FORM 1 THE PATENTS ACT 1970 (39 of 1970) & The Patent Rules, 2003 APPLICATION FOR GRANT OF PATENT (See section 7, 54 & 135, and rule 20(1))	(FOR OFFICE USE ONLY) Application No: Filing Date: Amount of fee paid: CBR No: Signature: 700340456

	Application No.	201941035383
	Filing date:	03:09:2019
	Amount of Fee paid:	8800/-
	CBR No:	28446
	Signature	3/9/19

1. APPLICANT'S REFERENCE / IDENTITY NUMBER. (AS ALLOTED BY OFFICE)	

2. TYPE OF APPLICATION [Please tick (✓) at the appropriate category]

Ordinary (✓)		Convention ()		PCT-NP ()	
Divisional ()	Patent of Addition ()	Divisional ()	Patent of Addition ()	Divisional ()	Patent of Addition ()

3A. APPLICANTS

Name in Full	Nationality	Country of Residence	Address of Applicant
ALVA'S EDUCATION FOUNDATION	**Indian**	**India**	**ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY SHOBHAVANA CAMPUS, MIJAR, MOODBIDRI, DAKSHINA KANNADA - 574225, KARNATAKA, INDIA**

3B. CATEGORY OF APPLICANT [Please tick (✓) at the appropriate category]

Natural Person (✓)			Others ( )

4. INVENTOR(S) [Please tick (✓) at the appropriate category]

Are all the inventor(s) same as the applicant(s) named above?	Yes ()	No (✓)

If NO furnish the details of the inventors

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SIDDHARTHA PRAKASH DUTTAGUPTA	Indian	India	DEPARTMENT OF ELECTRICAL ENGINEERING, INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY, MUMBAI, 400076

5. TITLE OF THE INVENTION

" A PROCESS FOR ENHANCING HYDROGEN FUEL CELLS PERFORMANCE WITH NAFION PROTON EXCHANGE MEMBRANE OPTIMALLY EXPOSED TO ULTRAVIOLET RAYS "

6. AUTHORISED REGISTERED PATENT AGENT(S)		NA
	Name	NA
	Mobile no.	NA
7. ADDRESS FOR SERVICE OF APPLICANT IN INDIA	Name	**ALVA'S EDUCATION FOUNDATION**
	Postal Address	**ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY SHOBHAVANA CAMPUS, MIJAR, MOODBIDRI, DAKSHINA KANNADA - 574225, KARNATAKA, INDIA**
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	Mobile No.	**09892818760/ 09920818760**
	Fax No.	**08258 - 262726**
	E-Mail ID	**rpinto1942@gmail.com**

8. IN CASE OF APPLICATION CLAIMING PRIORITY OF APPLICATION FILLED IN CONVNETION COUNTRY, PARTICULARS OF CONVNETION APPLICATION

Country	Application number	Filing date	Name of applicant	Title of invention	IPC (as classified in the convention country)
Not Applicable					

9. IN CASE OF PCT NATIONAL PHASE APPLICATION, PARTICULARS OF INTERNATIONAL APPLICATION FILED UNDER PATENT CO-OPERATIVE TREATY (PCT)

International application number: Not Applicable	International filing date: Not Applicable

10. IN CASE OF DIVISIONAL APPLICATION FILED UNDER SECTION 16,

PARTICULARS OF ORIGINAL (FIRST) APPLICATION

Original (first) application number: Not Applicable	Date of filing of Original (first) application: Not Applicable

11. IN CASE OF PATENT OF ADDITION FILED UNDER SECTION 54, PARTICULARS OF MAIN APPLICANT OR PATENT

Main application/ Patent Number: Not Applicable	Date of Filing of main application: Not Applicable

12. **DECLARATION**

i) Declaration by the inventors

(In case the applicant is an assignee: the inventors may sign herein below or the applicant may upload the assignment or enclose the assignment with this application for patent or send the assignment by post/ electronic transmission duly authenticated within the prescribed period)

We, the above named inventors are the true and first inventors for this invention and declare that the applicants herein are our assignee or legal representative.

(i)
(a) Date: 3/9/2019
(b) Signature of the inventors:
(c) Name: **PREETHAM CASTELINO**

(ii)
(a) Date: 3/9/2019
(b) Signature of the inventors:
(c) Name: **SOHAN POOJARI**

(iii)
(a) Date: 3-9-2019
(b) Signature of the inventors:
(c) Name: **SUNNY RAMNIWAS SHARMA**

(iv)
(a) Date: 3.9.2019
(b) Signature of the inventors:
(c) Name: **POOJARI PRASHANT SHEKAR**

(v)
(a) Date: 3/9/2019
(b) Signature of the inventors:
(c) Name: **CHIRAG SATISH POOJARI**

vi)
(a) Date: 3/9/2019
(b) Signature of the inventors:
(c) Name: **JAYARAMA ARASALIKE**

(vii)
(a) Date: 03/9/2019
(b) Signature of the inventors:
(c) Name: **SATYANARAYAN**

(viii)
(a) Date: 3.9.2019
(b) Signature of the inventors:
(c) Name: **RICHARD PINTO**

(ix)
(a) Date: 3-9-2019
(b) Signature of the inventors:
(c) Name: **SHRIGANESH PRABHU**

x)
(a) Date: 3/9/2019
(b) Signature of the inventors:
(c) Name: **SIDDHARTHA PRAKASH DUTTAGUPTA**

ii) Declaration by the applicant:
I, the applicant hereby declare that:-

- ☐ I am in possession of the above mentioned invention.
- ☐ The provisional/complete specification relating to the invention is filed with this application.
- ☐ The invention as disclosed in the specification uses the biological material from India and the necessary permission from the competent authority shall be submitted by us before the grant of the patent to us.
- ☐ There is no lawful ground of objection to the grant of the patent to us.
- ☐ I am the assignee or legal representative of true and first inventors.
- ☐ The application or each of the application, particulars of which are given in Para 5 was the first application in convention country/countries in respect of our invention.
- ☐ I claim the priority from the above mentioned applications filed in convention country and state that no application for protection in respect of the invention had been made in a convention country before that date by me/us or by any person from which we derive the title.
- ☐ My application in India is based on international application under Patent Cooperation Treaty (PCT) as mentioned in Para – 9.
- ☐ The application is divided out of our application particulars of which are given in Para-10 and pray that this application may be treated as deemed to have been filed on.....under section 16 of the Act.
- ☐ The said invention is an improvement in or modification of the invention particulars of which are given in Para-11

13. FOLLOWING ARE THE ATTACHMENTS WITH THE APPLICATION

(a) Form 2

Item	Details	Fee	Remarks
Complete specification	No. of Pages : 17		
No. of Claims	No. of claims : 1 No. of Pages : 1	₹8800/-	Addl. pages - N/A Addl. Claims - N/A
Abstract	No. of Pages : 1		
No. of Drawings	No. of drawings : 5 No. of pages : 5		

In case of a complete specification, if the applicant desires to adopt the drawings filed with his provisional specification as the drawings or part of drawings for the complete specification under rule 13(4) , the number of such pages filed with the provisional specification are required to mentioned here.

(b) Complete specification (in confirmation with the international application)/ as amended before the International preliminary Examination Authority (IPEA), as applicable (2 copies).

(c) Sequence listing in electronic format.

(d) Drawing (in confirmation with the international application)/ as amended before the International preliminary Examination Authority (IPEA), as applicable (2 copies).

(e) Priority document (s) or a request to retrieve the priority document(s) from DAS (Digital Access Service) if the applicant had already requested the office of first filing to make the priority document(s) available to DAS.

(f) Translation of priority document/ Specification/ International Search Report/ International Preliminary Report on Patentability.

(g) Statement and Undertaking on Form 3.

(h) Declaration of Inventor ship on Form 5.

(i) Power of Attorney.

(j) Total Fee ₹ --------- in Cheque bearing no: _____dated this _____ drawn from _____bank, _____.

We hereby declare that to the best of our knowledge, information, and belief that the fact and matters stated herein are correct and we request that a patent may be granted to us for the said invention.

Dated this 3rd day of September, 2019.

For **ALVA'S EDUCATION FOUNDATION,**

Authorized Signatory:

M. Mohan Alva

Name in full: Dr. Mohan Alva

Designation: Chairman

Seal: Chairman
Alva's Education Foundation (R)
MOODBIDRI - 574227, D.K.

To,
The Controller of Patents,
Patent Office Chennai,
Chennai – 600 032.

700340460

FORM 2
THE PATENTACT 1970
(39 of 1970)
&
The Patents Rules, 2003
COMPLETE SPECIFICATION
(See section10 and rule 13)

TITLE OF THE INVENTION

"A PROCESS FOR ENHANCING HYDROGEN FUEL CELLS PERFORMANCE WITH NAFION PROTON EXCHANGE MEMBRANE OPTIMALLY EXPOSED TO ULTRAVIOLET RAYS"

APPLICANT'S NAME AND ADDRESS

ALVA'S EDUCATION FOUNDATION

ADDRESS

ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY, as Indian having its address at SHOBHAVANA CAMPUS, MIJAR, MOODBIDRI, DAKSHINA KANNADA – 574225, KARNATAKA, INDIA

The following specification describes and ascertains the nature of this invention and the manner in which it is to be performed:

700340457

FORM 3
THE PATENTS ACT, 1970
(38 OF 1970)
&
The Patents Rules, 2003
STATEMENT AND UNDERTAKING UNDER SECTION 8
(See section 8 rule 12)

1. Name of the Applicant

We, ALVA'S EDUCATION FOUNDATION, addressed at ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY, an Indian having its address at SHOBHAVANA CAMPUS, MIJAR, MOODBIDRI, DAKSHINA KANNADA - 574225, KARNATAKA, INDIA, do hereby declare that we have not made any application for the same/substantially the same invention outside India

2. Name, address and nationality of the joint applicant. - N.A.

Name of the country	Date of application	Application No.	Status of the application	Date of publication	Date of grant
NA	NA	NA	NA	NA	NA

3. Name and address of the assignee: Not Applicable

4. To be signed by the applicant or his authorized registered patent agent: Not applicable

5. Name of the natural person who has signed

For ALVA'S EDUCATION FOUNDATION,

Authorized Signatory:

Name in full: Dr. Mohan Alva

Designation: Chairman

Seal: Chairman
Alva's Education Foundation (R)
MOODBIDRI - 574227, D.K.

To The Controller of Patents,
The Patent Office,
at Chennai

PATENT OFFICE CHENNAI 04/09/2019 16:00

FIELD OF INVENTION

The present invention is related to a process for the enhancements of efficiency of Hydrogen fuel cell (HFC) power density using nafion membrane exposed with an optimum dose of ultraviolet (UV) rays as polymer electrolyte membrane (PEM). In particular, the enhancements of efficiency of HFCs is with a novel design of hydrogen humidification setup.

BACKGROUND OF THE INVENTION

HFCs are of great interest for a variety of energy applications, especially for automotive industries due to their potential for generation of clean electrical energy with high efficiencies at a lower environmental cost than currently available energy sources. They are electrochemical devices that use humidified hydrogen along with oxygen from air, to produce electrical energy and heat. The technology of HFC devices is maturing with potential for extremely high conversion efficiencies. The advantages such as clean energy generation and high conversion efficiency will find numerous applications, especially in fuel cell vehicles of the future

The new and renewable sources of energy are continuously evolving to minimize long-term dependence on oil and other fossil fuels. HFCs are potential candidates for this purpose. These devices have the potential to be a renewable energy source, owing to their very high efficiency, high energy density, and quiet operation. The proton exchange membrane is an important component of HFC. The main function of the membrane is to allow the transport of protons generated at the anode and prevent direct contact of hydrogen and oxidant (oxygen/air). The second important component of HFCs is flow channels for the flow of humidified hydrogen at the anode and oxygen/air at the cathode. The second function of the flow field plate is the collection of electrons at anode for external delivery of power.

Various improvements in PEM fuel cells including HFCs have been devised in prior art some of the measures are as follows.

Indian Patent 201841040380 Enhancement of micro direct methanol fuel cell (μ-DMFC) performance using micro channels fabricated from <100> silicon wafer orientation and P(VDF-TrFE) coated nafion membrane as proton exchange membrane. This invention shows an enhancement of μ-DMFC performance using micro-channels fabricated from <100> silicon wafer orientation result in trepozoidal microchannels for flow of methanol in silicon; and a coating of P(VDF-TrFE) on nafion proton exchange membrane introduce the hydrophobicity resulting in reduction in methanol crossover. Both these inventions enhance the power output of DMFCs.

Indian Patent 201941009746 is for enhancement of direct methanol fuel cell (DMFC) performance with nafion proton exchange membrane optimally exposed to ultraviolet rays.This invention is for the enhancement of direct methanol fuel cell performance using nafion membrane irradiated with optimum dosage of ultraviolet (UV) rays as proton exchange membrane. Particularly, the present invention contains processes like fabrication of fuel flow channels in silicon wafers, exposure of nafion membrane to UV rays, preparation and loading of catalysts on gas diffusion layers, preparation of membrane electrode assembly and assembling of DMFCs. This invention uses UV irradiated nafion membrane as proton conducting membrane in the development of direct methanol fuel cell.

US5231954A related to hydrogen/oxygen fuel cell. In this an electrolysis cell is provided for use in connection with a combustion engine, for generating hydrogen and oxygen gases which are added to the fuel delivery system as a supplement to the gasoline or other hydrocarbons burned therein. The hazard of explosion of the mixture of generated gases is eliminated by withdrawing the gases through a connection with the vacuum line of the positive crankcase ventilation (PCV) system of the engine and by utilizing a slip-fitted top cap for the electrolysis cell, which cooperates with the PCV vacuum line to prevent explosive containment of generated

gases in case of accident. Use of the generated gases as a fuel supplement enables substantial increases in fuel efficiency, while at the same time reducing the emission of pollutants.

US6387559B1 relates to a fuel cell system and the method of forming the fuel cell system including a base portion, formed using a singular body, and having a major surface. At least one fuel cell membrane electrode assembly is formed on the major surface of the base portion. A fluid supply channel including a mixing chamber is defined in the base portion and communicating with the fuel cell membrane electrode assembly for supplying a fuel-bearing fluid to the membrane electrode assembly. An exhaust channel including a water recovery and recirculation system is defined in the base portion and communicating with the membrane electrode assembly. The membrane electrode assembly and the cooperating fluid supply channel and cooperating exhaust channel forming a single fuel cell assembly.

US4085709A relates to hydrogen fuel system for a vehicle. The system is used with an internal combustion engine, is mounted on a vehicle and is operable primarily when the vehicle is at rest for generating and storing hydrogen gas on the vehicle. The system includes a gas cylinder, an electrolyzer connected to the gas cylinder, a D.C. power supply connected to the electrolyzer and including electrical apparatus for converting A.C. current to D.C. current and a control circuit connected to the D.C. power supply, to the electrolyzer, and to the gas cylinder, all of which are mounted within the vehicle. The control circuit for controlling generation and storage of hydrogen gas is operable from and connectible to a conventional A.C. source.

US6660423 relates to a fuel cell device and the method of forming the fuel cell device including a base portion, formed of a singular body, and having a major surface. At least one fuel cell membrane electrode assembly including a plurality of hydrophilic threads for the wicking of reaction water is formed on the major surface of the base portion. A fluid supply channel including a mixing chamber is defined in the base portion and communicating with the fuel cell membrane electrode assembly for supplying a fuel-bearing fluid to the membrane electrode assembly. An exhaust channel including a water recovery and recirculation channel is defined in the base

portion and communicating with the membrane electrode assembly and the plurality of hydrophilic threads. The membrane electrode assembly and the cooperating fluid supply channel and cooperating exhaust channel forming a single fuel cell assembly.

US20090029202A1 is on fuel cell using deuterium. Disclosed are fuel cells and methods of using fuel cells involving the use of an anode input gas comprising deuterium.

US20060183015 relates to an efficient and passive micro fuel cell includes an anode plate, a reaction plate, a cathode plate and a condensation plate. The anode plate draws a dilute solution of methanol from a fuel tank to delivery to a series of upper oxidation reaction room through micro-channels by thermal capillarity. The condensation plate separates carbon dioxide and vapor from each other. Meanwhile, the methanol solution is delivered to a plurality of lower oxidation reaction rooms. Protons pass through the inner walls of the reaction holes and a porous membrane layer and arrive in the lower reduction reaction rooms. The lower reduction reaction rooms and the lower oxidation reaction rooms have reaction holes whose inner walls have carbon nanotubes and catalysts. A plurality of upper reduction reaction rooms delivers oxygen for the reduction reaction and drains the reduced water at the same time.

US20150061600A1 relates to water reactive hydrogen fuel cell power system. A hydrogen fuel cell system includes devices and methods to combine reactant fuel materials and aqueous solutions to generate hydrogen. The fuel cell system includes a fuel cell, a fuel cartridge, and a supply of pressurized aqueous solution to generate power for portable power electronics. The fuel cartridge includes a top cap with an over-molded face seal gasket that provides an offset injection point on the fuel cartridge. The aqueous solution is delivered into the fuel cartridge to generate hydrogen for the fuel cell which then produces power for the user of the electronics.

US6093501A relates to fuel cell using an aqueous hydrogen-generating process. This is an improved fuel cell system that utilizes hydrogen and air. The hydrogen of the fuel cell is derived from a hydrogen-generating process wherein H_2O is passed over a bed of iron material. The hydrogen generating process uses a catalyst, or freshly-ground iron material, or both, and generates the hydrogen for the fuel cell in situ at lower-than-normal temperatures when the H_2O reacts with the iron material. The fuel cell can be used to power a stationary system or a land vehicle, such as an automobile. The bed of iron material can be replenished periodically or continuously.

CN101579632 relates to the field of fuel-cell catalyst, in particular discloses a nickel palladium/ silicon microchannel catalyst. The preparation thereof is as follows: the step of electroless plating deposit of a nickel palladium membrane is carried out on a silicon microchannel frame, and a nickel palladium/ silicon microchannel composite material is processed by rapid annealing for 6 to 10 minutes at the temperature from 300 to 500 DEG C under the argon atmosphere. The nickel palladium/ silicon microchannel catalyst can be used for preparing the electrode of the integratable direct methanol fuel cell.

CN102751526B relates to hydrogen fuel cell, system and method thereof for dynamic varying humidity control. The present invention discloses a hydrogen fuel cell system and a dynamic and variable humidity control method; the hydrogen fuel cell stack assembly comprises an outer plate and a gas distribution device; stack assembly using the monocoque housing package; the outer panel is fixed to the gas distribution device monocoque housing, the outer panel means including an outer gas distribution plate gas distribution device for working gas flow and cooling air distribution means, the fan mount is provided on an outer plate of the gas distribution device working stream, for connection to the work of the fan, the working air stream outside plate means projecting into the housing from outside the housing interior, said heat sink means comprises a valve disposed in the outer housing, A T F N communicating with the housing interior cooling passage disposed on the housing

and the vents, the channel is provided with cooling fan on the heat sink mount for the cooling fan is connected. Hydrogen fuel cell power generation according to the present invention is to improve the efficiency, reduce costs and improve service life.

CA 2400027 relates to a membrane, in particular, a membrane for use in a methanol fuel cell. The inventive membrane comprises complexing agents for cations and, therefore, functions like an anion exchanger. In a particular embodiment, the membrane comprises complexing agents selected from the group of crown ethers, cryptates, or of cryptate-like compounds based on carbon cyclic compounds or silicon cyclic compounds.

EP 1191621 relates to an inorganically modified membrane consists of an organic sulfonated polymer and an inorganic phase made of oxides of silicon, organically modified silicon, titanium and/or zirconium. The oxides can be partially replaced by phosphates.

US6833167 relates to a methanol fuel cell comprising a membrane which conducts metallic cations, in which the metallic cations induce the transport of the charge inside the membrane and are advantageously guided in a circuit in the form of a base from the cathode chamber to the anode chamber. The inventive methanol fuel cell prevents the methanol drag associated with proton-conductive membranes, thus producing higher power outputs on a regular basis. A separate transport of the water produced by the reaction is not necessary.

WO2017084377 relates to the technical field of fuel cells, and specifically, to a novel proton exchange membrane for a methanol fuel cell. The proton exchange membrane comprises a porous anode aluminium oxide template. A nafion membrane layer is disposed on the surface of the porous anode aluminium oxide template. An inert metal layer is disposed on the surface of the nafion membrane

layer. In the present invention, the structure is compact and does not have a crackle, which effectively restrains the infiltration of methanol in the methanol fuel cell, and improves the utilization rate of the methanol of the methanol fuel cell and the service life of the methanol fuel cell; the proton exchange membrane has a simple structure and low production cost.

CN105680077 belongs to the technical field of a fuel cell, in particular to a proton exchange membrane. The proton exchange membrane is prepared from a combination comprising a sulfonated poly ether ether ketone solution, sulfonated polyphenylene oxide sppo, a polyaniline filter liquid, heteropoly acid and a titanium dioxide fluid. The proton exchange membrane has the advantages of favorable mobility and processability; with the combination of the titanium dioxide fluid, the sulfonated poly ether ether ketone solution, the sulfonated polyphenylene oxide sppo and the polyaniline filter liquid, the reduction of proton conductivity can be reduced, the methanol permeability of the composite proton exchange membrane is effectively reduced, the comprehensive performance of the proton exchange membrane is improved, the methanol permeation problem when an nafion membrane is used for a direct methanol fuel cell (DMFC) is solved, the proton conductivity is also not reduced, and the requirement for PEM used by the DMFC is met; and the proton exchange membrane can be used for the DMFC and also can be used for an alcohol fuel cell such as a direct ethanol fuel cell.

US6846584B2 relates to the process for generating electricity with a hydrogen fuel cell. The object of the invention is the coupling of a hydrogen fuel cell to an enzymatic process for the production of electricity and the transformation and sequestration of CO2. Gaseous CO2 emissions from processes such as hydrocarbon reforming are transformed into carbonate or bicarbonate ions and hydrogen ions by the enzymatic system in order to prevent their contribution to the greenhouse effect. The hydrogen ions resulting from the enzymatic process are recovered and combined in order to supply the hydrogen fuel cell. Finally, water, a

by-product of the oxidizing reaction of the hydrogen fuel cell, is recovered and recycled back into the aqueous enzymatic system.

WO2016205972 discloses a poly(oxadiazole aryl ether-co-bisphenol fluorine) proton exchange membrane and a preparation method thereof. The proton exchange membrane is obtained by one step; specifically: mixing and reacting a base polymer obtained from a decafluorobenzadiazole and bisphenol fluorine copolymer with a functionalized reagent and forming a membrane to obtain the proton exchange membrane. The reaction with the functionalized reagent is primarily realized via nucleophilic aromatic substitution. The proton exchange membrane obtained by the present invention has a high ion conductivity; at 30°C the conductivity is 58 $mS \cdot cm^{-1}$, and at 70°C it reaches 137 $mS \cdot cm^{-1}$. Further, the proton exchange membrane has strong mechanical properties and a low methanol permeability, the methanol permeability being less than half that of a nafion® 117 membrane. Upon assembling the membrane in a direct methanol fuel cell and testing, results showed that at 90°C, the maximum power of the cell was 75 $mW \cdot cm^{-2}$, and at 100°C, the maximum power reached 85 $mW \cdot cm^{-2}$.

CN101119925B is on Hydrogen fuel cell having a fuel processor buffered. In this patent a fuel cell system comprising a fuel cell used in generating hydrogen in a hydrocarbon fuel processor. The system further includes a portion of the hydrogen storage fuel processor buffers the generated hydrogen. Then when the fuel processor may be an amount less than the fuel cell output temporary operating requirements need, in various ways, for example, supplied to the fuel cell of this memory is used during system boot hydrogen, or.

US8186315B2 Hydrogen fuel assist device for an internal combustion engine and method A hydrogen fuel system for an internal combustion engine includes a water reservoir and a fuel cell in fluid communication with the water reservoir. An oxygen

line is fluidly coupled to the hydrogen fuel cell and receives and transports oxygen away from the fuel cell. A hydrogen line is fluidly coupled to the fuel cell and receives and transports hydrogen away from the fuel cell. An engine gas interface is fluidly coupled to the oxygen line and the hydrogen line, and operatively coupled to an engine intake. The engine gas interface receives oxygen and hydrogen from the oxygen and hydrogen lines, and introduces the hydrogen and oxygen into the engine intake. A vibration sensor is operatively coupled to the engine gas interface to detect engine vibration of the internal combustion engine, and deactivates the fuel when the sensor does not detect vibration from the engine.

US7569294B2 Modular portable battery charging system using hydrogen fuel cells Battery charging system comprising a hydrogen source module adapted to provide gaseous hydrogen; a hydrogen fuel cell power module comprising a hydrogen fuel cell and a power delivery outlet unit adapted to transfer power generated by the fuel cell to a secondary battery for recharging the secondary battery; and coupling and transfer means adapted to connect and disconnect the hydrogen source module and the hydrogen fuel cell power module.

US7838168B2 Functionally integrated hydrogen fuel cell A proton exchange membrane fuel cell has a unit cell assembly including an anode side and a cathode side. The anode side has a cooling base plate, a conductor assembly, a hydrogen flow field, a water absorbing element, and a hydrogen duct assembly. The cathode side has an air flow field, a conductor assembly, an air flow distributor, and an insulating compression plate with wing extensions. A membrane electrode assembly is disposed between the anode side and the cathode side physically connecting the flow fields on both the anode and cathode sides. A sealed anode assembly creates a sealed hydrogen volume and includes the anode conductor assembly, the hydrogen duct assembly, and the membrane electrode assembly all disposed between the insulating compression plate and the cooling base plate. The fuel cell may comprise multiple unit cell assemblies arranged in planar, folded, stacked, or pancake configuration

CN100459268C Hydrogen storage-based rechargeable fuel cell system A method for converting electric energy into chemical energy electrochemical system (20) and convert chemical energy into electrical energy. The electrochemical system includes apparatus electrical energy into chemical energy, and chemical energy into electrical energy, which electrical energy into chemical energy apparatus and converting chemical energy of a common electrode for the devices to share energy. In various embodiments, the present invention provides a hydrogen generator / fuel cell hybrid system. Effect of active electrode of the hydrogen generator in the plurality of embodiments the common electrode functions as a source of hydrogen fuel cell, and the common electrode portion or all of a fuel cell anode. Hydrogen, oxygen, and water can be circulated in the system.

Indian Patent 311/KOLNP/2013 relates to system and method for supplying hydrogen gas, and hydrogen fuel cell system. In this a system and method for supplying hydrogen gas, and a hydrogen fuel cell system are provided to solve inconvenience caused by the requirement for replacing a hydrogen storage container during hydrogen gas supplement. The system for supplying hydrogen gas includes a hydrogen storage unit, a hydrogen conveying unit and a charging device connected to the hydrogen storage unit, where the charging device includes a charging opening matched with a hydrogen gas infusing unit. It may be noted that according to the technical solution provided by the embodiments of the present invention, when hydrogen gas needs to be supplemented, an external infusing device may be used to infuse hydrogen gas to the hydrogen storage container in the hydrogen storage unit through the charging opening, which avoids replacement of the hydrogen storage container during an entire infusing process, and makes an intensive hydrogen gas supplement process more convenient and faster.

Indian Patent 9139/DELNP/2013 relates to hydrogen fuel cell and system thereof and method for dynamic variable humidity control. Disclosed are a hydrogen fuel cell

and system thereof, and a method for dynamic variable humidity control; the hydrogen fuel cell comprising a stack assembly and an outside plate gas distribution device; the stack assembly is encapsulated with a hard housing; the outside plate gas distribution device is fixed on the hard housing; the outside plate gas distribution device comprising a working gas flow outside plate gas distribution device and a heat dissipation gas distribution device; the working gas flow outside plate gas distribution device is provided with a fan mount for connecting with a working fan, and the working gas flow outside plate gas distribution device extends into the inner cavity of the housing from outside of the housing; the heat dissipation gas distribution device comprising a heat dissipation channel disposed outside of the housing and connected to the housing inner cavity, and a heat dissipation vent disposed on the housing; and the heat dissipation channel is provided with a heat dissipation fan mount for connecting with a heat dissipation fan. The hydrogen fuel cell of the present invention improves power generation efficiency, reduces costs and increases service life.

OBJECT OF THE PRESENT INVENTION

One or more of the problems of the conventional prior art may be overcome by various embodiments of the present invention.

Accordingly, the primary object of the present invention is to provide a hydrogen fuel cell device with higher efficiency and power output by using a UV exposed nafion membrane as PEM with a variable hydrogen humidification setup.

It is another object of the present invention, wherein the said HFC device uses processes of engraving flow channels using CNC machine and Cr-Au deposition methods for the preparation of humidified hydrogen/oxygen flow channels in aluminum.

It is even another object of the present invention, wherein the said HFC device uses Pt nano particles loaded Gas diffusion layer at both anode and cathode as catalysts.

It is one aspect of the present invention, wherein the said nafion membrane is irradiated on both sides with UV rays of optimum dosage of 190mJ/cm^2.

It is one aspect of the present invention, wherein the said HFC device works with humidified hydrogen and humidification has been done using hydrogen humidification setup.

It is one aspect of the present invention, wherein the said HFC device is assembled by sandwiching UV exposed nafion membrane in between two catalysts loaded GDLs which are placed between two aluminium flow channels, one at anode and other at cathode.

SUMMARY OF THE PRESENT INVENTION

According to the basic aspect of the present invention, there is provided an enhanced HFC performance with higher power output. This invention uses UV exposed nafion membrane as PEM. The process for fabrication of aluminium flow channels comprises engraving using CNC machine followed by cleaning and sequential sputtering of Chrome-Gold (Cr-Au) to form electrical contacts on hydrogen/oxygen flow channels. Karl Suss aligner Model MJB3 is used to irradiate optimized dosage of 190mJ/cm^2 UV rays on both sides of nafion membrane. HFC devices are assembled by sandwiching UV exposed nafion membrane in between platinum catalyst loaded GDLs which are placed one each between anode and cathode aluminium hydrogen flow channels.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 illustrates schematic of HFC, wherein a represents inlet for humidified hydrogen, b represents aluminium hydrogen/oxygen flow channels, c represents GDL, d represents Pt catalyst at anode and cathode, e represents UV exposed nafion membrane as proton exchange membrane, f represents outlet for water at cathode side, g represents inlet for oxygen, h represents metallic layer for electrical

contacts, e^- represents electrons, H^+ represents hydrogen ions, according to present invention.

Figure 2 illustrates the peak proton conductivity of nafion membrane exposed on both sides to various doses of UV rays.

Figure 3 illustrates the hydrogen humidification setup with water bubbler and control valves.

Figure 4 illustrates the exploded view of hydrogen fuel cell.

Figure 5 illustrates the process flow for assembly of HFC comprising aluminium flow channels for hydrogen, Pt catalyst loaded GDL, and UV rays exposed nafion membrane, Pt catalyst loaded GDL, aluminium flow channels for oxygen/air, according to present invention.

Part Name	Part Number
a	Inlet for humidified hydrogen
b	Hydrogen/oxygen flow channels
c	GDL
d	Pt catalyst at anode and cathode
e	UV exposed nafion membrane as proton exchange membrane
f	Outlet for water at cathode side
g	Inlet for oxygen
h	Metallic layer for electrical contacts
i	Hydrogen reservoir
j	Oxygen/air reservoir
k	Gas valves
l	Water bubbler
m	Hydrogen Fuel Cell

DETAILED DESCRIPTION OF THE INVENTION WITH REFERENCE TO ACCOMPANYING DRAWINGS

The preferred embodiment of the present invention will now be explained with reference to the accompanying drawings. It should be understood however that the disclosed embodiments are merely exemplary of the invention, which may be embodied in various forms. The following description and drawings are not to be

construed as limiting the invention and numerous specific details are described to provide a thorough understanding of the present invention, as the basis for the claims and as a basis for teaching one skilled in the art how to make and/or use the invention. However, in certain instances, well-known or conventional details are not described in order not to unnecessarily obscure the present invention.

HFCs are among the leading devices for clean energy generation for variety of applications. HFC consists of the following: A proton-conducting membrane (Nafion) is sandwiched between two catalysts loaded GDLs at anode and cathode (electrodes) of HFC. Humidified hydrogen diffuses through the micro-porous GDL (which regulates the transport of hydrogen) to the catalyst which generates protons and electrons. The protons then diffuse through the nafion membrane to the cathode. The electrons move from anode to cathode through the external circuit. Protons and electrons react with oxygen at the cathode catalyst to form water.
The equations for the process with humidified hydrogen as a fuel are as shown below:

$$\textbf{Anode}: 2H_2 \rightarrow 4H^+ + 4e^-$$

$$\textbf{Cathode}: O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$$

$$\textbf{Overall}: 2H_2 + O_2 \rightarrow 2H_2O$$

A schematic of HFC is shown in Figure 1.
The entire MEA is sandwiched between two aluminium flow channels which regulate the flow of hydrogen at the anode and air/oxygen at cathode as shown in Figure 1. The negative charge (electrons) collected by the metallic electrode moves into the external circuit from anode to cathode, thus balancing the charge transfer process.

The heart of the HFC is MEA which consists of micro-porous GDL (Toray carbon paper) which regulates the flow of fuel to the catalyst at the anode, a high efficiency catalyst layer (Pt) for the generation of protons (H^+) from humidified hydrogen, a high proton conductance membrane layer (nafion) for the transfer of protons and a high efficiency catalyst (Pt) at the cathode for the conversion of oxygen, protons and

electrons into water. Microchannels fabricated on aluminium for the flow of hydrogen at the anode and air/oxygen at the cathode serve as flow channels. A metallic layer (Cr-Au) on the fuel flow channels of aluminum (both at anode and cathode) is used for the exit of electrons from anode through the external circuit and entry into the cathode for charge balance.

The process of assembling hydrogen fuel cell comprises the following:

1) Fabrication of fuel cells

Flow channels for the flow of hydrogen at anode and air/oxygen at cathode along with respective storage reservoirs are fabricated by engraving aluminium using CNC machine.

2) **Fabrication of electrical contacts**

Chrome-gold sputtering is carried out to deposit Cr (10nm) and Au (150nm) for conduction of electrons (that accumulate on the GDL surface facing the flow channels) towards the external electrical circuit.

3) Preparation of UV exposed PEM:

Nafion (50 microns thick) is cut into required dimensions. It is cleaned with acetone and IPA. It is post-baked at 100°C for 1 hour to remove any moisture or water molecules present. Exposure of nafion is carried out on both sides of nafion by using UV source of Suss Microtec aligner Model MJB3 with optimized UV dose of 190 mJ/cm^2. Shown in Figure 2 is plot showing variation of proton conductivity of nafion membrane with increasing UV radiation dose. The peak proton conductivity is at 190 mJ/cm^2 of UV radiation.

4) Preparation of MEA:

The UV irradiated nafion membrane is sandwiched between two catalysts loaded GDLs at anode and cathode (electrodes) to form the MEA of HFCs.

5) Assembling of the HFCs

With reference to Figures1 and 4, the said process for assembling the HFCs - starting from anode to cathode, comprises aluminium hydrogen reservoir with flow channels with Cr-Au layer | Nano-particles loaded GDL | UV-exposed nafion membrane | Nano-particles Pt loaded GDL| aluminum oxygen/air reservoir with flow channels with Cr-Au layer.

Although the invention has been described with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as alternative embodiments, will be apparent to persons skilled in the art. It is, therefore, contemplated that the appended claims will cover all modifications that fall within the true scope of the invention.

WE CLAIM

1. A process for the enhancement of efficiency of An HFC device performance with the use of nafion membrane exposed with optimum dosage of UV rays as proton exchange membrane along with a humidification setup, the process comprising of:

    a) Fabrication of aluminium flow channels with reservoirs for hydrogen and oxygen/air by engraving using CNC machine.

    b) Sputtering Cr-Au on hydrogen flow channels.

    c) Exposing with UV rays with an optimum dose of 190mJ/cm^2 on both sides of nafion membrane and using it as proton exchange membrane in HFCs.

    d) Sandwiching optimally UV exposed nafion membrane between two Pt catalyst loaded gas diffusion layer (GDL) thereby forming membrane electrode assembly.

Wherein, the HFC is assembled by sandwiching the membrane electrode assembly between two aluminium flow channels of HFC for enhanced power output.

Dated this 3rd day of September, 2019.

For ALVA'S EDUCATION FOUNDATION,

Authorized Signatory: M. Mohan Alva

Name in full: Dr. Mohan Alva

Designation: Chairman

PATENT OFFICE CHENNAI 04/09/2019 16:01

Seal: Chairman Alva's Education Foundation (R) MOODBIDRI - 574227, D.K.

Application No Total number of sheets: 5

Applicant Name: **ALVA'S EDUCATION FOUNDATION** Number of sheet: 1/5

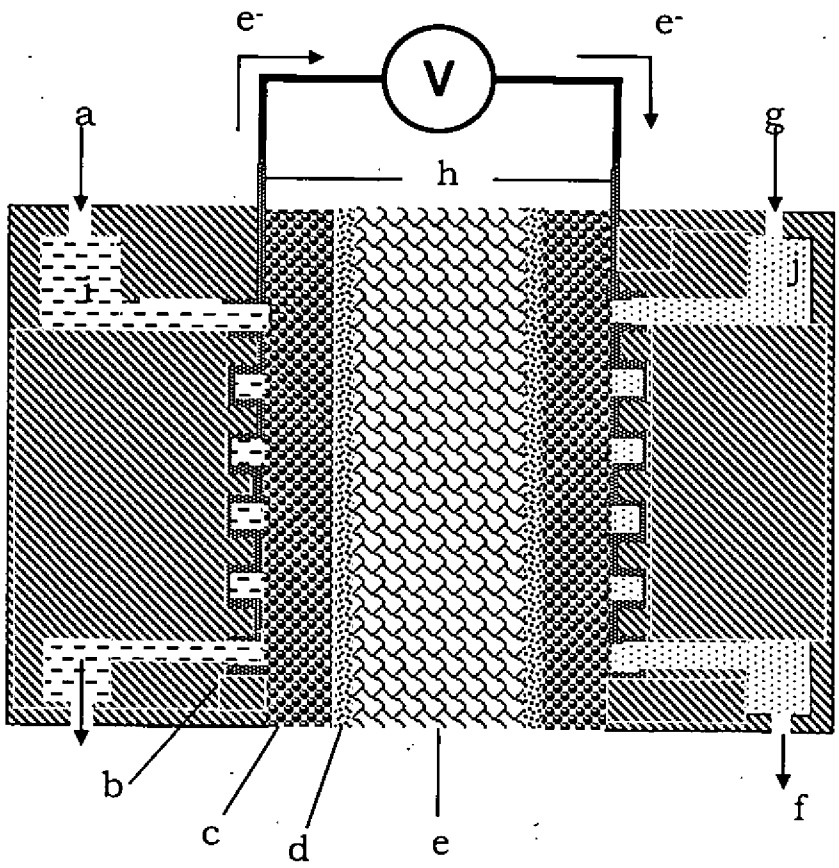


FIGURE 1

Dated this 3rd day of September, 2019.

For ALVA'S EDUCATION FOUNDATION,

Authorized Signatory:

Name in full:Dr. Mohan Alva

Designation: Chairman

Seal:

Chairman
Alva's Education Foundation (R)
MOODBIDRI - 574227, D.K.

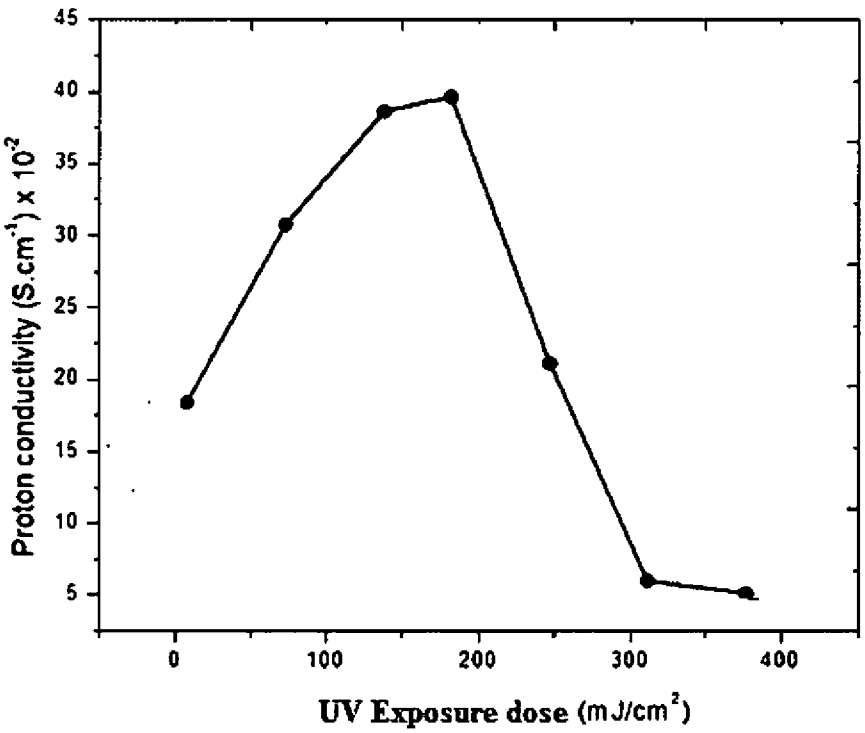


FIGURE 2

Dated this 03rd day of September, 2019.

For ALVA'S EDUCATION FOUNDATION,

Authorized Signatory: M. Mohan Alva

Name in full: Dr. Mohan Alva

Designation: Chairman

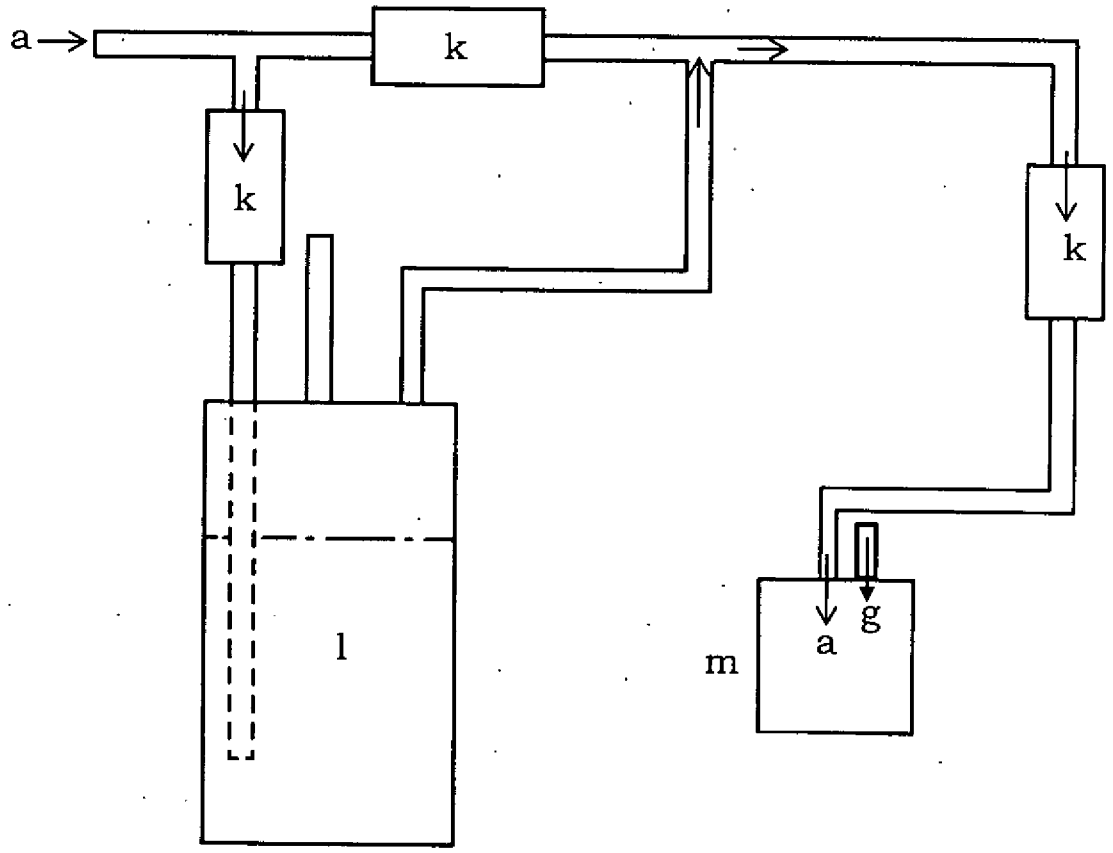
Seal: Chairman
Alva's Education Foundation (R)
MOODBIDRI - 574227, D.K.

Application No

Total number of sheets: 5

Applicant Name: **ALVA'S EDUCATION FOUNDATION**

Number of sheet: 3/5



Dated this 3rd day of September, 2019.

For ALVA'S EDUCATION FOUNDATION,

Authorized Signatory:

Name in full:Dr. Mohan Alva

Designation: Chairman

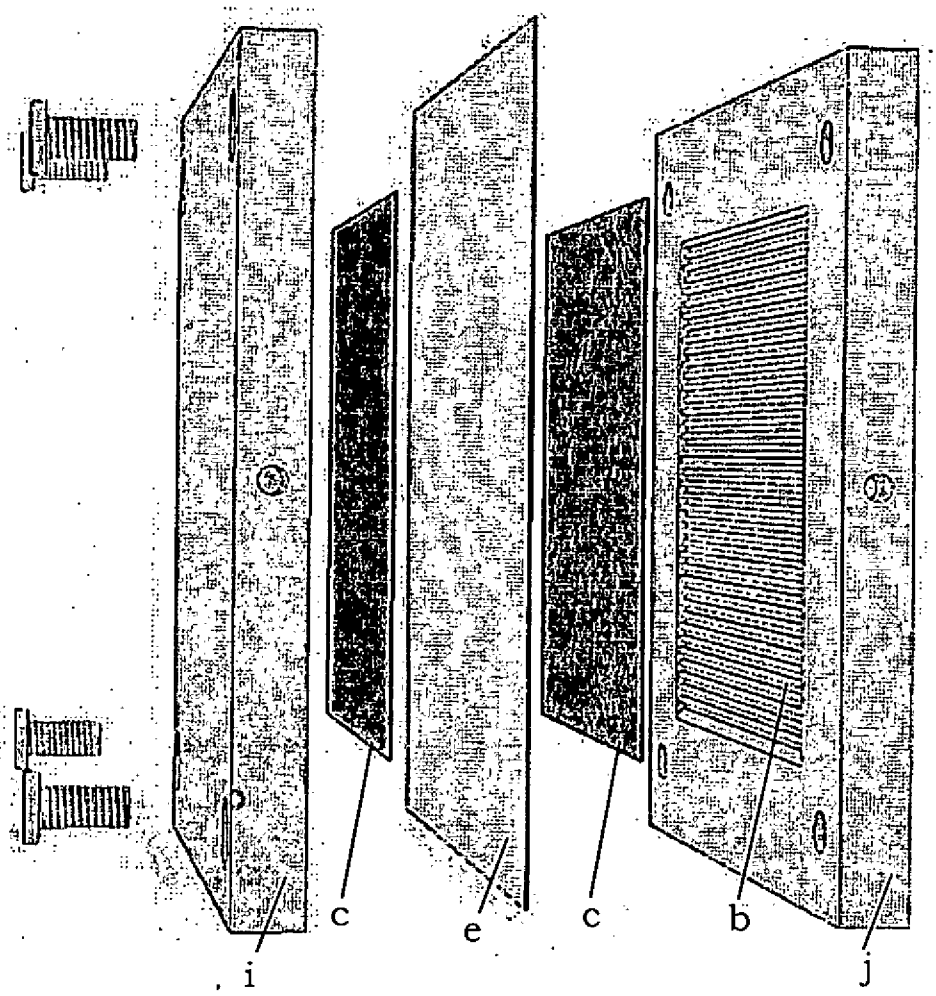
Seal: **Chairman**
Alva's Education Foundation (R)
MOODBIDRI - 574227, D.K.

Application No

Total number of sheets: 5

Applicant Name: **ALVA'S EDUCATION FOUNDATION**

Number of sheet: 4/5



Dated this 3rd day of September, 2019.

For ALVA'S EDUCATION FOUNDATION,

Authorized Signatory: M. Mohan Alva

Name in full: Dr. Mohan Alva

Designation: Chairman

Seal: Chairman
Alva's Education Foundation (R)
MOODBIDRI - 574227, D.K.

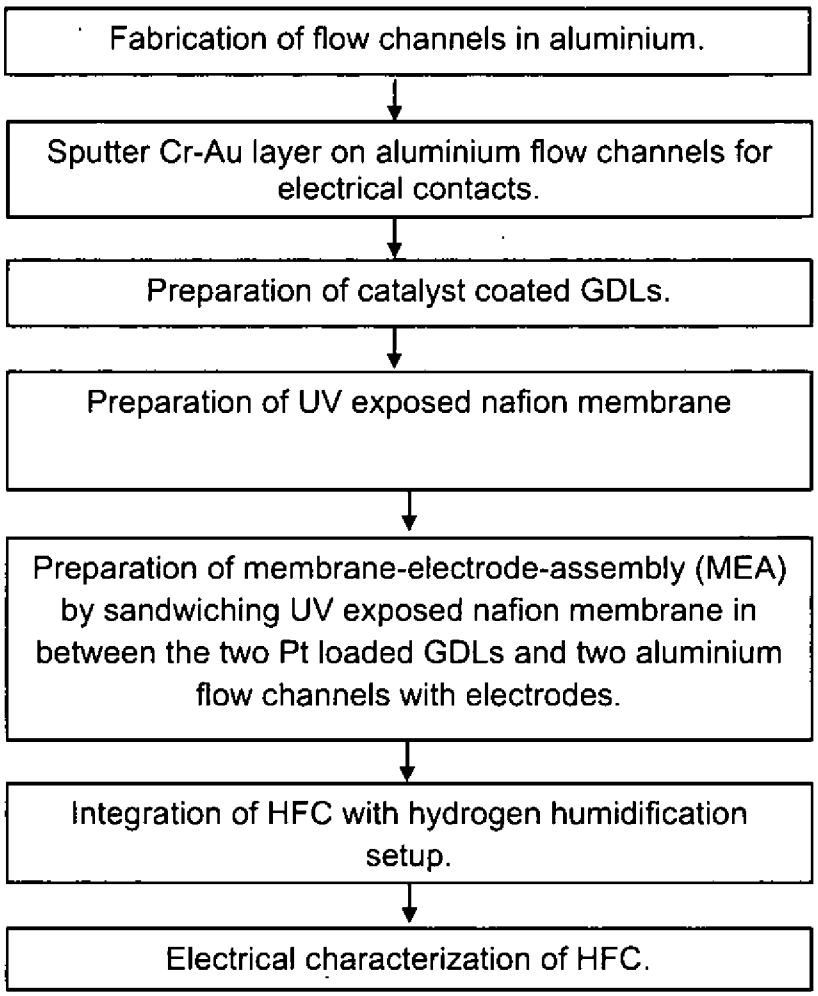


FIGURE 4

Dated this 3rd day of September, 2019.

For ALVA'S EDUCATION FOUNDATION,

Authorized Signatory: M. Mohan Alva

Name in full: Dr. Mohan Alva

Designation: Chairman

Seal:

Chairman
Alva's Education Foundation (R)
MOODBIDRI - 574227, D.K.

700340458

FORM 5
THE PATENT ACT, 1970
(39 of 1970)
&
The Patents Rules, 2003
DECLARATION AS TO INVENTORSHIP
[See section 10(6) and rule 13(6)]

1. NAME OF APPLICANTS

Name	Nationality	Address
ALVA'S EDUCATION FOUNDATION	India	**ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY, SHOBHAVANA CAMPUS, MIJAR, MOODBIDRI, DAKSHINA KANNADA - 574225, KARNATAKA, INDIA**

I hereby declare that the true and first inventor(s) of the invention disclosed in the specification filed in pursuance of our application
Application no:

Title : **"A PROCESS FOR ENHANCING HYDROGEN FUEL CELLS PERFORMANCE WITH NAFION PROTON EXCHANGE MEMBRANE OPTIMALLY EXPOSED TO ULTRAVIOLET RAYS"**

Dated :

2. INVENTORS

Name	Nationality	Address
PREETHAM CASTELINO	**Indian**	**ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY,SHOBHAVANA CAMPUS, MIJAR, MOODBIDRI, DAKSHINA KANNADA - 574225, KARNATAKA, INDIA**
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SIDDHARTHA PRAKASH DUTTAGUPTA	**Indian**	**DEPARTMENT OF ELECTRICAL ENGINEERING, INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY, MUMBAI, 400076**

Dated this 3rd day of September, 2019.

For ALVA'S EDUCATION FOUNDATION,

Authorized Signatory:

Name in full: Dr. Mohan Alva M. Mohan Alva

Designation: Chairman

Seal: Chairman Alva's Education Foundation (R) MOODBIDRI - 574227, D.K.

Chairman
Alva's Education Foundation (R)

3. DECLARATION TO BE GIVEN WHEN THE APPLICATION IN INDIA IS FILED BY THE APPLICANT(S) IN THE CONVENTION COUNTRY:- **NA**

We the applicant(s) in the convention country hereby declare that our right to apply for a patent in India is by way of assignment from the true and first inventor(s) **NA**

4. STATEMENT**NA**

I assent to the invention referred to in the above declaration, being included in the complete specification filed in pursuance of the stated application.

Dated this_____ day of _____2019.

Signature :**NA**

Name: **NA**

To

The Controller of Patents,
The Patent Office at Chennai.

PATENT OFFICE CHENNAI AT 04/09/2019 16:00

700340459

FORM 9

THE PATENTS ACT, 1970
(39 of 1970)

REQUEST FOR EARLY PUBLICATION
[See section 11A(2); rule 24A]

CBR : 28446
Date : 03:09:2019
Amt : 1375D/-

3/9/19

We, **ALVA'S EDUCATION FOUNDATION,** addressed at **ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGYSHOBHAVANA CAMPUS, MIJAR, MOODBIDRI, DAKSHINA KANNADA - 574225, KARNATAKA, INDIA** hereby request for early publication of my Patent application No_____ dated _____ for the invention **"A PROCESS FOR ENHANCING HYDROGEN FUEL CELLS PERFORMANCE WITH NAFION PROTON EXCHANGE MEMBRANE OPTIMALLY EXPOSED TO ULTRAVIOLET RAYS"** "under section 11A(2) of the Act.

Dated this the 3rd day of September 2019.

For **ALVA'S EDUCATION FOUNDATION,**

Authorized Signatory: M. Mohan Alva

Name in full: Dr. Mohan Alva

Designation: Chairman

Seal: Chairman
Alva's Education Foundation (R).
MOODBIDRI - 574227, D.K.

Application No:

Title: **A PROCESS FOR ENHANCING HYDROGEN FUEL CELLS PERFORMANCE WITH NAFION PROTON EXCHANGE MEMBRANE OPTIMALLY EXPOSED TO ULTRAVIOLET RAYS**

Applicant: **ALVA'S EDUCATION FOUNDATION**

ABSTRACT

According to the basic aspect of the present invention, there is provided an enhanced hydrogen fuel cell (HFC) device power. The HFCs used hydrogen flow channels fabricated in aluminium sheet for transport of fuel (humidified hydrogen at anode and air/oxygen at cathode in this case) and nafion membrane with optimally exposed to ultraviolet (UV) rays as proton exchange membrane. The process comprises sequential sputtering of Chrome-Gold to form electrodes and electrical contacts on fuel flow channels. HFC devices are assembled: first, by preparing membrane electrode assembly (MEA) consisting of optimally UV exposed nafion membrane sandwiched between two Pt catalyst loaded GDLs; and second, by sandwiching MEA between hydrogen fuel flow channels with reservoir for hydrogen at anode and flow channels with reservoir for oxygen/air at cathode for enhanced power output.

Rs 22550/-

September 3, 2019

D.NO : 73481

700340454

From

RICHARD PINTO,
Alva's Education Foundation,
Alva's Institute Of Engineering And Technology
Shobhavana Campus, Mijar, Moodbidri,
Dakshina Kannada - 574225, Karnataka, India
Email: ariv@leintelligensia.com

Bpl
New Applm
F. 9

3/9/19

To

The Controller of Patents,
The Patents Office,
Guindy,
Chennai – 600032.

Sir,

Ref: Patent application for "**A PROCESS FOR ENHANCING HYDROGEN FUEL CELLS PERFORMANCE WITH NAFION PROTON EXCHANGE MEMBRANE OPTIMALLY EXPOSED TO ULTRAVIOLET RAYS**" in the name of **ALVA'S EDUCATION FOUNDATION**

*****

Referring to the above, we are enclosing an **application for filing Complete Specification.**

Form 1 original signed by the applicant – 5 pages.

Form 3 original signed by the applicant- 1 page.

Form 5 original signed by the applicant -2 pages.

Form 9 original signed by the applicant- 1 page

Form2-Complete specification – 17 pages

Claims- 1 page (Total No of Claims-1)

Drawings- 5 pages

Abstract- 1 page

Total No. of Pages- 24 pages.

We submit Fee of total Rs.22550/- by cash. (Rs.8800/- for filing complete specification and Rs. 13750 for earlier publication).

We request you to take the above on record.

Thanking You,

yours faithfully,

RICHARD PINTO.

Encl: As above.