SYNTHESIS OF Co_3O_4 NANOPARTICLES FOR NH_3 GAS SENSING AT ROOM TEMPERATURE & CELL VIABILITY ANALYSIS

THESIS SUBMITTED TO THE BHARATHIAR UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY IN PHYSICS

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Accredited with A++ Grade by NAAC, An ISO 9001-2015 Certified Institution

NIRF 2022- 6th Rank

COIMBATORE - 641 004

MAY 2023

Chapter VII

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SUMMARY AND CONCLUSION

Summary

The first chapter is introductory. It explains the potential application of cobalt oxide nanoparticles in nano sensors for detecting ammonia gas, which is very harmful in nature. It also explains the use of nanomedicines, which can be used for long periods for cancer therapy without or with very small side effects. Advantages of using inorganic oxides such as cobalt oxide for nanomedicine as anticancer agents due to their strong cytotoxic activity even when administered in small amounts are also discussed.

The second chapter gives the survey of literature on cobalt oxide nanoparticles. Survey on the previous and ongoing research enables to know the present status of applications of the material. Every aspect of the work was surveyed thoroughly to overcome the difficulties in preparation and application of pure & doped cobalt oxide nanoparticles and moreover to find a new pathway in the field of research. This chapter gives explanation about experimentation, characterization, results and applications of these nanoparticles as reported by earlier researchers.

The third chapter describes the experimental techniques employed. The growing area of nanotechnology has directed to the promotion of different preparation methods. The aim of this section is to provide a coherent picture about fundamental methods established for the synthesis and processing of nanoparticles, especially the importance and uniqueness of the hydrothermal method.

In the fourth chapter explanation is given on different characterization techniques utilized to analyze structural, morphological & optical properties of prepared nanoparticles. By XRD analysis, the crystallinity was confirmed. To confirm the formation of cobalt oxide nanoparticles TEM, SEM, EDX, FTIR & UV analysis were done.

Effectiveness of work has been described separately for pure and doped Co_3O_4 nanoparticles in the following working chapters.

In the fifth chapter, a comparative study of gas sensing properties at room temperature for pure and doped (Zn, Fe, Cu and Ni) cobalt oxide nanoparticles were

explained for different concentrations (1ppm-5ppm) of NH_3. A detailed explanation about the efficiency of the nanoparticles in gas sensing is given.

The sixth chapter deals with the application in the field of nanomedicine. In this chapter the comparative cell viability study of pure and doped (Zn, Fe, Cu and Ni) cobalt oxide nanoparticles is reported for five different drug concentrations. The percentage of cell viability is reduced with increase in concentration of cobalt oxide nanoparticles. The percentage of cell viability increases with increase in doping concentration of cobalt oxide nanoparticles. Fe doped Co_3O_4 nanoparticles proved to be efficient in their action on cancerous cell lines with lower toxicity than the Zn, Cu and Ni doped Co_3O_4 nanoparticles.

The seventh chapter gives a summary of the results obtained in the entire work. The newly fabricated nanoparticles are highly efficient for NH_3 detecting applications. Finally the utilization of newly synthesized nanoparticles as a simple treatment for elimination of cancer stem cells was evidently demonstrated in this work.

Conclusion

Various studies on the preparation of Co_3O_4 nanoparticles had been reported by earlier researchers. In this work, hydrothermally synthesize pure and doped Co_3O_4 nanoparticles and study the possibility of their application in ammonia gas nanosensors and cancer therapy. The Co_3O_4 nanoparticles were doped with three different concentrations (3%, 5% and 10%) of Zn, Fe, Cu and Ni & were characterized. The NH_3 gas sensitivity studies were carried out at room temperature. Utilization of animal models in vivo studies helps to overcome the drawbacks of in vitro studies.

Structural properties and morphology of synthesized pure and doped Co_3O_4 nanoparticles were studied by X-Ray Diffraction (XRD), Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), Energy Dispersive X-ray Analysis (EDX) and Fourier Transform Infrared Spectroscopy (FTIR). Optical characteristics were analyzed by UV-Visible Spectroscopy (UV-VIS).

XRD analysis exhibited the synthesized nanoparticles were highly crystalline in nature. Crystallite size & lattice parameters were calculated from X-ray diffraction analysis. It is seen that the synthesized nanoparticles are in wurtzite hexagonal structure.

Uniform distribution of grains was confirmed by TEM analysis. SEM images ensure the spherical shape. From the micrograph image, minimum agglomeration was observed which might have occurred due to the dopants. EDAX spectrum confirmed the presence of Co, Oxygen and the dopants without any foreign elements.

Bending and stretching vibrations of oxygen and cobalt were examined by the FTIR spectrum. Existence of doped components bound to surface of Co_3O_4 was evidenced from FTIR analysis. From the optical studies it was found that Co_3O_4 nanoparticles are highly absorbing in nature and bandgap energy was calculated.

The best sensitivity properties of nanosensors have been found with the use of Fe doped Co_3O_4 nanoparticles. The improvement in the NH_3 gas sensitivity has been established with an increase in the doping concentration.

The developed Fe doped Co_3O_4 nanoparticles are proved to be excellent biocompatible nanomaterials for the treatment of cancerous cells lines with toxicity below 200 μg/ml concentration. These findings might facilitate the investigation and production of anticancer agents from inorganic particles. They act as a good system for drug delivery & offer new perspectives for diagnostic & targeted therapeutic approaches for the treatment of cancer.