Preparation and Study the Effect of MgO Nano Photocatalyst for HHO Electrolysis cell Application to produce hydrogen

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الخلاصة

تم تحضير الحفاز الضوئي النانونوي (MgO) من المواد الأولية لها . يشير تحليل نتائج حيود الأشعة السينية (XRD) إن الغشاء المحضر ذو تركيب متعدد البلورات، وهي متوافقة مع الجداول القياسية. وقد تم دراسة طوبوغرافية سطح المادة باستخدام مجهر القوة الذرية (AFM)، اذ أظهرت النتائج بان المادة ذات بنية نانومترية. قمنا بتصميم خلية التحليل الكهربائي(HHO) من زجاج بايركس ، تم تحضير الأقطاب النانويه من SnO2 /Al2O3، ودراسة تأثيرإضافة الحفاز الضوئي على حجم إنتاج الغاز، وتاثير تغير التيار على الحجم بمرورالزمن.

الكلمات المفتاحية

خلية التحليل الكهربائيHHO ; الحفاز الضوئي النانوي ; الأقطاب النانويه من SnO2 /Al2O3.

Abstract

MgO nano photocatalyst is successfully synthesized from its raw materials. The X-ray diffraction analysis indicates that the prepared films are polycrystalline structure, which is compatible with standard tables. The morphology of (MgO) nanoparticles, is examined by using the atomic force microscope (AFM). It shows that it is constructed from nanostructure materials. HHO electrolysis cell of glass Pyrex has been designed for this study. SnO2/Al2O3 electrodes is prepared as well. The effect of adding nano photocatalyst on the volume of gas production was studied. In addition, the effects of current and time on the volume are investigated.

Keywords

HHO electrolysis cell; Nano photocatalyst; SnO2/Al2O3 nano electrodes.

Introduction

Hydrogen has been used in many fields such as military, industry and trading [1]. It becomes the promising fuel for future applications; therefore hydrogen production methods have drawn significant interest nowadays. Investigations on electrolytic hydrogen production have been precisely done for more than century. Among the available methods, photo-catalytic splitting of water into hydrogen and oxygen has economic benefits. yet, the semiconductor mediated water splitting has been studied by many researchers [2]. Nanomaterials have received high attention at the last few years due to their small size and large surface area [3]. The coating of MgO on TiO2 resulted in threefold increase the catalytic activity of TiO2 for the degradation of cationic surfactants [4]. The crystal structure, shape and size of ZnO/MgO nanoparticles were studied by Chaitanya Lakshmi [5]. The reaction of aluminum (Al) with aqueous alkaline solutions to generate hydrogen was described early [6]. As well as the texture of Al2O3-SnO2 binary oxides system obtained via sol–gel chemistry was studied by Kirszensztejn [7].

The aim of this research is to design HHO Electrolysis and to prepare (MgO) as nano Photocatalyst and study its effect on the hydrogen production.

Experiment

MgO photocatalyst was prepared by dissolving Mg (CH3COO)2. 2H2O in ethanol. Then NaOH solution was titrated into the above solution under ultrasound. After it being sonicated about (20) min, transparent solution could be achieved. All organic substances were removed by reduced distillation. Then it was dried at (50) °C for about (1.5) h under vacuum condition. Finally, MgO nano-particles with different sizes could be obtained by calcination as shown in fig. (1).

Fig.(1):Nano MgO substance preparation.

In this study, aluminum is used as substrate. For SnO_2 deposition, the aluminum wafers were chemically etched in dilute hydrofluoric acid to remove native oxides. Subsequently, after oxide removing, the substrates were located in vacuum chamber to fabricate the SnO_2/Al_2O_3 heterojunction. Crystalline SnO_2 films were deposited on cleaned aluminum substrates using, (8) ns, Nd:YAG laser at (532) nm. The laser beam was focused on high purity SnO_2 target using (4) cm positive lens. The substrates were placed at (5) cm distance from SnO_2 target. The chamber was kept at vacuum pressure of (10^{-3}) mbar. The SnO_2 target was ablated from (10 to 80) pulses (5–20) min to get thin films.

HHO Electrolysis cell was successfully designed and manufactured for this study. Fig. (2) shows the cell which constructs of glass Pyrex cylinder. It contains two holes one for entering the thermometer and the other for exiting the gas. As well as the cell includes a quartz lens to enter the optical beam. The electrodes SnO_2/Al_2O_3 on a serial form P-N-P-N-P-N, where (p) represent positive electrode and (N) for negative electrode. different amount of currents were applied and then the volume of produced hydrogen at each current was measured.

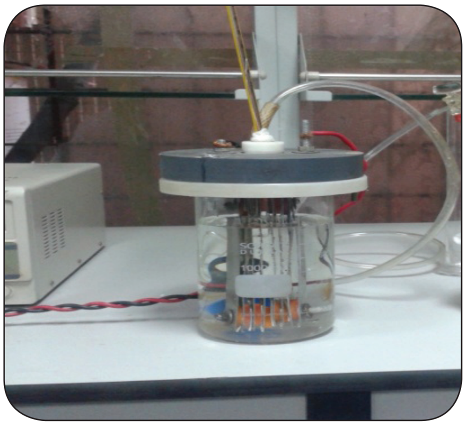

Fig. (2) Setup of hydrogen production.

The purity and structure of electrodes and photocatalyst were examined by X-ray diffraction. X-ray diffraction device (XRD-6000 Shimadzu Japan) was used in this study. The system use (Cu Kα radiation line of wavelength of (1.54) Å in 2θ˚ range from (10˚ - 90˚).

Surface topology was deliberated by Atomic Force Microscopy (AFM).

Results and Discussion

Fig. (3) shows the X-ray diffraction patterns of the (MgO) nanoparticles. XRD peaks were found at 2θ values of (33.5^{o}), (57^{o}) and (64^{o}), referring to diffraction from (111), (110) and (002) planes.

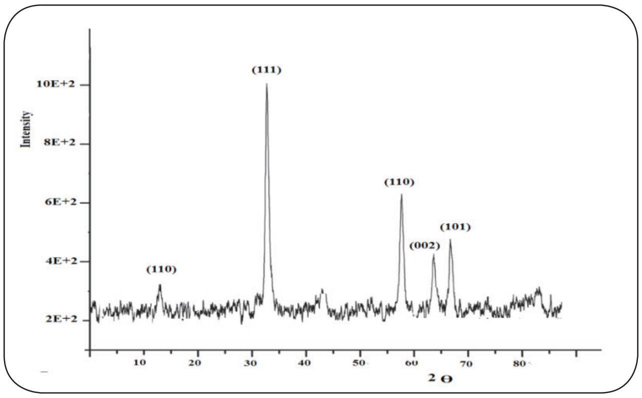

Fig. (3): X-ray diffraction pattern of MgO nanoparticles.

The X-ray diffraction pattern of the SnO_2/Al_2O_3 films was shown in Fig. (4). The peaks of (29.1^{o}), (49^{o}) and (52^{o}), were corresponding to diffraction from (101), (002) and (110) planes.

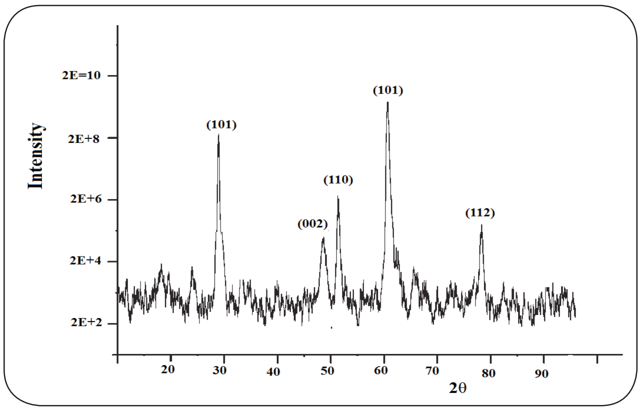

Fig. (4): X-ray diffraction pattern of nano SnO_2/Al_2O_3 electrod.

The AFM image was shown in Fig. (5). The result shows that MgO is homogenous and the distribution of granules is uniform.

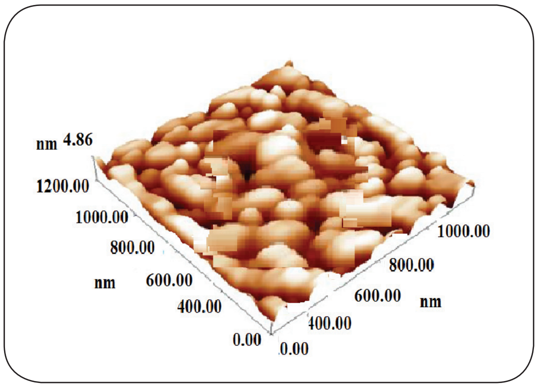

Fig. (5): Atomic force microscope of MgO nanoparticles.

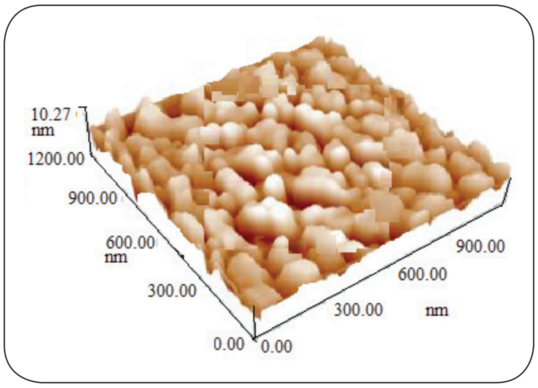

Fig. (6): Atomic force microscope of SnO2/Al2O3 electrode.

In addition AFM image of SnO_2/Al_2O_3 was shown in Fig. (6). The image demonstrates more homogeneity and smaller size compared to MgO image.

To study the photocatalyst activity, the hydrogen production was investigated with and without MgO nanoparticles as photocatalysts. As shown in Table (1).

Table (1): Determination of HHO Electrolysis cell characteristic

Volume H_2 (ml)		Time (min)	Voltage (Volts)	Current (Amp)	Electrical Power (P)	Resistance (R)
Without Photocatalysts	With Photocatalysts					
2	4.2	0.5	12	2.4	28.8	5
3.5	6.1	1	12	3.5	42	3.42
9.1	11.3	1.5	12	4.2	50.4	2.86
14.4	17.2	2	12	4.9	58.8	2.45
18.6	21.1	2.5	12	5.3	63.6	2.26
23.3	26.5	3	12	6.1	73.2	1.97

the existence of hydrogen production increased with photocatalysts compared to that without photocatalysts. The variation of the volume with increasing time at constant voltages (12) V was shown in Fig. (7).

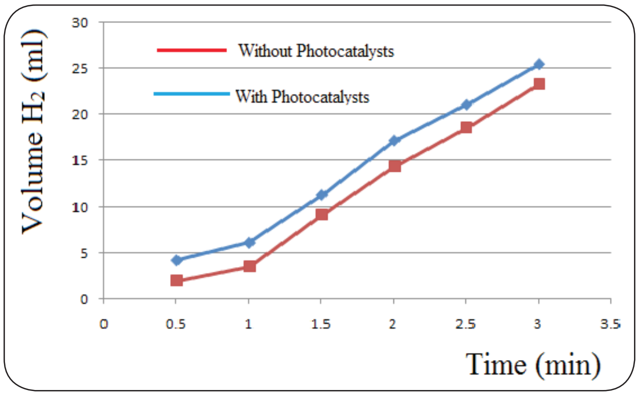

Fig. (7): The relationship between volume and time

It is clear from this Fig. that the volume of the hydrogen production is directly proportional with time. It can be observed that the gas production increases sharply with time. Never the less, the production of hydrogen increased strongly by the presence of photocatalysts compared with the increment without photocatalysts. This may due to the addition of photocatalysts speeds up the interaction process. It is obvious from Fig. (8) that there is a positive relationship between current and volume of the hydrogen production.

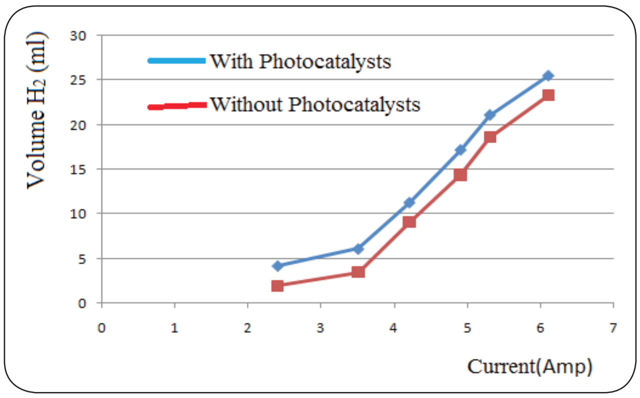

Fig. (8): The relationship between volume and current

Adding the photocatalyst to the interaction in the electrolytic cell resulted in saving energy by increasing the production of chemical reactions. As well as it speeded up the formation due to the large surface area. This allows more number of photons that hit the catalyst and large adsorption capacity will result. Furthermore it reduced pollution by reducing the byproducts of the interactions.

Conclusion

It was found out that the increment in the volume of gas with photocatalysts is more efficient. It can be observed that the gas production increases sharply with time as well as with current. Most of the photocatalysts used to produce hydrogen are heterogeneous catalysts.

Reference

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