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Enhancement of Nano Catalyst for an Alkaline Fuel Cells

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Abstract- **An alkaline fuel cell, which was developed using nano catalyst (Pt:CNTs) for electrodes. Study has been prepared (Pt:CNTs) nano catalyst, The Structural characteristics were studied through the analysis of X-ray diffraction (XRD) of the prepared nano catalyst for determining the yielding phase and Scanning Electron Microscope (SEM), were used to characterize, Mesh stainless steel catalyst substrate had an envelope structure and a large surface area. In addition, study the characterization of the electrochemical parameters. Electrochemical modelling and nano catalyst led to optimization of cell voltage, current & power densities and the results are found to be 1.76 V, 3.9 A.**

Keyword- **An alkaline Fuel Cells; (Pt:CNTs) ;Electrochemical parameters ; Nano catalyst**.

I. INTRODUCTION

The anode and cathode are covered in a layer of a catalyst and this catalyst increases the rate of chemical reactions that occur when anode and cathode(Zhang *et al.*, 2010), The development of catalytic efficiency and very low cost are the main source of an alkaline fuel cell. Catalysts have attracted much attention over the past three decades as a promising solution for clean energy generation and solution for environmental treatment, water, air and other treatments (Akira*et al.*, 2007), The main barriers in fuel cells must be overcome, Which are the high-cost materials used in manufacturing and their high cost, Because of these materials, Researchers have focused on using nanotechnology to reduce costs by improving cell efficiency (Elena *et al.*, 2009), More catalysts, materials used in electrodes for fuel cells is platinum (pt) because of its excellent properties in high catalytic oxidation activity, But the cost is a major obstacle Pt in the commercialization of fuel cell technology (Theeraporn *et al.*, 2017). A study by researcher A.L. Stepanov possessing platinum nanoparticles has a wide range of properties that can be used for many practical applications.(Stepanov*et al.*, 2014). Researchers have made efforts to find cheaper metals than replaceable platinum catalysts being expensive, However, The Pt catalyst is still widely used because of its high catalytic activity and high stability (Tzyy*et al.*, 2012). Researchers are making great efforts towards improving fuel cells, cost and durability. Another major concern is that platinum is not only expensive but also its non-crystalline nature, so think of other substances (Chanchal *et al.*, 2014; Zhang*et al.*, 2010). Because of the high cost of fuel cells are one of the obstacles to marketing. The use of nanotubes as support to put reduces about 40% of the total cost (Wei and Ravi 2011). In the 1960s carbon materials were first used as catalysts. And recently seen rapid advances in nanotechnology (Kenneth *et al.*, 2009). Carbon nanotubes are the most sought after catalysts, supporting low-temperature fuel cell (Ermete 2009). There is also an advantage in supporting heterogeneous stimulation due to its electrical, mechanical properties (Wenzhen *et al.*, 2003). B. Escobar Morales and his team studied the electrochemical properties of carbon-supported nano particles of pot by analyzing the catalytic response of the oxygen reduction reaction. As well as motivation parameters such as the charge transfer factor and the exchange current density of the catalyst were studied (Wei and Ravi, 2011).

II. Experimental :

II.1. Preparation of (CNTs:Pt) nano catalysis

Carbon nano tube (CNT) is mixed with H_2SO_4 acid by 3: 1. Respectively as to establish active sites on the surface to improve catalyst on CNT surface. Add H_2PtCl_6 With mixed by Sonicators Qsonica, LLC, Then add ethylene glycol (EG), A reduced agent to reduce surface Pt ions to nano particles of pt metal, Leading to a Pt / CNT catalyst. After that, Washing with deionized Water & drying. The samples were then pressed with a special press to form two electrodes for the alkaline fuel cell. As shown in Figure 1a, 1b

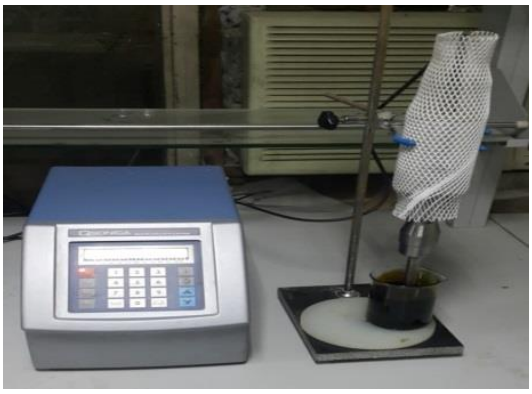

Figure 1a, Device of QsonicaSonicators

Figure 1b,Nano (Pt:CNTs) catalyst electrodes

II. 3. Design parts of the Electrolytic Water analysis for the preparation of Hydrogen Gas:

Because hydrogen gas is important in the manufacture of this system, an electrolyser has been built, consisting of the unit of the cell, the gas drying unit and the hydrogen storage.

II.4. Preparation of hydrogen gas unit

The electrolysis cell is made of stainless steel plates of a kind 314, And the electrodes are isolated from each other, By the purpose of isolating each gas separately (hydrogen and oxygen). These electrodes are immersed in an electrolyte solution, prepared from distilled water, and added to 0.30 molar of potassium hydroxide (KOH). The external wall consists of organic glass to prevent leakage of gases with an area of (22x22) cm2 and a thickness of 1 cm. This cell is connected to the electrical source of a solar cell operating at 10 volts and up to 4 Amps. As shown in Figure 2 .

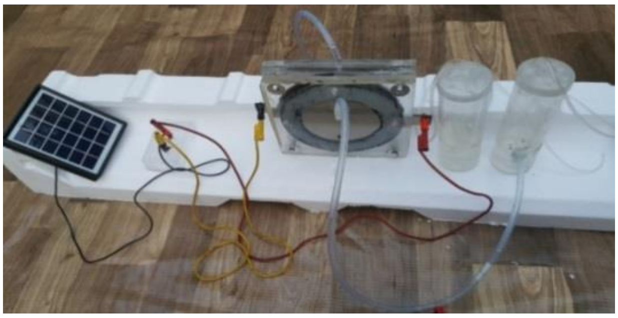

Figure 2.The electrolysis cell

II.5. Hydrogen gas drying and storage unit:

This system was designed by placing carbon nanotube with a water vapor pipette in a vial of compressed plastic, as shown in Figure 3.

Figure 3.Hydrogen gas dryingand storage system

II.6 . Alkaline Fuel Cell

The nanocatalyst (Pt :CNTs) to electrodes were used. Made for this purpose, with an area (4x3.5) cm2 and thickness 0.1 cm. The exterior wall consists of organic glass to prevent gas leakage. Three holes for entering the first and second hydrogen to introduce oxygen and the third to release water vapor, As well as an internal room between the electrodes Is an electrolyte solution of potassium hydroxide. It is prepared from distilled water and added to 0.28 molar of potassium hydroxide.

III. Results and Discussion:

III.1. XRD Measurement

The XRD patterns of Pt/CNT catalysts were. It could be found that there was an obvious sharp CNTs (002) plane at $2\theta=23.4$. The XRD patterns for the characteristic reflections for Pt showed a series of diffraction peaks at 2θ of 35.6°, 48.1°, and 60.1° are often assigned to (111), (220) and (101) planes, Implied that the Pt particles in the prepared catalysts were the typical cubic surface structure. Other peaks of Pt/CNT are confirmed in the previous studies (Nengwu et al., 2015;Jianshe et al., 2016). As shown in figure 4.

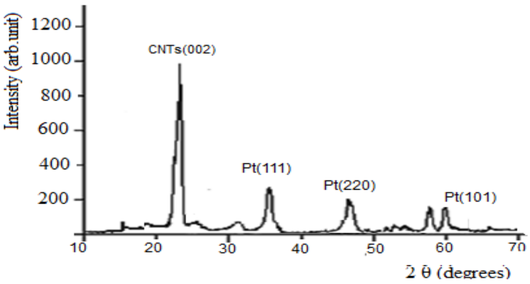

Figure 4.XRD analysis of (Pt :CNTs)

III.2. SEM Measurement

Through SEM image testing it was shown that the Nano (Pt :CNTs), As in Figure 5 has been found different in size, length, And shape, It has been observed a bundle of Pt nano particles intertwined the tubes with each other in a different direction .

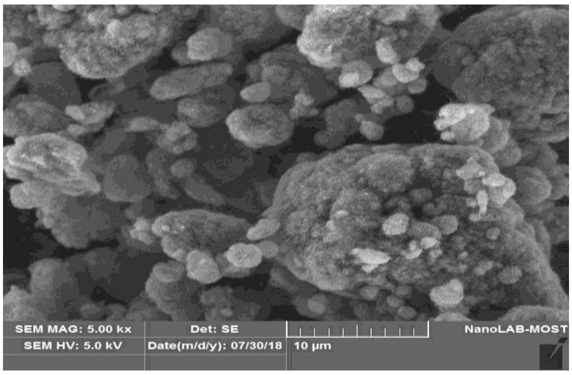

Figure 5.SEM analysis of (Pt :CNTs)

The volume of hydrogen for the electrolysis cell, It has been studied by its relationship current, voltages with the time this gas is used in the alkaline fuel cell, As shown a table.(1) and Figure 6.

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

Volume hydrogen (ml)	Current (A)	Time (min)	Voltage (Volts)
0.2	4	5	2.3
0.8	4	5	2.8
1.3	4	5	3.6
2.4	4	5	5.0
3.5	4	5	6.1
4.6	4	5	7.2
5.3	4	5	8.1
6.1	4	5	9.6

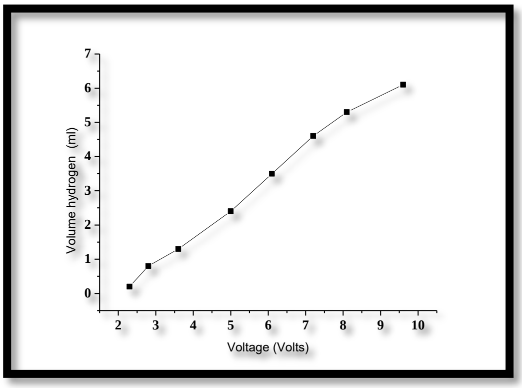

Figure 6.The relationship between Volume of hydrogen and voltage

Hydrogen gas, As described above, It has been pumped into the cell via the anode of the catalyst (Pt :CNTs), Which in turn decomposes hydrogen molecules into atoms and then into protons and electrons passing through an external charge circuit (OH-1) in the opposite direction from the cathode through the electrolyte solution to the anode electrode . When the oxygen molecules break down at the cathode electrode to combine with the electrons traveling through the outer load circuit to be a water molecule again at the anode electrode accompanied by a rise in basal cell temperature For more than 60° , To obtain a voltage of 1.76 volts and a current of 3.5 A, As shown in figure 7.

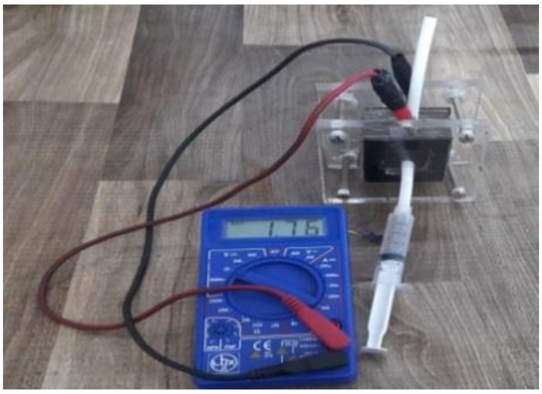

Figure7.fuel cell of electricity production

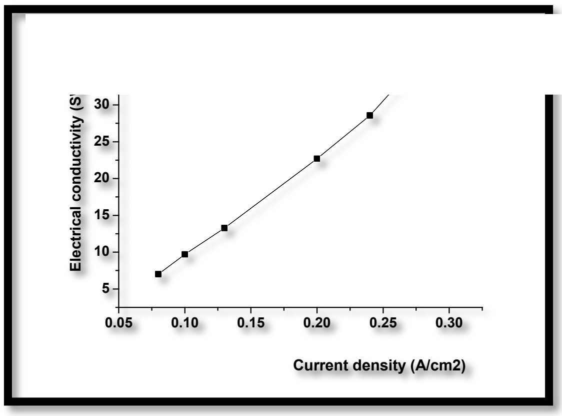

Figure 8. The relationship between current density -Electrical conductivity

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 the fuel cell in an electrochemical process (Pakkanen, 2007). The actual voltage output of a real fuel cell is less than the ideal voltage dynamically expected. Moreover, The greater the current derived from the fuel cell, The lower the voltage output of the cell, Limiting the total energy that can be connected. Electrical conductivity increases with an increase in the current density, As shown in the table (2) and Figure 8. The voltage of fuel cell decreased with the current density, As shown in Figure 9. additionally the current supplied by a fuel cell is directly proportional to the amount of fuel consumed. Therefore, as fuel cell voltage decreases, The electric power produced per unit of fuel also decreases.

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

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

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

Electrical conductivity (S\cm)	Current (A)	Current density (A/cm^2)	Voltage(V)	Power (Watt)
7.01	1.08	0.08	1.76	1.9
9.71	1.4	0.1	1.65	2.31
13.29	1.78	0.13	1.53	2.72
22.69	2.8	0.2	1.41	3.95
28.58	3.4	0.24	1.36	4.63
36.54	3.9	0.28	1.22	4.76

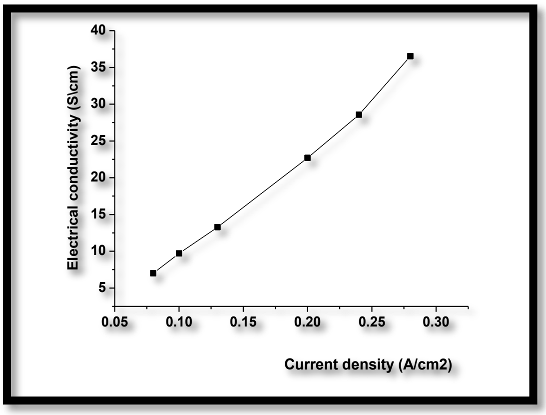

Figure 9. The relationship between voltage - current density

IV. Conclusions

The dispersion of Pt nanoparticles on the CNT surface formed (Pt :CNTs). The results showed an improved X-ray diffraction pattern. All the materials involved in the manufacture of the cell electrolysis are simple primary materials and cheaply available in the local market. Alkaline fuel cell developed so that nanotubes used as a catalyst and a coating material to the cell to accelerate the process of interaction as well as increase the surface area to the electrodes. This study found that the increase in the volume of hydrogen increases the current, as well as the electrical conductivity with increasing the current density. While voltage with decreasing the current density.

V. References:

Akira, F.;Xintong, Z.and Donald. A.T.*(2007)* .*International Journal of Hydrogen Energy* 32,2664–2672.

Chanchal, G.; Priyanka, H.; Maheshwari, S.; Sasikala, A.and MathurR.B. (2014 *). Mater Renew Sustain Energy* 3:36 DOI10.1007/s40243-014-0036-3.

Elena, S.; Guillermo, R.; Javier, G.and Martınez, K. (2009).*Renewable and Sustainable Energy Reviews* 13 .2373–2384.

Ermete A. (2009 *).Applied Catalysis B: Environmental* 88 , 1–24.

Jianshe, W.;Changhai, L.; Mohammad, N.B.; Niancai, C.;Adam, R.;Suidong, W. and Xueliang S. (2016) *International Journal of Hydrogen Energy*, Volume 41,Issue 2, 12, Pages 936-943.

Kenneth, B.K.;Teo, C.S.; Manish, C. and William I.M.(2003). *American Scientific Publishers* ,Volume X: Pages (1–22) ISBN: 1-58883-001-2/$35.00.

Nengwu, Z.;Jianjian, H.; Weihang, S.;Lixing, T.;Pingxiao, W. andHaiqin, M. (2015) . *Int.. J. Electrochem. Sci.*, 10 , 2634 – 2645.

Pakkanen, A.(2007) masters degree of programmers in renewable energy, University of Jyvaskyla

Stepanov,L.;Golubev,A.N.; NikitinS.I. and Osin,Y.N, (2014). *Rev.Adv. Mater. Sci*. 38 , 160-175

Theeraporn, P. and Thapanee S.(2017) .*Rev. Adv. Mater. Sci*. 52, 107-112.

Tzyy-Lung, L.Y.;Hsiu-Li, L.; Po-Hao, S. and Guan-Wen, W.(2012*) . The Open Fuels & Energy Science Journal,5*, 28-38.

Wei, Z.;Ravi,S.and Silva,P. (2011). *Rev.Adv.Mater. Sci*. 29 , 1-14.

Wenzhen, L.; Changhai, L. and Weijiang Z.(2003) .,*J. Phys. Chem*. B, 1076292-6299

Zhang, W.;Sherrell, P.; Minett, A.I.; Razal, J.M. and Chen, J.(2010). *Energy Environ. Sci*. 3,1286–1293..