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Development of carbon nanotubes catalyst supported for alkaline fuel cell technology

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Abstract Study of the development of an activated carbon nanotube catalyst for alkaline fuel cell technology. Through the prepared carbon nanotubes catalyst by an electrochemical deposition technique. Different analytical approaches such as X-ray diffraction (XRD) to determine the structural properties and Scanning Electron Microscope (SEM), were used to characterize, Mesh stainless steel catalyst substrate had an envelope structure and a large surface area. Voltages were also obtained at 1.83 V and current at 3.2 A of alkaline fuel cell. In addition, study the characterization of the electrochemical parameters.

1 Introduction

One of the most promising technologies is the alkaline fuel cell technology. Hydrogen typically uses fuel to convert these cells into electrical energy through electrochemical reactions [1]. Researchers are making a great deal of effort towards improving fuel cells, cost and durability. Other major concerns are that platinum is not only expensive, its amorphous nature is platinum so think of other materials like carbon nanotubes which have a unique structure, high crystal, conductivity [2,3,4,5]. Carbon nanotubes (CNTs) possess a distinctive form and good mechanical properties, as well as thermal conductivity and electrical properties are high [6]. It is hollow carbon structures with one or more walls [7]. Because of these unique characteristics since the time of discovery in 1991, carbon nanotubes (CNTs) found many applications [8,9]. Carbon nanotubes preparation is done by electrostatic discharge, laser ablation [5] and chemical vapor decomposition [10,11]. Feng Zhang and his group studied the growth of semiconducting carbon nanotubes with a sudden narrow-band distribution [12]. There are also useful to support in heterogeneous catalysis because of its electrical mechanical properties [13]. The catalysts are chemical compounds that have attracted great attention over the past three decades as a promising solution for clean energy generation and a solution to environmental problems and water, air and other treatment [14]. Therefore, the development of catalyst efficiency and very low cost are the main source of fuel cells. In this context, carbon materials such as carbon nanotubes [15] will use effectively to support and improve catalyst performance [16].

2 Experimental

2.1. Preparation of carbon nanotubes.:

Sulfuric acid was mixed with nitric acid in a 2:1, then gradually added to the 1 g of the graphite for 40 min with stirring. The solution was heated to 60 °C and leaves the solution was left for 2 days, where the graphic was deposited at the bottom. Some carbon reactions are floating and the floating carbon is transferred to the deionized water (1) liter. After flipping for half an hour, the solution was filtered and then dried. As show in Figure 1a, 1b.





Figure 1a, Preparation of Carbon nanotube substance

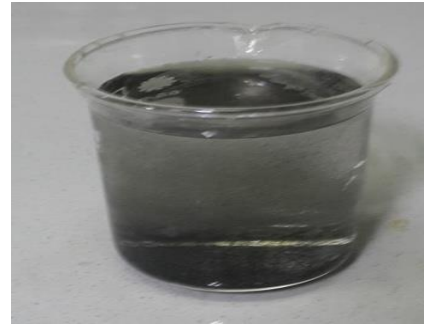


Figure 1b, Some of Carbon nanotube reactions are floating

2.2. *Electrolysis Cell*

The electrolysis cell consists of stainless steel plates of type 314 No. 2 isolated from each other, for the purpose of isolating each gas separately (hydrogen and oxygen), including a plate of organic glass. These electrodes are immersed in an electrolyte solution, the electrolyte solution was prepared by add 28 g of KOH to (1000) liter volume of distilled water . The outer wall consists of organic glass to prevent leakage of gases (14.5x12) cm² from the cell , 1 cm thick, as show in Figure 2 .



Figure 2.The electrolysis cel

2.3. *Alkaline Fuel Cell*

A manufactured alkaline fuel cell is a tool to convert chemical energy into electrical energy. In this paper, carbon nanotube electrodes of wire mesh (2) were used, As shown in Figure 3 . Manufactured for this purpose, with an area of (4x3.5) cm² and a thickness of 0.1 cm. As well as an internal chamber between the electrodes. It is electrolyte solution potassium hydroxide. It is prepared from distilled water and added to 0.28 molar of potassium hydroxide. The external wall consists of organic glass to prevent leakage of gases, three openings to enter the first hydrogen and the second to enter the oxygen and the third to release steam for water.



Figure 3.Mesh electrodes

3. Results and discussion

3.1. XRD Measurement

The structure and morphological of fabricated nanostructures were investigated by XRD, CNTs branching advancement could be followed by XRD spectrum that explain clearly the change in faces growth and time growth. The growth direction takes place over (110) plane, with time a new peak at $2\theta = 43.97$ deg. Appear related to (002) plane that reflect the beginning of CNTs branching at this direction. As shown in Figure 4 , Other peaks of carbon nanotubes are confirmed in the previous studies [17].

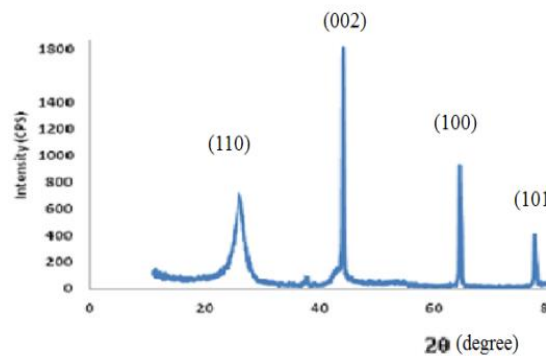


Figure 4. X-ray diffraction analysis of carbon nanotube

3.2. SEM Measurement

Through SEM image testing it was shown that the carbon nanotubes as in Figure 5 were found different in size, length and shape, it was observed that a bundle of nanoparticles intertwined the tubes with each other in a different direction.

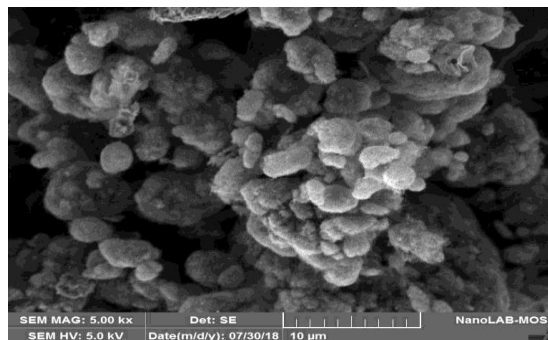


Figure 5. SEM analysis of carbon nanotube

3.3 . Study the size of the hydrogen produced by the electrolytic cell with the current relationship and the stability of time is significantly useful so that this gas can be used into the fuel cell, different amount of currents were applied and then the volume of hydrogen produced in each current was measured. The results of this experiment show that the electrolytes produce the amount of hydrogen when the same values of current are used as table (1) and Figure (6) show

Table.1. Show the relationship between Volume of hydrogen and Current

Volume hydrogen (ml)	Time (min)	Current (A)	Voltage (Volts)
0	5	0	6
0.9	5	1.1	6
1.2	5	1.4	6
2	5	1.9	6
2.5	5	2.3	6
3.7	5	2.8	6
5.3	5	3.2	6
6.2	5	3.6	6

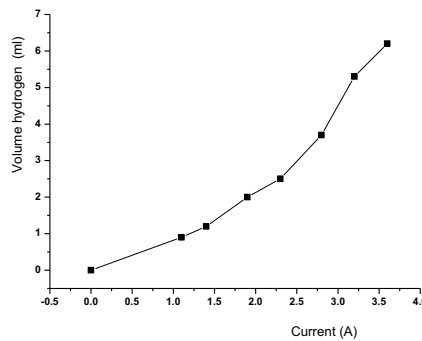


Figure 6.The relationship between Volume of hydrogen and Current

Hydrogen gas was released from the disintegration of water molecules in the electrolyser cell into the cell through the anode electrode to touch the layer of nano carbon catalyst, which in turn decomposes the molecules of hydrogen into atoms and then to protons and electrons pass through the outer load circuit, (OH^{-1}) in the opposite direction of the cathode electrode through the electrolyte solution to the anode electrode. Dissociation of the oxygen molecules at the cathode electrode, to combine with the electrons traveling through the outer load circuit to form a water molecule again at the anode electrode accompanied by an increase in the temperature of the alkaline cell to more than 50-90 degrees Celsius, to obtain a power of up to 1.83 V and a current of 3.2 A, As Figure 7 . Show.

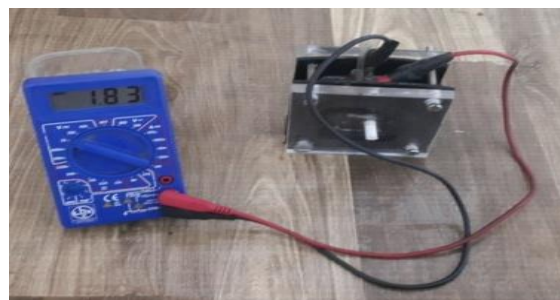


Figure 7.fuel cell of electricity production

Table.2. Show the relationship between the electrical conductivity with current and voltage of alkaline fuel cell

Electrical conductivity σ (S\cm)	Current (A)	Current density (A/cm ²)	Voltage(V)
6.82	1.1	0.079	1.84
8.9	1.4	0.1	1.79
12.11	1.7	0.12	1.6
17.47	2.1	0.15	1.37
26.16	2.8	0.2	1.22
35.08	3.6	0.26	1.17

Note:
$$\sigma = \frac{I * L}{V * W * T} \quad (1)$$

σ electrical conductivity I: current (A), L: sample length (cm) W: sample width (cm), T: sample and thickness (cm)

As show in Figure 8 ,the voltage of fuel cell decreased with the current density flow rate. At 0.5 L/min flow rate of H₂ gas. Shown in Figure 9 electrical conductivity increases with increasing in the current. Same in flow rate of hydrogen and oxygen gases, hydrogen has the highest energy density per unit weight than any other chemical fuel for many applications. It can be converted directly into electricity by fuel cell in an electrochemical process [18].

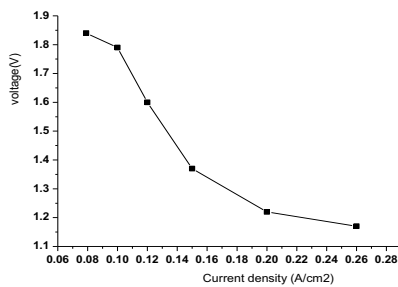


Figure 8. The relationship between voltage - Current density

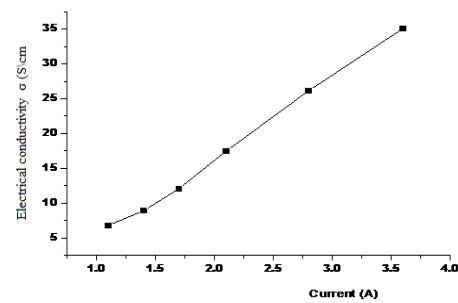


Figure 9. The relationship between current-Electrical conductivity at 0.5 L/min flow rate of H₂ gas

The amount of energy produced by the alkaline cell depends on the thickness and quantity of the carbon atoms that drive the hydrogen particles into the electrons in the form of energy, as well as the purity and amount of hydrogen supplied to the alkaline cell. The higher the purity is, the higher the energy of Oxygen from the other electrode (cathode). This increases the energy and efficiency of the cell[19].

4 Conclusions

1-The alkaline fuel cell has been tested in this paper for its necessary properties that are the operative temperature vary is wide, the composition of those cells is straightforward. Cost is low because of the simplicity of the material. Electrical efficiency, Its flexibility to use a wide range of electrical stimuli.

2-We have presented a simple chemical method for producing CNTs in liquid solution at 60 °C.

3-In this research, carbon nanotube was synthesized successfully from graphite material as electro-catalyzes for fuel cell application.

4-This study found that the increase in the volume of hydrogen increases the current, as well as the electrical conductivity with increasing the current

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