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Green Synthesis of Nano Cobalt Oxide by using *Hibiscus rosa-sinensis*

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Abstract

This research article provides the synthesis and characterization of Cobalt Oxide nano particles by eco-friendly green chemistry method. The cobalt oxide nano particles were synthesised by using leaf extract of Hibiscus rosa-sinensis. The light violet coloured leaf extract of hibiscus rosa-sinensis was used as catalyst and stabilizer for the synthesis of nano particles from precursor cobalt chloride hexa hydrate. So obtained cobalt oxide nano particles were characterized by EDAX, SEM, XRD, FTIR, TGA. EDAX confirms the presence of cobalt and oxygen in the nano particles. SEM studies shows the sponge and few cubical spine like structure of cobalt oxide with average grain size of 60 nm. XRD studies confirms the nano size of particles and maximum peak was obtained at (311) confirms the presence of nano cobalt oxide.

Keywords: *Green Synthesis, Hibiscus rosa-sinensis, Nano Cobalt Oxide*

1.0 Introduction

Nano particles were synthesised by many researchers from last decades in order to improve their properties like optical, magnetic, mechanical and catalysis[1-6]. In the field of catalysis where nano particles tune their shape, size and surface area.

In order to reduce the cost and toxicity for the synthesis of nano particles most of the researchers have chosen green synthesis method i.e., from flowers, seeds, pulp, stems and also from leaves reaction mode were done on Glib-interfusion of metal oxide nano particle with eco elegant track[7-9]. Nano particles of Cobalt Oxide (Co_3O_4) which exhibits unique chemical and physical properties which extends their applications in many industries[10]. To owe more attention for its structural and redox properties cobalt shows various oxidation states like CoO, Co_2O_3, Co_3O_4 to gain stochiometric polymorph[11]. The synthesis of nano Co_3O_4 particles by using green synthesis method in order to reduce hazardous by-products, cost of chemicals and which reduces toxicity from environmental conditions and being energy intensive[12]. There are many methods to synthesise of cobalt oxide nano particles i.e., sol-gel, chemical vapor deposition, thermal deposition of cobalt precursors, Sono-chemical rate[13-19], were used. Some mechanisms like hydrothermal, chemical spray pyrolysis, combustion method, micro emulsion method[20-25] were used for the synthesis of cobalt oxide nano particles with different morphologies. However, these synthesis methods have many drawbacks like complex synthesis steps, cost-effective equipment's, high temperatures and long reaction time all these methods are environmental congenial.

Cobalt oxide nano particles exhibits normal spinel structure and consider as a multi-functional because it exhibits many applications in magnetic semi-conductors[26,27] super-capacitors, solar-energy storage and pigments, field emission materials[28] lithium-ion batteries.

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Mechanism of green synthesis of nano particles obtained from plants which contains a variety of phytochemicals like terpenoids, quinones, ketones, flavonoids. Raw hibiscus leaves are rich in carbohydrates, calcium, magnesium, potassium and vitamins like C and B. Leaves are used for medicines because leaves are rich in phytochemicals like polyphenols especially poly saccharides, anthocyanins, organic acids. These act as a reducing agent and also capping agent[19]. These leaves are high in antioxidants and consists of many potential benefits which helps in weight loss, reduces the growth of bacteria in cancer cells.

In the future we intend to use the synthesized material for electroless Ni-P/ nano Cobalt Oxide for corrosion studies like potentiodynamic polarization and electrochemical impedance as our future studies.

2.0 MATERIALS AND METHODS

2.1 Origin of *Hibiscus rosa-sinensis*

Hibiscus belongs to the family malvaceae which is a shrub consists of three thousand species. Hibiscus leaves are glabrous coarsely serate, ovate with prominent margins from 8 to 10.5 cm length. Hibiscus belongs to the kingdom: plantae, class: Dicotyledonae, division: angiosperms. These plants were found at throughout the world which grows in tropical and sub-tropical regions.

2.2 Preparation of *Hibiscus rosa-sinensis* Leaf Extract

Fresh hibiscus leaves washed thoroughly with distilled water. The leaves were dried at room temperature. Later chopped into small pieces (250 gm) and boiled with 500ml of distilled water at atmospheric pressure until formation of gel. The gel was filtered through Whatman filter paper then filtrate was stored in a glass bottle after cooling and incubated[29-32].

2.3 Synthesis of Cobalt Oxide Nano Particles

The obtained gel act as a reducing agent for the synthesis of cobalt oxide nano particle. The extract (62 ml) was mixed with 250 ml of cobalt chloride hexahydrate solution kept at continuous stirring around 700 rpm and temperature were kept at 175^{0}C. At starting of the reaction spontaneous combustion were observed where gel was liquified and naturally decomposition occurs this is known as redox-active process because polyphenols present in the leaves which act as a reduction agent. The precursor was crushed into powder with mortar and pestle. These precursors were calcined at 600^{0}C for 150 minutes.

3.0 Results and Discussion

3.1 Surface Morphology and Microstructure

The elemental composition of the nano Cobalt Oxide

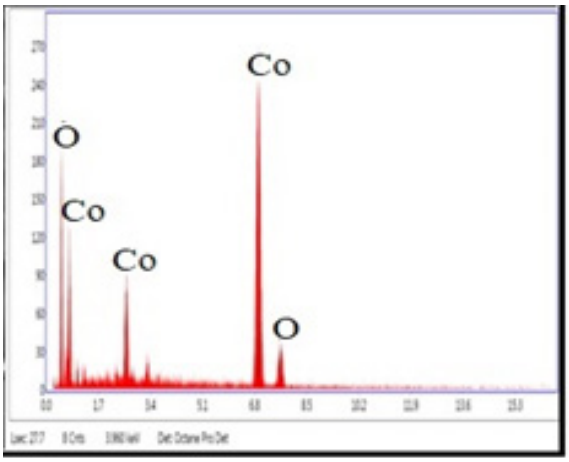

Figure 1. EDAX images of nano Cobalt Oxide powder.

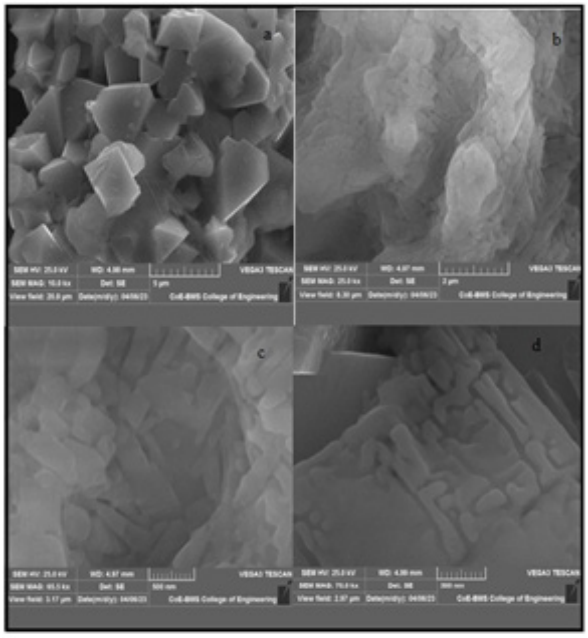

Figure 2. SEM images of nano Cobalt Oxide powder with different magnifications a) 5 µm b) 2 µm c & d) 500nm.

powder is shown in the Figure 1. The EDX pattern confirms the presence of cobalt and oxygen.

Figure 2 displays the scanning electron micrograph of nano cobalt oxide powder by using sol-gel method. With different magnification of the micrographs. The particles which exhibits spherical rod shape, cubical spine like structure. The shape of the nano particles is dependent upon the nature of compounds present in the leaves extracts.

3.2 FTIR Analysis

Figure 3 exhibits comparison between leaves powder and nano cobalt oxide powder were done. The characteristic bands of O-H (polyphenols) at 3351 cm^{-1}, stretching vibration of C-H at 2977 cm^{-1} and C-H (due to deformation of alkynes) at 662 cm^{-1}.

The same bands, with a slight increase in the intensity of the peaks can be seen in the FTIR spectrum of nano Co_3O_4 O-H peak is shifted to 3512 cm^{-1}, confirms that inter- action between extract of hibiscus leaves and nano cobalt oxide powder i.e., mostly due to the coupling between flavonoids and terpenoids in the hibiscus leaves extract. The strong absorption peak is observed at 662 cm^{-1} correspond to the metal-oxygen stretching vibration, confirms the spinal structure of nano Co_3O_4.

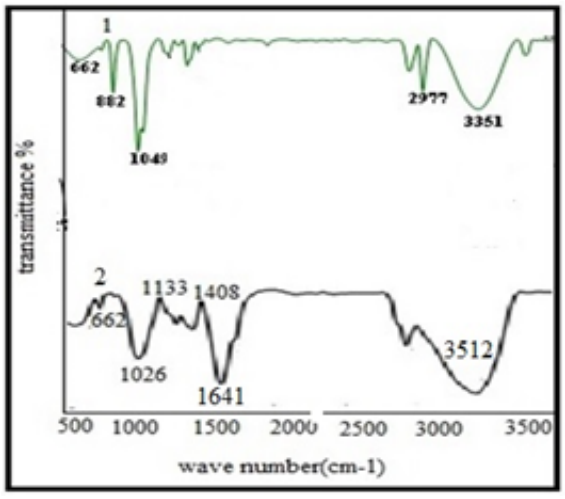

Figure 3. FTIR spectrum for 1) leaf powder 2) Nano cobalt oxide powder

3.3 XRD Analysis

The XRD diffraction of the Cobalt Oxide Nano particles are shown in the Figure 4 which exhibits the peaks (202), (311), (404) confirms that cubic phase of nano cobalt oxide where the particles are in nano size and crystalline in nature because green synthesized nano particle rearranges the atomic structure due to the dimensions of biosynthetic particles are small in size[33].

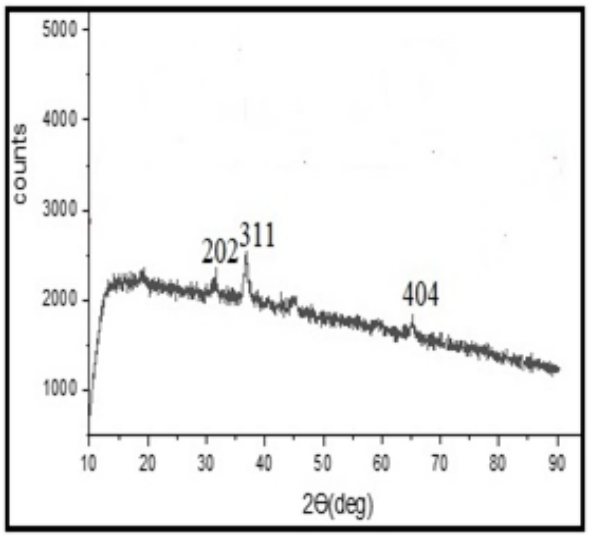

Figure 4. XRD pattern of nano cobalt oxide.

3.4 TGA Analysis

From the figure observed that thermal properties of cobalt oxide nano particles were done by thermogravimetric analysis. The TGA curve of nano cobalt oxide exhibits the decomposition the weight loss of sample were done at 500^{0}C because the evaporation of adsorbed water on

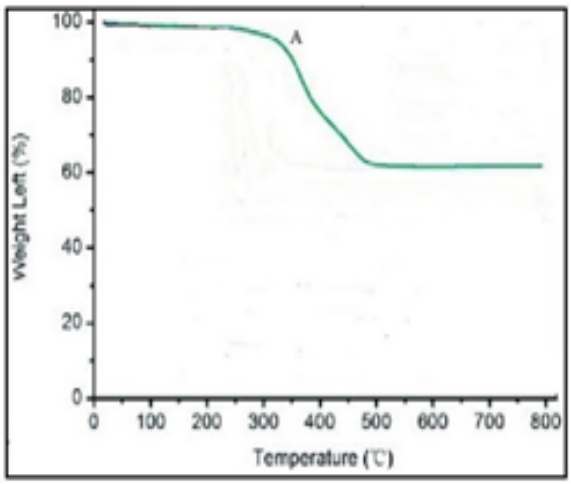

Figure 5. TGA analysis nano Cobalt Oxide.

the surface of nano cobalt oxide powder weight loss was observed. Based on above information one can conclude that the green synthesized nano Co_3O_4 has high thermal stability which is favorable for the application in electronic devices.

4.0 Conclusions

Green synthesis of nano cobalt oxide interfusion was done by using leaf extract of *Hibiscus rosa-sinensis* by using sol gel method.

- This study reports that a non-toxic eco-friendly approach for synthesis of cobalt oxide in nano scale range has potential
- It was observed that the crystalline structure and cubical spine pattern nano cobalt oxide.
- The synthesized nano cobalt oxide particle exhibits good optical and morphological properties. It concludes that the *Hibiscus rosa-sinensis* leaf extract has considerable amount of bioactive compounds which can be able to reduce the size and stabilize the nano particle.
- Synthesized nano cobalt oxide has high thermal stability which is confirmed by using TGA.

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