Platinum Based Catalyst for Improved Glucose Fuel Cells and Continuous Glucose Sensors

Patent Title:	Methods and Apparatus for the Oxidation of Glucose Molecules
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EP Patent No:	EP 1 341 603 B1
Chinese Patent No:	ZL 01804931.1
Versitech Ref No:	IP00038

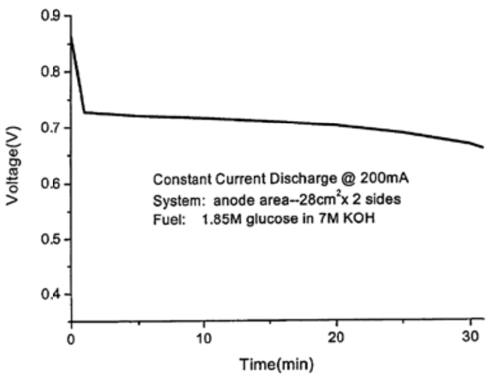
This invention describes a platinum based catalyst that can be used in glucose-air fuel cells with good performance at room temperature. It can also be applied as a key electrode material in a sensor for detecting glucose concentration in neutral or alkaline media.

Market Opportunity

Fuel cells can have a very high efficiency in converting chemical energy to electrical energy, especially when they are operated at low power density and use pure hydrogen and oxygen as reactants. A recent study by SBI Energy predicts the fuel cell market could possibly reach over US$1 billion by 2014. This has drawn much interest from renewable energy investors. According to another report provided by Fuel Cell Technologies, the fuel cell was estimated at nearly US$598 million in 2010 and could double to $1.22 billion by 2014. This signifies a Compound Annual Growth Rate (CAGR) of about 20%. [1].

These forecasts suggest a favorable opportunity for our platinum based catalyst invention. Furthermore, the catalyst is not only limited to the fuel cell market – it can also be used for continuous glucose sensors. The National Diabetes Fact Sheet of America [2] shows that 25.8 million people or 8.3% of the population in the United States are suffering from diabetes. They would all potentially benefit from a convenient glucose monitoring technology, which is a growing market. Frost and Sullivan issued two separate reports on the European and North American markets in 2010 that predict significant growth. In Europe the continuous glucose monitoring market is still in the development stage and revenues are expected to reach US$ 52.0 million by 2016. In North America, total revenue is expected to grow at a CAGR of 5.6% from 2009 to 2016 and reaching $5.23 billion by 2016.

The HKU Invention



This invention relates to inorganic catalysts and their use in the oxidation of organic molecules. Electrochemical oxidation of glucose has been studied as a method to detect dissolved glucose in blood or other media. Currently, enzyme electrodes are used in commercial blood glucose sensors. However, there are some drawbacks including limited shelf life, low tolerance to elevated temperature and cost. The poor performance of these catalysts is also a major reason why no workable glucose-air fuel cell has been presented in the past.

The current invention provides the composition of an inorganic catalyst that allows direct oxidation of organic molecules, including carbohydrates and short chain alcohols with very low oxidation potential and moderate to high current density. A direct glucose-air fuel cell prototype using the catalyst has demonstrated a peak power density of 3mW/cm^2 at room temperature with an open circuit voltage of 1.08V.. The discharge curve of this fuel cell is shown in the figure. These results exceed those achieved by methanol-air fuel cells which are the main contender in the portable fuel cell market. The use of glucose as a power source for consumer electronics devices has many advantages compared to methanol and other fuels. It is inexpensive, easily available, conveniently stored, non-toxic and safe.

The current invention discloses that by adding cobalt or its oxides to platinum, the activity for glucose oxidation can be markedly increased in neutral and alkaline media compared to the use of other precious metals like iridium, ruthenium, rhodium and gold. The results previously achieved with glucose-oxygen fuel cells showed power densities only in the microwatts per sq. cm compared to the above stated 3 mW/cm^2 at room temperature.

In addition, the applicability of this electrocatalyst as a glucose sensor is also proven in a flow injection analysis setup. The corresponding dynamic linear response range for the glucose concentration and comparison tables with other electrocatalysts are provided in the full patent document.

About the Lead Inventor

Kwong-Yu Chan is a Professor in the Department of Chemistry, the University of Hong Kong. He has a B.Sc. from the University of Alberta and an M.S. and a Ph.D. from Cornell University, all in Chemical Engineering. He worked briefly as an assistant lecturer in Hong Kong Polytechnic, as an engineer in Hong Kong Oxygen & Acetylene Company and as a research associate at Case Western Reserve University. At HKU, he has maintained an active research program on molecular simulation and materials for fuel cells and electrochemical applications. He has published over 130 papers on various topics in electrochemistry, physical chemistry, and materials. Currently, he is the Asian editor of Journal of Experimental Nanosciense.

References

[1] http://www.renewablepowernews.com/archives/1783
[2] http://www.diabetes.org

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