

The Application of Diamond Electrode^{*} in Producing Hydrogen

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Abstract: This paper introduces an approach of producing hydrogen by using impurity diamond electrodes in water electrolysis. Diamond electrode shows a high voltage, so it has a capability of anticorrosion, and producing hydrogen can be increased in water electrolysis, and can be used to treat waste water. It can form a cycle system of green energy resource by combining solar energy cell with fuel cell.

Key words: electrolysis water; hydrogen production; diamond electrode; solar energy; fuel cell

CLC number: O646.51 **Document code:** A **Article ID:** 0529-6579 (2005) S2-0011-03

1 Introduction

The application and development of the new energy resources have become more and more important due to shortness of fossil fuels such as petroleum, natural gas and coal. Besides solar, wind and geothermal energy, hydrogen leads to important role in the fields of energy consumption of the world in 21st century. It is clean, abundant and reproductive^[1,2].

There are many methods to produce hydrogen. Electrolysis of water is main method but it consumes more energy. There are almost 300 factories to produce hydrogen using water electrolysis and the energy consuming is over 1 billion kW per year^[3] in this way. Only if uniting the technology of solar energy (using a renewable source), water electrolysis can be used to produce hydrogen in large scale.

2 Diamond electrodes

Traditional electrode materials are platinum, tantalum and alloy etc^[4,5] in water electrolysis, and platinum's properties are superior but very expensive, so it cannot be used in large scale. We make a study of the impurities diamond electrodes. The results indicate that its properties are better than platinum's. Diamond electrodes have high voltage window of 3.0V in water solution, while platinum electrode voltage is 1.5V in same condition^[6,7]. (see Fig. 1)

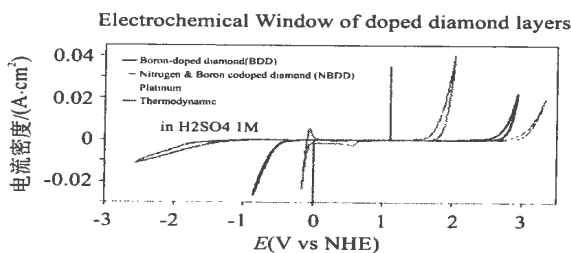


Fig 1 Electrochemical potential windows of different type of electrodes

3 Application of diamond electrode in producing hydrogen

Diamond electrodes show a high voltage, in that hydrogen evolution is increased.

A series of experiments were made on testing the performance of diamond, platinum and tantalum electrodes. These results demonstrate that current density of diamond electrodes is as twice as platinum's. (it is illustrated as follows).

Moreover, diamond electrodes possess several important properties including stability, anticorrosion and long-life, it can be insured that the electrodes have chemical inertness and reactive activity, and also have evident advantage in price. So it has a great future in the field of waste water treatment. It has an evident effect for treating waste water with diamond electrodes by electrolysis. For example, treating waste water which COD is 10 000 mg/L, electrolysis with diamond electrodes can make COD decrease by 90% in the short period.

* 收稿日期: 2005-07-10

基金项目: 天津市自然科学基金资助项目 (023602511)

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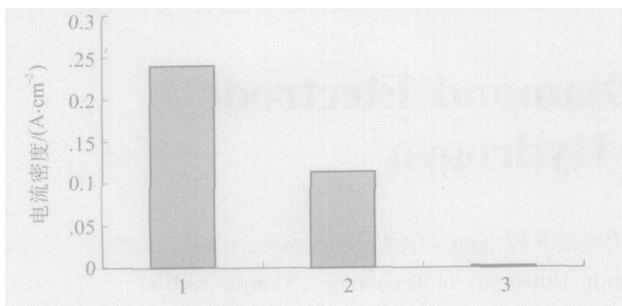
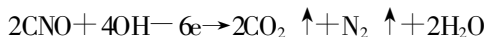
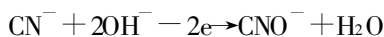


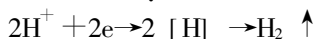
Fig 2 Comparative experiment of electrolyze water to hydrogen production

1—Impure Diamond Electrode
2—Platinum Electrode 3—Tantalum Electrode

Setting an example for treating cyanic water, we can specify the processes of producing hydrogen and treating waste water by electrolysis:



Cathode Side;



Cyanogens are oxidized as the inorganic nonpoisonous products on anode side, while hydrogen is produced on cathode side. Waste water is treated with diamond electrodes, which makes waste water come to standard level of discharging.

4 Circulatory system of energy

Diamond electrodes are fully used to treat waste water. In this way contaminants can be oxidized on anode side, while hydrogen is produced on cathode side. A fuel cell uses this hydrogen as a feedstock to generate electricity which it can be back to electrolysis system of treating waste water. That forms a cycle system, which can be combined with a light-cell of solar energy to treat waste water (see Fig. 3).

Electrolyzing system starts to operate by a light-cell of solar energy. Hydrogen produced is transferred into hydrogen store-tank which can be used as a feedstock of a fuel cell to generate electricity. In this way, the system of waste water treatment can be run continuously without input of electric energy. If hydrogen is surplus in some period, it will be delivered to outside system in the form of fuel.

The energy efficiency of fuel cell is about 60%. The average efficiency of the proton exchange membrane fuel cell (PEMFC) is about 62.2%, namely 62.2% hydrogen energy transforms to electric energy, while the rest of

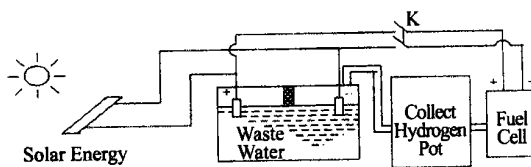


Fig 3 Circulatory system of waste water treatment with solar energy-fuel cell

hydrogen is consumed in the form of heat.^[8] Electrolytic temperature is about 70~80 °C in the trough of producing hydrogen. So when the heat from a fuel cell is used to heat the electrolysis trough, which gives a high efficiency.

5 Results

The proceeding mention confirms that the cost of producing hydrogen can be greatly reduced using impurities diamond electrodes (high hydrogen evolution, electrode long-life, low cost), so using diamond electrodes to produce hydrogen is the most prospects for future. Specially, using this method to treat waste water, fuel cells can be combined with light-cell of solar energy to form a circulatory system of green energy source, which will give a high efficiency.

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金刚石电极在电解水制氢中的应用

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摘 要：掺杂金刚石电极电势窗宽，用于电解水制氢，产氢率高，电极有很强的防腐功能，可以进行电解法污水处理，结合太阳能电池、燃料电池可以构成绿色能源环保系统。

关键词：电解水；制氢；金刚石电极；太阳能；燃料电池

中图分类号：0646.51