Enhanced Polymer Membrane Improving Direct Methanol Fuel Cell Performance

Patent Title:	Polymer Composite Membrane and Method of Making the Same
US Patent No:	7,459,487
Versitech Ref No:	IP00147

This invention describes the benefits and the method of manufacturing of a modified Nafion® polymer electrolyte membrane that can significantly improve the performance of direct methanol fuel cells (DMFC).

Market Opportunity

The global fuel cell market is forecast to mushroom in the coming years. According to BCC Research [1], the global fuel cell market will reach US$ 13 billion by 2012, up from US$ 1.7 billion in 2007, representing a staggering Compound Annual Growth Rate (CAGR) of 50%. Allied Business Intelligence, meanwhile, reports the fuel cell market will exceed US $16 billion in total sales by 2011 and thus achieve a CAGR of 51% from 2005 to 2011 [2]. Pike Research has announced that they believe the current period of product development will lead to commercialization of portable fuel cells at an increasingly larger scale from about 2015 [3].

While slightly varying in numbers, these market forecasts all project a very high growth rate for the fuel cell market in general and for the portable fuel cell market in particular. According to Frost & Sullivan, DMFC technology is a prospective technology for portable applications as compared to hydrogen powered devices because methanol is easier to handle and it promises more energy density for a given volume of fuel. Technological glitches such as methanol crossover, platinum loading, efficient membranes for ion conductivity, methanol cartridges infrastructure and low efficiency (reported efficiency is in the range of 25 to 40%) have been the main technological issues slowing the pace of commercialization. Frost & Sullivan state that improvements in membrane technology have the potential to speed up the process of commercialization of portable fuel cell applications.

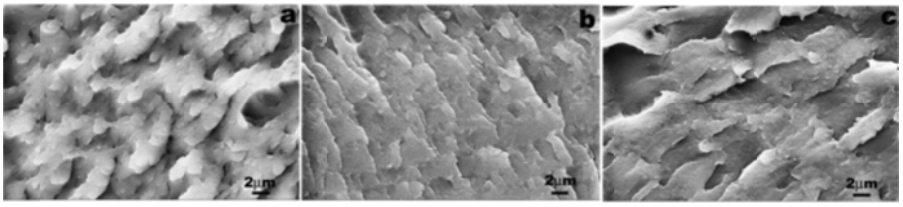
The HKU Invention

Direct methanol fuel cells (DMFC) can be used to replace existing batteries in portable electronic products such as laptops computers and mobile phones.

DMFC needs a membrane to separate the anode and cathode contents but, at the same time, to allow ionic conductivity within the fuel cell. Nafion®, a perfluorosulfonic polymer, is a proton electrolyte membrane and is widely used in fuel cells for operation under room temperature and up to 180 °C. Various attempts have been made to either replace Nafion® or to form a composite membrane. However, such attempts have drawbacks such as reduced proton conductivity, additional cost and instability.

The current invention introduces a composite membrane that supports both low methanol permeability and high proton conductivity, and thus improves the performance of a DMFC. The making of this membrane is based on commercially available Nafion® membranes.

Specifically, this polymer composite membrane uses polyfurfuryl alcohol (PFA) in various contents to fill the internal pores of the polymer member. This is achieved by subjecting the perfluorosulfonic polymer to a furan-based monomer, followed by polymerization of the latter. The figure shows some SEM images of different types of this material ((a) Nafion 115, (b) Nafion–5.4PFA, (c) Nafion–12.4PFA). The actual performance of the Nafion-PFA composite membrane in an anode-membrane-cathode (MEA) assembly with 10% (vol) methanol in water as fuel under ambient air at room temperature and at an elevated temperature has been experimentally proven. The peak power density in the PFA modified MEA is more than ***three (3) times*** that of the MEA using an unmodified Nafion membrane (e.g. 5 mW/cm^{-2} vs. 1.6 mW/cm^{-2} for Nafion-4.7PFA at room temperature).



About the Lead Inventor

The lead inventor of this invention is Prof Kwong Yu Chan, who is a Professor with the Department of Chemistry at the University of Hong Kong. His main interest is in electrochemical and materials technologies for cleaner energy and environment.

References

[1] http://www.bccresearch.com/report/EGY047A.html

[2] http://www.stocksjournal.com/pwac.cfm

[3] http://www.pikeresearch.com/research/fuel-cells-for-portable-power-applications

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