Direct Methanol Fuel Cell Corporation

COMMITTED TO FUEL CELL COMMERCIALIZATION

Direct Methanol Fuel Cell Corporation, founded in 2001, believes that the first commercial mass market for fuel cells will be in portable electronics such as notebook computers and mobile phones where consumers and companies have already demonstrated a willingness to pay a premium for convenience and increased productivity.

SPECIALIZED IN FUEL INFRASTRUCTURE

Fuel cells produce electricity as long fuel is provided. Widespread and low cost availability of safe packaged fuel is critical to the successful commercialization of fuel cells. DMFCC is developing a global network of cartridge manufacturers and distributors to provide the industry with a robust fuel infrastructure.

PROVIDING NEEDED PATENT PROTECTION

DMFCC willing provide the protection of the Caltech/USC patents to fuel cell manufacturers and OEMs, thus removing any potential roadblock to commercialization.

DMFCC's Chief Executive Officer and Founder is Dr. Carl Kukkonen, who was formerly a Caltech employee and served as Director of the Center for Space Microelectronics Technology at the NASA Jet Propulsion Laboratory (JPL). Prior to joining JPL, Dr. Kukkonen was at Ford Motor Company where he was the Company's expert on hydrogen as an alternative automotive fuel. Dr. Kukkonen received his Ph.D. in Theoretical Physics from Cornell University.

Direct Methanol Fuel Cell Corporation

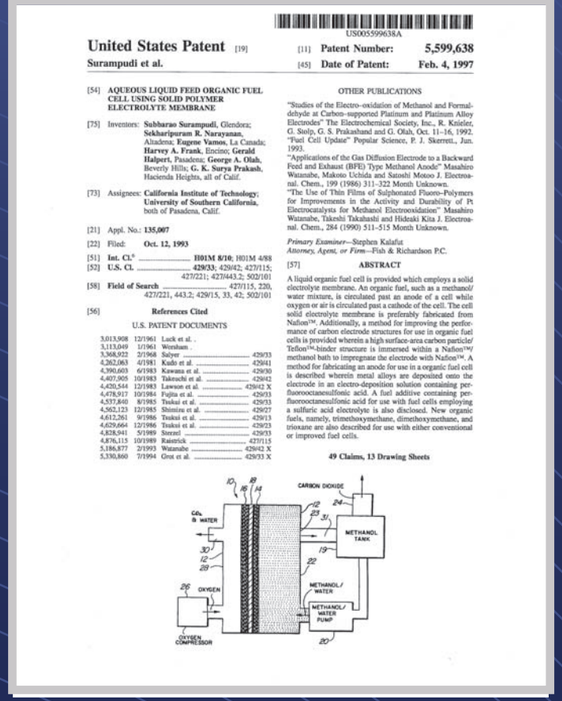
Dr. Carl Kukkonen
171 N. Altadena Drive
Pasadena CA, 91107
Ph: 626-768-3375
Fax: 626-578-9063
kukkonen@dmfcc.com

Direct Methanol Fuel Cell Corporation

Packaging Energy for the Fuel Cell Industry

Disposable Fuel Cartridges

Intellectual Property Protection for Direct Liquid Hydrocarbon Fuel Cells



US005599638A

United States Patent [19]
Surampudi et al.

[11] **Patent Number: 5,599,638**
[45] **Date of Patent: Feb. 4, 1997**

[54] **AQUEOUS LIQUID FEED ORGANIC FUEL CELL USING SOLID POLYMER ELECTROLYTE MEMBRANE**

[75] Inventors: **Subbarao Surampudi**, Glendora; **Sekharipuram R. Narayanan**, Altadena; **Eugene Vamos**, La Canada; **Harvey A. Frank**, Encino; **Gerald Halpert**, Pasadena; **George A. Olah**, Beverly Hills; **G. K. Surya Prakash**, Hacienda Heights, all of Calif.

[73] Assignees: **California Institute of Technology**; **University of Southern California**, both of Pasadena, Calif.

[21] Appl. No.: **135,007**

[22] Filed: **Oct. 12, 1993**

[51] **Int. Cl.**[6] **H01M 8/10**; H01M 4/88
[52] **U.S. Cl.** **429/33**; 429/42; 427/115; 427/221; 427/443.2; 502/101
[58] **Field of Search** 427/115, 220, 427/221, 443.2; 429/15, 33, 42; 502/101

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,013,908	12/1961	Luck et al.	
3,113,049	1/1961	Wernham	
3,368,922	2/1968	Salyer	429/33
4,262,063	4/1981	Kudo et al.	429/41
4,390,603	6/1983	Kawana et al.	429/30
4,407,905	10/1983	Takeuchi et al.	429/42
4,420,544	12/1983	Lawson et al.	429/42 X
4,478,917	10/1984	Fujita et al.	429/33
4,537,840	8/1985	Tsukui et al.	429/33
4,562,123	12/1985	Shimizu et al.	429/27
4,612,261	9/1986	Tsukui et al.	429/13
4,629,664	12/1986	Tsukui et al.	429/33
4,828,941	5/1989	Stonel	429/33
4,876,115	10/1989	Raistrick	427/115
5,186,877	2/1993	Watanabe	429/42 X
5,330,860	7/1994	Grot et al.	429/33 X

OTHER PUBLICATIONS

"Studies of the Electro-oxidation of Methanol and Formaldehyde at Carbon-supported Platinum and Platinum Alloy Electrodes" The Electrochemical Society, Inc., R. Kriseler, G. Sioly, G. S. Prakashand and G. Olah, Oct. 11-16, 1992.
"Fuel Cell Update" Popular Science, P. J. Skerrett., Jun. 1993.
"Applications of the Gas Diffusion Electrode to a Backward Feed and Exhaust (BFE) Type Methanol Anode" Masahiro Watanabe, Makoto Uchida and Satoshi Motoo J. Electroanal. Chem., 199 (1986) 311–322 Month Unknown.
"The Use of Thin Films of Sulphonated Fluoro-Polymers for Improvements in the Activity and Durability of Pt Electrocatalysts for Methanol Electrooxidation" Masahiro Watanabe, Takeshi Takahashi and Hideaki Kita J. Electroanal. Chem., 284 (1990) 511-515 Month Unknown.

Primary Examiner—Stephen Kalafut
Attorney, Agent, or Firm—Fish & Richardson P.C.

[57] **ABSTRACT**

A liquid organic fuel cell is provided which employs a solid electrolyte membrane. An organic fuel, such as a methanol/water mixture, is circulated past an anode of a cell while oxygen or air is circulated past a cathode of the cell. The cell solid electrolyte membrane is preferably fabricated from Nafion™. Additionally, a method for improving the performance of carbon electrode structures for use in organic fuel cells is provided wherein a high surface-area carbon particle/Teflon™-binder structure is immersed within a Nafion™/methanol bath to impregnate the electrode with Nafion™. A method for fabricating an anode for use in a organic fuel cell is described wherein metal alloys are deposited onto the electrode in an electro-deposition solution containing perfluorooctanesulfonic acid. A fuel additive containing perfluorooctanesulfonic acid for use with fuel cells employing a sulfuric acid electrolyte is also disclosed. New organic fuels, namely, trimethoxymethane, dimethoxymethane, and trioxane are also described for use with either conventional or improved fuel cells.

49 Claims, 13 Drawing Sheets

Disposable Fuel Cartridges for Notebook Computers Mobile Phones Portable Electronic Devices

DISPOSABLE CARTRIDGE DESIGN & SAFETY CERTIFICATION

Direct Methanol Fuel Cell Corporation (DMFCC) has expertise in fuel cell cartridge design and safety certification. Since 2002, DMFCC has been working with the fuel cell industry, Underwriters Laboratories (UL), CSA International and the International Electrotechnical Commission (IEC) to develop international standards for the safety and performance of fuel cells and disposable fuel cartridges. DMFCC cartridges are designed to the highest standards, and to comply with the challenging international safety requirements.

CUSTOM DESIGN FOR YOUR APPLICATION

Recognizing that each application may require a cartridge with a different size, shape, or feature, DMFCC will work in partnership with customers to rapidly develop and patent custom disposable cartridges for their specific applications.

CARTRIDGE MANUFACTURING

DMFCC's global network of cartridge manufacturing partners are trusted suppliers to top OEMs. DMFCC can also provide safety certification and manufacturing of cartridges designed by customers. If a customer has a preferred cartridge manufacturer, DMFCC will work with that manufacturer.

GLOBAL DISTRIBUTION

DMFCC's cartridge distribution partners are developing a worldwide fuel cartridge infrastructure to support global sales of customers' portable electronic devices.

Custom Cartridge Design and Manufacturing Available

Please contact the company for further information.

Patent Protection for Direct Liquid Hydrocarbon Fuel Cells

56 ISSUED & 62 PENDING PATENTS WORLDWIDE

The direct liquid hydrocarbon fuel cell was invented and developed by the NASA Jet Propulsion Laboratory (JPL), which is operated by Caltech, and the University of Southern California (USC). Hydrocarbon fuels include methanol, ethanol, formic acid, formaldehyde, dimethoxymethane and others. Methanol is the most common fuel. Caltech/USC have 56 issued and 62 pending patents worldwide on the direct liquid hydrocarbon fuel cell technology. Direct Methanol Fuel Cell Corporation (DMFCC) has obtained a license to all of these patents. Caltech and USC are DMFCC shareholders.

EXTENSIVE PATENT COVERAGE

The Caltech patent portfolio includes the fundamental idea of a direct hydrocarbon fuel cell that uses a polymer electrolyte membrane (PEM), catalysts, construction of the anodes, cathodes, and membrane electrode assemblies (MEAs), as well as alternative membranes. Other patents include water recovery, methanol sensors and filters, monopolar/planar stacks and electrolysis of methanol to produce hydrogen. Contact the company for a copy of issued patents.

PARTNERING TO ADVANCE FUEL CELL ADOPTION

DMFCC will work cooperatively with fuel cell manufacturers and OEMs to provide them with the patent protection they need, using DMFCC's "have made", "import", and licensing rights. Instead of a license fee, DMFCC prefers to work with an OEM on a cartridge supply arrangement which would allow DMFCC to provide innovative and safe fuel cartridges specific to each fuel cell-powered device manufactured by the OEM. DMFCC and its partners will manufacture cartridges to an OEM's specifications, certify that the cartridges meet international safety standards, and distribute them on a global basis. If an OEM also desires to perform any of these functions, DMFCC is willing to work in partnership with the OEM. Using the cartridge approach, rather than requiring an upfront fee, DMFCC will share the market risk with the OEM and also will provide a valuable service by supplying cartridges to the marketplace.

www.dmfcc.com