, nanoparticles, thin films, 3D architectures, and composites have been synthesized through different methods [5–9]. The Co_3O_4 materials have been extensively investigated for their numerous promising modern applications for example, in thin film catalysis, as gas sensors, in electrochemical capacitors, as magnetic materials, in heterogeneous catalysis and so forth [10–14].

Specifically, the oxidative synergist movement of cobalt oxide is moderately notable, and can be utilized to upgrade the gas reaction, selectivity, and gas reaction energy. The gas-detecting attributes are affected to a large extent by the morphology, measurement, and porosity of nanostructures [15].

Many earlier researchers have reported their investigations on the sensing properties of Co_3O_4 to different gases: xylene, ethanol, methanol, NH_3, NO_2, H_2S, CO, and so forth [16–24]. In this paper, an effort has been made to study the effectiveness of Co_3O_4 nanoparticles in the sensing of NH_3gas.

Ammonia (NH_3) is a caustic and hazardous colorless gas with a characteristic pungent smell. It is very important to monitor and control the ammonia concentration in the environment [25].

In the present work, the gas sensing properties of hydrothermally synthesized Co_3O_4 nanoparticles are investigated in detail. The obtained results reveal that they exhibit a superior sensitivity to NH_3 at room temperature, and also show good reproducibility and short recovery times.

2. Experimental details

All chemicals were of analytical grade and used as received without further purification.

In a typical procedure, 1 wt% of cobaltous nitrate [$Co(NO_3)_2{\cdot}H_2O$] was dissolved in distilled water with vigorous stirring. Next,

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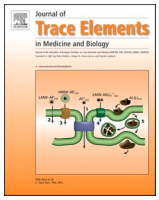

Evaluation of cytotoxic activity of Fe doped cobalt oxide nanoparticles

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ABSTRACT

Background: This contribution of work describes a new strategy for manufacturing cobalt oxide nanoparticles and the results assured that, its efficiency was increased by adding Fe ions. The anticancer drugs usually have a limited medical value owing to their nonspecific cytotoxicity. It has been proven that by using the nanosystems to deliver tablets to tumour cells reduces the toxic quality. Because of these qualities, nanoparticles can be used as a stronger rival for potent cancer treatment.
Method: This study investigated the cytotoxicity of iron doped cobalt oxide nanoparticles through trypan blue exclusion method.
Result: The newly generated Fe doped Co_3O_4 nanoparticles had proved its biocompatibility from the report of reduced toxicity below 200 μg/mL on malignant cell lines.
Conclusion: The observed findings may encourage the development of anticancer drugs based on the inorganic particles, especially Fe doped Co_3O_4 nanoparticles, that could be serve as an excellent framework for the drug delivery and provide a new perspective for interpreting and targeting various therapeutic methodologies to tumours.

1. Introduction

Nanotechnology might provide a quick and accurate detection to concentrate on tumour tissues with less toxicity even if they occur in a tiny fraction of cells [1,2]. Gold, silica, platinum, cobalt oxide, titanium dioxide, copper oxide, iron oxide, zinc oxide, metallic, other inorganic nanoparticles have recently become popular for cancer imaging and treatment. Despite the fact that the medicines used to treat tumours are more harmful than the nanoparticles used [4]. The anticancer drugs mostly had a limited medical value owing to their non-specific cytotoxicity. The uses of nanosystems to deliver tablets to tumour cells have been shown to reduce the toxic quality [5].

The nanotechnology appears to be the most likely choice for more effective and secured cancer therapy [6]. The ability of the medications turned in, vehicle to bypass through the tumour vascular walls and the interstitial space is far a primary necessity for potent drug delivery to the tumours [7]. The particle size of strong medications determines how quickly it is delivered to its target site. As compared to microscale particles, the nanoparticles have a huge surface area, high solubility, the increased bioavailability, regulated drug administration [8]. They also have a great potential for attracting medicines with high efficacy. Because of these qualities nanoparticles are a stronger competitor and a more potent for the cancer treatment. The nanoparticles with smaller diameter less than 100 nm, followed by the effective cell absorption are precisely tiny enough to get access to intracapillary region [9]. Despite the fact that the nanoparticles have been proposed as an anticancer treatment, their toxicity to most of the cancer cells has not been investigated well [10].

The fourth most prevalent element in the earth's crust is iron. Because of the widespread presence of iron in nature, as well as its unique oxidized structures and inexpensive extraction costs, identifying new uses for iron oxide nanoparticles has become quite appealing [11]. The iron oxide nanoparticles have been transported as an anticancer, immunosuppressive, anticonvulsant, anti-inflammatory, antibiotic, antifungal medicines. Cell viability dissection can be useful in a variety of test methods such as determining the microbiological resistance, tumour susceptibility, spontaneous cell death in various test conditions. The investigation of the relation between nanomaterials and living organisms would be done through invivo studies. The vitality of the cells in vivo cytotoxicity might have been assessed by the trypan blue exclusion method. Trypan blue is a water soluble dye, which is used in the prohibition test to distinguish between viable and non-viable cells. Under a

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Short communication

Synthesis, characterization, and NH_3 gas sensing application of Zn doped cobalt oxide nanoparticles

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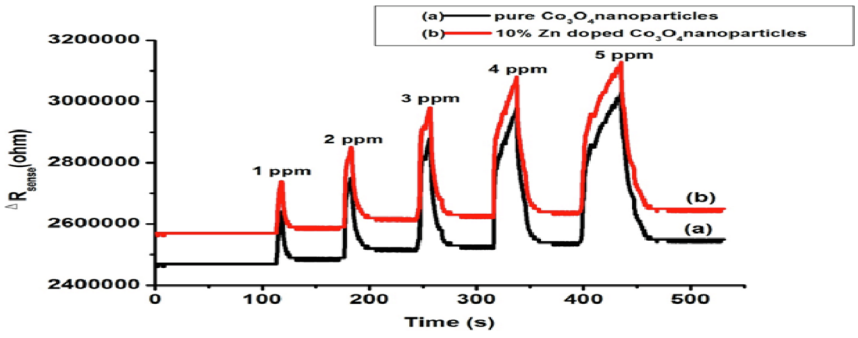
GRAPHICAL ABSTRACT



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ABSTRACT

Metal oxide semiconductor gas sensors have a wide level of applications. They have the benefits of being powerful, fast, lightweight, dependable, safe and durable. In the current investigation, Cobalt oxide (Co_3O_4) nanoparticles were prepared using hydrothermal method. So as to build the productivity, the synthesized Co_3O_4 nanoparticles were doped with ZnO. X-ray diffraction (XRD) technique was used to examine the structure of the synthesized Co_3O_4nanoparticles. The surface morphology of the nanoparticles was studied by Scanning Electron Microscopy and the elemental analysis done by EDX. FTIR was used to confirm the molecular constituents of the Co_3O_4 nanoparticles. Optical characterization was done by analyzing the UV absorption spectrum. The gas sensing properties of pure nanocrystalline cobalt oxide have been researched and compared with that of Zn doped cobalt oxide nanoparticles. The response of the Zinc doped Co_3O_4nanoparticles to ammonia gas was found to be better than that of pureCo_3O_4 nanoparticles, exhibiting their potential for application in nanosensors.

1. Introduction:

In the most recent decades, metal oxide semiconductors have established a significant space of the group of nanostructures attributable to their remarkable structures, intriguing properties, and potential applications [1], which contrast from those of the relating bulk - state materials [2]. Cobalt oxide (Co_3O_4) is one of the most significant attractive p-type semiconductors known, and has discovered applications [3] in numerous fields such as heterogeneous catalysts [4], electrochromic devices [5], and solid-state sensors [6].

In the course of recent years, semiconducting metal oxides are being utilized to monitor gases which impact the environment [7]. These sensors have been demonstrated to be sensitive to a large range of gases, with reactions changing with target gas concentration and device

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Synthesis of Cu doped cobalt oxide nanoparticles as ammonia gas sensor operating at room temperature

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ABSTRACT

In this work, hydrothermally synthesized copper doped cobalt oxide nanoparticles were utilized for the detection of ammonia gas. The powder samples were described by different characterization techniques. XRD spectrum revealed the crystalline structure of the sample. The morphology and component analysis of nanoparticles was done by SEM and EDAX respectively. The FTIR investigation affirmed the presence of functional group in the sample. Optical properties were assessed by UV–Vis spectroscopy. The optical properties were evaluated by UV–Vis spectroscopy. Doping is an effective way to increase gas sensitivity. The sensing properties of cobalt oxide nanoparticles has been enhanced due to the utilization of Cu as a dopant. In the present work, we put emphasis on a cost effective method to achieve supreme sensitivity towards NH_3 gas at room temperature even at a lower concentration of 5 ppm. The presence of Cu ions on the surface of Co_3O_4 nanoparticles was found to enhance the sensor performance.

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1. Introduction

Transition metal oxides structure a noteworthy moreover, differing family of materials which have pulled in colossal thought in various fields of creative energy inferable from their phenomenal electronic, optical, magnetic and catalytic properties [1–3]. Regardless, copper doped cobalt oxide based gas sensors have ascended a more affordable choice since they have long term stability, incredible electrical conductivity additionally, high electrocatalytic activity [4]. Likewise, those substances have observed capability use in a huge organization of robust nation applications [5].

Among varied gas sensing materials, metal compound semiconductors show higher execution over alternative sensors for their wonderful physical and chemical properties and distinctive structure [6]. These materials have a large band gap, permitting them to possess a full scope of electronic properties. The properties of metal compound semiconductors measures as typically as massively compact by the fabric size. Specifically, a material can show extraordinary properties due to the nanoeffect at the nanoscale, especially the semiconductor primarily based sensors gained wide interest as a result of its application within the field of environmental monitoring devices [7].

Copper compound, CuO is created on the surface of the nanoparticles and is comparatively cheap. Copper belongs to the group of I-VI compound of semiconductors. Copper has a vast range of applications like photo voltaic cell, tubular solar collectors, automobile glazing, control coatings, dye sensitized solar cells, photodetectors, electro conductive electrode, microwave shielding, coatings, superconductors, potential nanometer scale switch gas sensors [8]. Doping ofmetal ions by outside metal ions may end up with improved catalytic action and stability. Hence, the morphology, crystallinity, arrangement of particles, and electrochemical properties of Cu doped Co3O4 have been the subject of broad research trying to build up the composition, structure & properties. The copper doped cobalt oxide join well in high reliable quality and advancement with immaterial effort and receptiveness [9,10].

Ammonia is a natural, biological agent in organisms that assists with framing amino acids, which are the essential structures of proteins. It is both fabricated and delivered normally from bacterial procedures and the breakdown of organic matter. Ammonia is utilized in numerous industrial procedures, and as a compost and refrigerant. Ammonia gas as a colorless, alkaline gas contained

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