Characterization of nickel oxide nanocatalyst electrodes for an alkaline fuel cell

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Characterization of nickel oxide nanocatalyst electrodes for an alkaline fuel cell

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Abstract. In this paper had been studied the characterization of the nanocatalyst (NiO) Mesh electrodes. For fuel cell. The catalyst is prepared and also the electrodes The structural were studied through the analysis of X-ray diffraction of the prepared nanocatalyst for determining the yielding phase and atomic force microscope to identify the roughness of prepared catalyst surface, Use has been nanocatalyst led to optimization of cell voltage, current densities & power for a fuel cell.

Keywords: (NiO) nanocatalyst , electrolysis cell, an alkaline fuel cell, X-ray diffraction, atomic force microscope.

1. Introduction

Since the first decade of the twenty-first century. There has been a tremendous revolution of nanotechnology and many researchers have talked about it. The introduction of nanotechnology, that contributes considerably to sustainable economic growth, has broad applications in advanced technologies because of its characteristic properties [1], One amongst the foremost promising trends in nanotechnology is that it's utilized in electrolysis and fuel cells. The nanomaterial's obtained with this method are incredibly promising as light selective coatings, greatly increasing corrosion resistance and protection capability. [2] These nanomaterial's are characterized by reasonable electrical, [1, 3], To develop these cells and obtain low-cost nanotechnology alkaline fuel cell, by developing the catalyst efficiency. [4]. The researcher Yasuhiro Mizukoshi and Katsumi Yamada evaluated the electrochemical properties of NiO/Au. High-velocity electrochemical changes were obtained within one second by improvements in penis length and film thickness for the NiO film [5],The researcher Tomokazu Sakamoto and his group NIO/ Nb2O5 /C, catalysts were manufactured for electro-hydrazine electro-oxidation by evaporation. thermodynamic nanomaterials have been extensively tested in recent decades because of their high surface area, which severely affects their physical properties. And on reported nanostructure shapes [6], The NiO-CNT catalysts were supported Pd , By the researcher S. S. Hossain et al, that the NiO-CNT / Pd electrical catalysts show the high electrochemical activity and also the long-run stability of chemical oxidization were synthesized , characterized, and assessed of formic acid for fuel cell [7].

2. Experimental work

2.1. The mesh stainless-steel

The prepared mesh stainless-steel of type 316 was cleaned with is up and water, Before immersion in HCl solution (8-10%) for 5 minutes, then washed with acetone, ethanol and at last in ultrapure water via an ultrasonic treatment for 10 min then dried**.**

2.2. The prepared nano (NiO) catalyst electrode

The prepared mesh stainless-steel was cut into 3 cm long. One ends of stainless-steel of type 316 were connected to a cathode. The plating resolution has consisted of nickel sulfate, sodium acetate, and sodium sulfate mixture of temperature. Nickel sheet was used as an anode. The nanoporous nickel oxide film was deposited on the surface of the stainless. The deposited film is very porous, As shown in figure (1). Once deposited, the deposited stainless-steel was rinsed many times with deionized water, then dried.

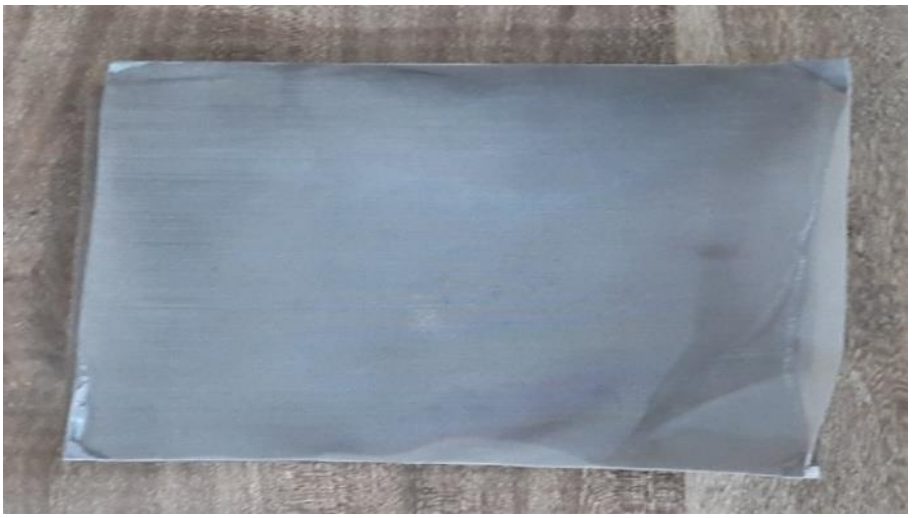

Figure1. nano (NiO) catalyst electrode

2.3. Design of electrolyser cell

consists outer wall of organic glass (14.5x14.5) cm2 to prevent leakage of gases from the cell, 0.1 cm thick of electrode. as well as consists of two electrodes isolated from each other, to isolate each gas separately (hydrogen and oxygen).

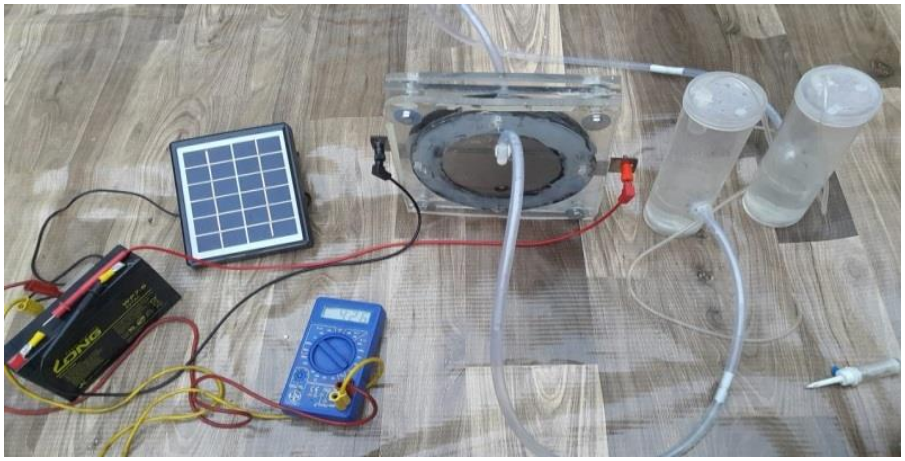

Figure2. The electrolysis method set up

2.4. An alkaline fuel cell

consists of nano (NiO) catalyst anode and cathode, with These two electrodes are separated by an electrolyte (KOH). An oxidant is fed to the cathode to supply hydrogen while fuel is fed into the anode to supply hydrogen. The outer wall of the cell consists of organic glass sheets.

3. Results and discussion

3.1 Structural properties

The most famous methods for studying the determination of the crystalline structure of any material or skinny layer are X-ray diffraction. The diffraction pattern is analyzed on the spacing and spacing of the material within the examined material [8], In figure. (3) and table (1) , Analysis of nano nickel oxide, Showed a series of diffraction peaks at 2 θ of 37.39 °, 42.089 ° , 43.092 °, 63.700 °, 75.15 °, and 78.93° can be assigned to (111), (200), (220), (311) (211) and (222) planes, The diffraction peaks show good crystalline nanoparticles and match very well with ideal lattice constants, In this paper, This result shows that the physical phases of the NiO nanoparticles have higher purity prepared as agreeing with [9,10,11].

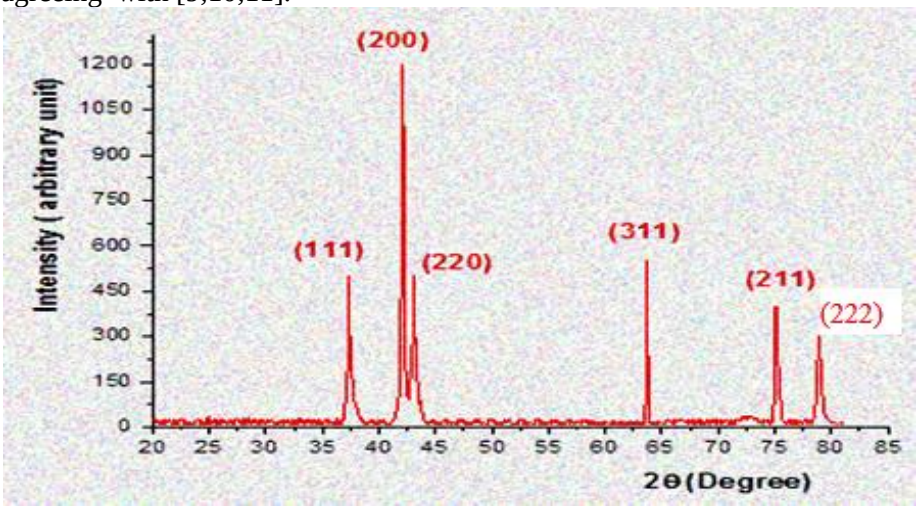

Figure 3. X-ray diffraction of NiO nanoparticles

Table 1. Peak data used for crystallite size estimation using the Scherrer formula for nano NiO

hkl	2theta [deg]	FWHM sample	Crystallite size [nm]	Average Crystallite size [nm]
(111)	37.39	0.42314	14.91670825	14.68331975
(200)	42.089	0.19908	29.61348227	
(220)	43.092	0.62618	9.264579907	
(311)	63.700	0.13679	25.73184801	
(211)	75.15	0.38451	5.293644395	
(222)	78.93	0.46512	3.279655669	

3.2 Morphological properties

The average grain size and surface morphology can be obtained by (AFM) analysis. Surface morphology of (NiO) was obtained very highly spaced, Randomly oriented and highly correlated of pores. It has found that the average particle size has 42.15 nm, As shown figure (4) a,b, As agree with [12,13]**.**

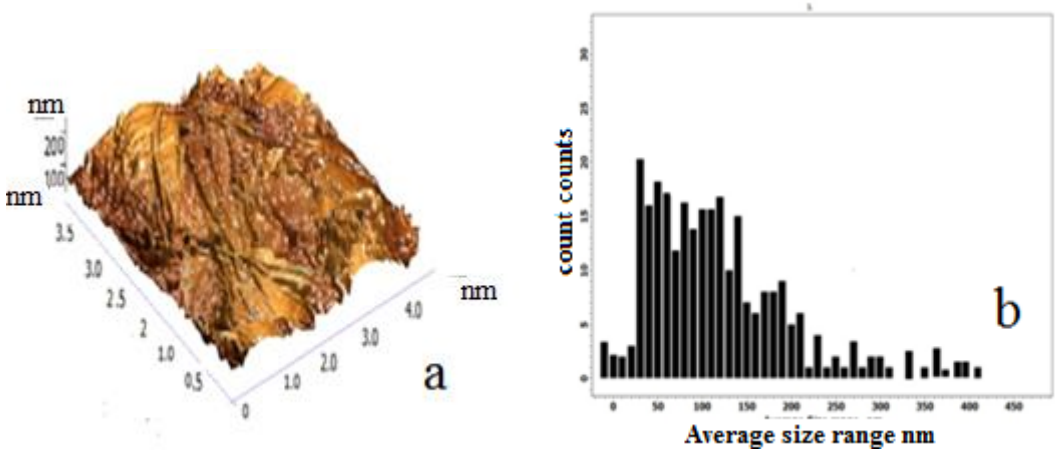

Figure. 4(a,b) .Atomic force microscope of nano NiO catalyst

3.3 Study the parameters for an alkaline fuel cell

Electrical conductivity increases with an increase in the current density, As shown in Figure 5. and table (2). The voltage of fuel cell decreased with the current, As shown in Figure 6 a,b. The energy produced by the alkaline cell depends on the purity and quantity of hydrogen supplied to it.

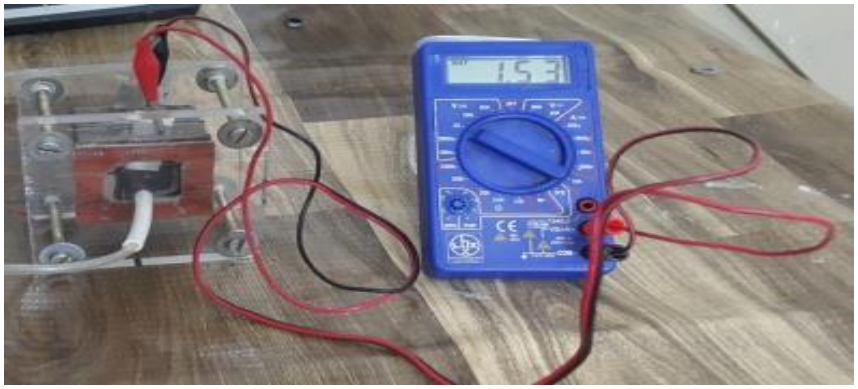

Figure 5 . The fuel cell

Table.2. Show the relationship between the current and voltage with electrical conductivity

Electrical conductivity (S\cm)	Current (A)	Voltage (V)	Power (Watt)	Time (min)
0	1.8	1.53	2.75	5
0.9	2	1.5	3	10
1.2	2.4	1.47	3.53	15
2	2.7	1.44	3.89	20
2.5	3.1	1.42	4.26	25
3.7	3.4	1.39	4.73	30

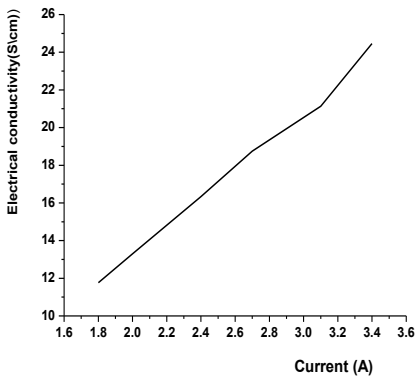

Figure 6a The relationship between current -Electrical conductivity

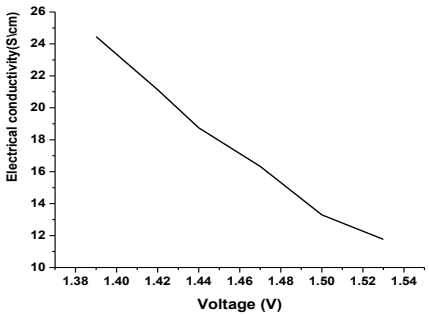

Figure 6b. The relationship between voltage - Electrical conductivity

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4 Conclusions

In this research, nano nickel oxide catalysts were synthesized successfully for membrane for fuel cell application. Manufacture of electrode for fuel cell of mesh stainless steel coated with a layer of nanocatalyst is considered inexpensive compared to other methods using precious and expensive metals.

It was found that the voltage of the fuel cell decreased with increasing the current for the same flow rate. While electrical conductivity increases with increasing the current

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