Electro chemical properties of nano flower NiO through coriander leaves extract for super capacitor applications

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Abstract - **Nano particles through green synthesis (via various extract from leaves ,fruits etc) plays a major role in preparing the cost efficient super capacitors with enhanced electrochemical performance. The advantage of green synthesis is that the electrochemical performance of the supercapacitors is greatly increases because of its high surface density and wrapping of coating layer around the electrode materials. In this work we present , the NiO Nanoparticles is prepared by using as extract from coriander leaves. The crystal and phase is confirmed by XRD analysis and SEM comfirms the morphological analysis. The electrochemical performance shows that the capacity retention is about 80 % after 3000 cycles . The cost efficient and high stability NiO supercapacitors is prepared through coriander leaves extract.**

keywords - **Supercapacitors , surface density, NiO Nanoparticles, coriander leaves extract.**

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1. Introduction

Now a days, a demand for energy storage devices is increased. Because, the usage of the electronic devices are increased. So, we need a best storage device, for some special applications. And we also using fuel cells, secondary batteries, capacitors to store an electrical energy[1]. But instead of that we can use super capacitors to store the energy. Because it has high benefits such as quick charging time, high efficiency, high capacity, maximum life cycle that is about 95% and the important benefit is it will store high amount of energy compared to the other storage devices. So, where the high energy storage is needed, a super capacitor is a best choice.

Energy storage plays an important role in this balancing act and helps to create a more flexible and reliable grid system. For example, when there is more supply than demand, such as during the night when low-cost power plants continue to operate, the excess electricity generation can be used to power storage devices[2].

Energy storage is the capture of energy produced at one time for use at a late time. A device that stores energy is generally called an accumulator or battery. Energy comes in multiple forms including radiation, chemical gravitational potential, electrical potential, electricity, elevated temperature, latent heat and kinetic. Energy storage involves converting energy from forms that are difficult to store more conveniently or economically storable forms[3].

Some technologies provide short-term energy storage, while others can endure for much longer. Bulk energy storage is currently dominated by hydroelectric dams, both conventional as well as pumped. Common example of energy storage are the rechargeable battery, which stores chemical energy readily convertible to electricity to operate a mobile phone, the hydroelectric dam, which stores energy in a reservoir as gravitational potential energy and ice storage tanks, which store ice frozen by cheaper energy at night to meet peak daytime demand for cooling. Fossil fuels such as coal and gasoline store ancient energy derived from sunlight by organisms that later died, became buried and over time were then converted into these fuels. Food is a form of energy stored in chemical form[4].

The properties of super-capacitors comes from the interaction of their internal material. Especially the combination of electrode material and type of electrolyte determine the functionality and thermal and electrical characteristics of the capacitors. The most commonly used electrode material for super capacitors is carbon in various manifestations such as activated carbon (AC) , carbon fiber-cloth (AFC), carbide-derived carbon(CDC), carbon aero gel, graphite (graphene),graphene and carbon nanotubes (CNTs)[5-10].

2 .EXPERIMENTAL PROCEDURE

2.1.1 Materials and methods

2.2.2 a) Preparation of coriander leaf extract

All the chemical and reagents used in this experiment were of analytical grade from Loba chemicals. The coriander leaves were purchased from vegetable markets, India. The coriander leaves were thoroughly washed and dried in shade. For preparing the plant broth solution, 20 gm dried leaves of coriander ware cut into small pieces and washed with distilled water. This was taken in a 250 ml beaker with 100 ml of distilled water and then boiled the mixture for 20 min at 80˚C. The extract was filtered through Whatman filter No.1 and then was stored at 5˚C and can be used with in a week.

2.2.3 b) Synthesis of NiO nanoparticles using coriander leaf extract:

A volume of 10 ml of coriander leaf extract was added to 100 ml of 1 mm aqueous nickel nitrate ($NiNO_3$) solution in a 250 ml Erlenmeyer flask. The color of the solution changes from green to pale yellow after the addition of coriander leaf extract and stirred the resulting solution for homogeneous mixing. The flask was kept at room temperature for over night and Ni nanoparticles were separate out and settle at the bottom of mixed solution of nickel nitrate and coriander leaf extract. The Ni nanoparticles thus obtained was purified by repeated centrifugation method at 5000 rpm for 15 min followed by redispersion of the pellet in deionized water. Then the Ni nanoparticles were dried in oven at 80˚C. The progress of the reaction is shown in figure.

a) coriander leaves **b) coriander leaf extract**

EXPERIMENTAL PROCEDURE

Preparation of NiO nanoparticles

3.Results and Discussion

3.1 XRD analysis

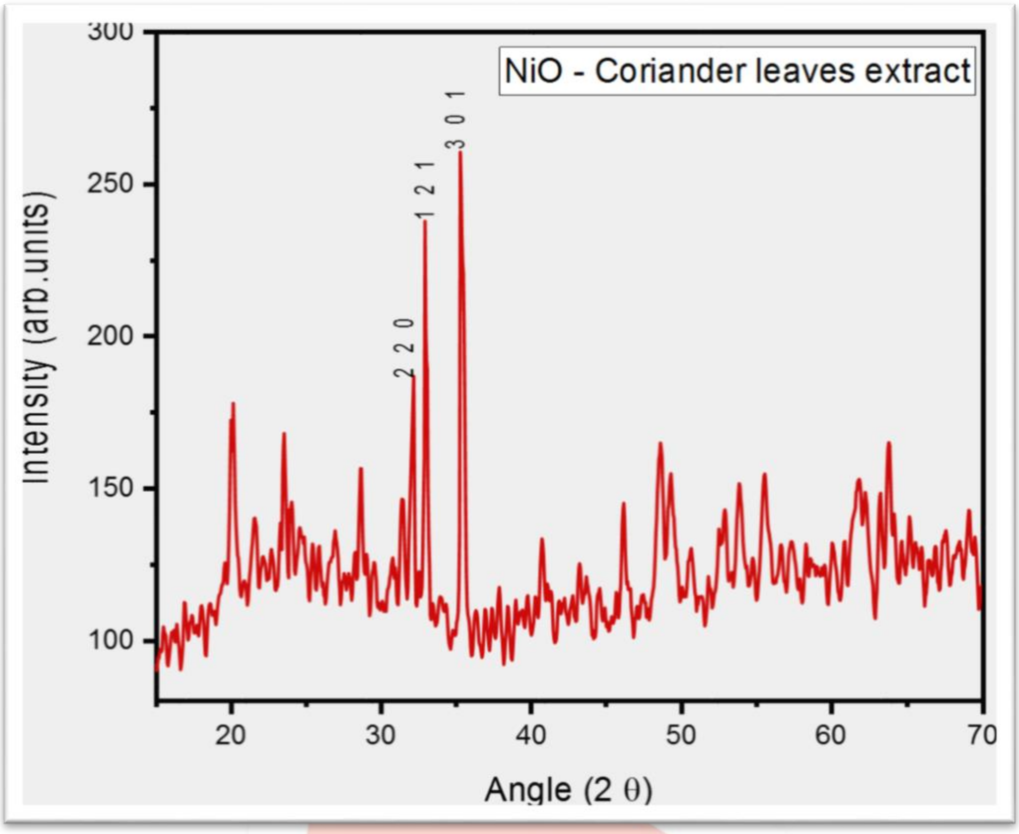


Fig 1: The XRD spectrum of the prepared NiO

The prepared NiO nanoparticles are analysed using XRD analysis , the figure (1) shows that all the peaks could be indexed to brunsenite structure are confirmed with the JCPDS card no. 47-1049. No diffraction peaks of impurity was not observed which shows that high purity of the prepared NiO material. The sharp and strong peak at 2ϴ = 32^0, 33^0, and 35^0 shows the high crystallinity nature of the materials[11].

The grain size of the prepared material was calculated using Schirrer formula $n\alpha = 2d \sin \Theta$. Using the schirrer formula the calculated grain size of the material is about 20-30 nm.

A strong peak occurs at 2θ = 31.8° which corresponds to the (2 2 0) reflection, while the peaks at 33.2° and 35.4° correspond to the (1 2 1) and (3 0 1) reflections respectively. These peaks indicate that the prepared NiO nanoparticles are with brunesite structure with hexagonal phase.[12]

3.2 SEM Images of the NiO nanoflower by coriander leaf extract

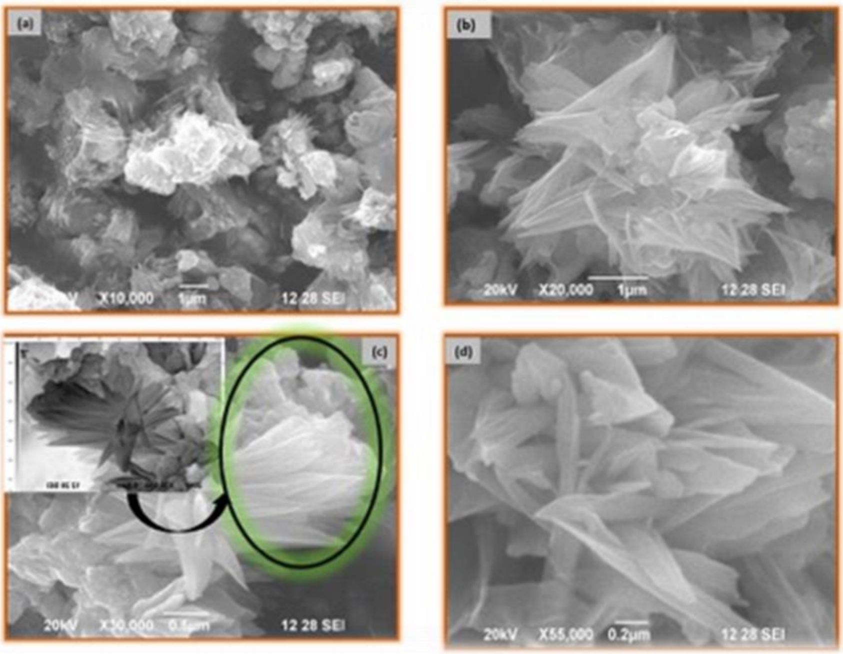


Figure 2: (a)(b)(c)(d) The sem images of the NiO

The SEM analysis was used to examine the structure and morphology of the prepared products. The Figure 2 (a-d) shows the images of the prepared flower shaped NiO nanoparticles , in which fig b,c shows the formation of the flower shaped nanoparticle with pretty high density. As shown in Fig (d) the it was easily observed that the hierarchical nano flower shaped structures consists of minute ultra thin nanosheets which is intermingle with each other. The thickness of the minute nanosheets is about 20-30 nm. To get the further information the formed nanoflowers are analysed through stimulating software for analyzing the surface changes at the nanoflowers.

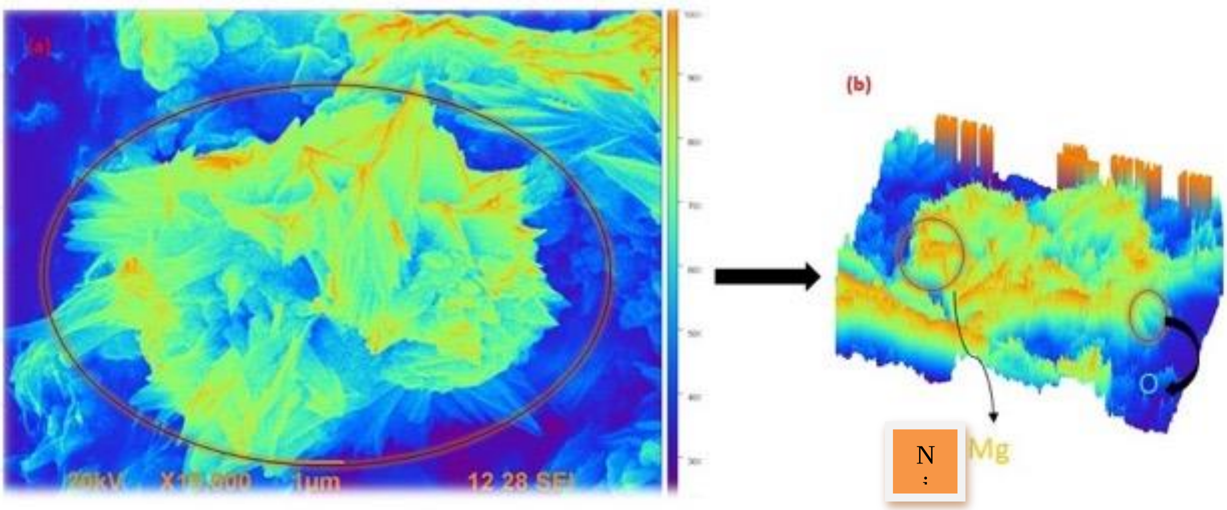


Figure 3 (a) the images of the formed nanoflower and (b) the 3d view of the flower shape using stimulating software.

The Fig 3 (a) the analyze image of the formed nanoflowers which confirmes that the density of the flower is high and with also the flowers are formed with high surface volume . The Fig (3b) shows the 3 dimensions view of the formed flower in which the combination of the orange –red spark shows the presence of ni and Green- blue sparks shows the presence of oxygen atoms. From the sem analysis we can confirms that , while preparing through coriander leaf extract the particles are formed with high surface volume and with high density which shows the good sign for the better electrochemical performance for the energy storage applications.[13]

3.3 Electrochemical Analysis

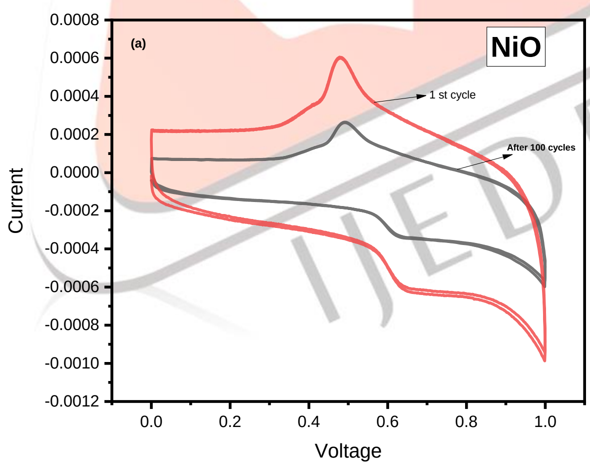
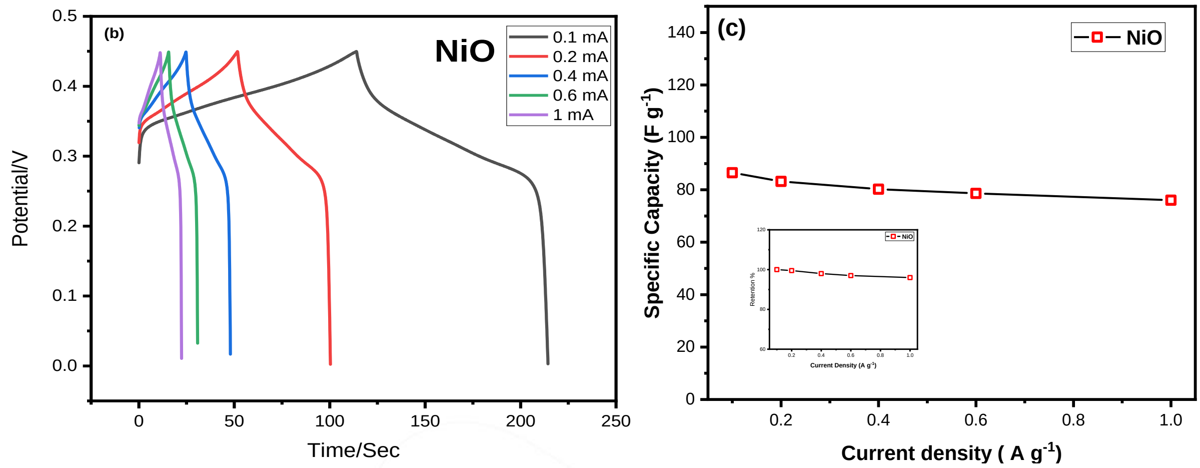


Figure 4 (a) the Cyclic voltametry analysis of the prepared for different cycles. B the Galvanostatic charge/discharge graph of Nanoflower NiO.

In order to study the pseudo-capacitive performance of the asprepared material, the as-grown NiO nanosheet assembles was employed as the working electrode and tested using 3 M KOH as the electrolyte in a three-electrode configuration system. The results were showed in Fig. 4. NiO flower assembles active material were first tested at 40 mV/s and the results were shown in Fig. 4 (a)[14]. From the consequence, one can found that NiO nanosheet assembles electrode exhibits much higher capacitive current density than pure nickel foam, revealing that pure nickel foam devotes little to the total capacitance of NiO nanoflower assembles. CV curves of the working electrode collected at various scan rates ranging from 3 to 40 mV s1 are shown in the potential range from -0.2 to 0.25 V to assess the rate dependent supercapacitive performance of the sample are shown in Fig. 4(a). From the CV curves in Fig. 4(a), we can observe that the capacitance is mainly on account of the redox reaction because the shape of the CV curves is distinguished from that of electric double-layer capacitance, which is normally close to an ideal rectangular, indicating that NiO flower assembles electrode exhibits Faradic pseudocapacitance behavior. The charge storage mechanism of NiO electrode may be caused by the following redox reaction [15]. From Fig. 4(a), we can find the area enclosed by the CV curves and the redox current increase with increasing scan rate and the shape of CV curve does not change very much even at a scan rate of 40 mV/s, revealing the good kinetic reversibility of NiO electrode. The galvanostatic charge-discharge test and cyclic behavior stability are tested by using the chronopotentiometry technique. Galvanostatic discharge tests were performed by using 3.0 M KOH as the electrolyte at different current densities from -0.2 to 0.25 V. Fig. 4(b) shows galvanostatic discharge curves of the sample at current densities of 0.5, 1.0, 1.2, 1.5, 2.0, and 3.0 A/g, respectively. As shown in the discharge curves, which represents very low IR drop, suggesting that NiO nanosheet assembles are good electrode materials in supercapacitors. Fig. 4 (c) demonstrates the calculated specific capacitance based on the discharge curves according to the above mentioned equation.[16]



The results were 86.76, 75.63, 73.66, 72.47, 70.6 and 64.72 F/g at current densities of 0.5,1.0,1.2,1.5, 2.0, and 3.0 A/g, respectively, demonstrating that the specific capacitance decreases with increasing current density.[18,19] As shown in Fig. 4(e), one can see NiO nanoflower assembles electrode retains 79.1% of its initial capacitance when the current density increases from 0.1 to 1 A/g, revealing the NiO electrode possesses a relatively high rate capability even at a current density of 1.0 A/g . It also further demonstrates NiO nanoflower assembles are excellent electrode materials for the supercapacitors. Cycling stability is a crucial factor for the supercapacitor electrode performance. Stability of NiO nanoflower assembles as an electrode material was evaluated by repeating continuous galvanostatic charge-discharge measurements at a current density of 0.2 A/g for 3000 cycles. The results were showed galvanostatic charge-discharge cycles of NiO nanoflower assembles electrode retain about 78.5% of the initial specific capacitance after 3000 cycles, indicating its excellent long-termcycling stability.The high capacitance retention implies that the as-synthesized NiO nanoflower assembles are suitable materials for supercapacitor applications.[20]

4. Conclusion

In summary, NiO assembles have been successfully synthesized via a facile hydrothermal process at low temperature in the absence of any surfactants. The as-synthesized products consisted of two dimensional nanosheets with the thicknesses of about 10-20 nm. The electrochemical properties of as-synthesized products shows specific capacitance of 81.76 F /g at discharge current densities of 1 A /g and excellent cycling stability (retain 78.5% after 3000 cycles at 0.5 A/g), indicating their excellent electrochemical performance and good cycling stability. The electrochemical performance can make the hierarchical NiO structures to be one of the prospective electrode materials for electrochemical energy storage applications.

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