

September 20-23, 2011
City of Cuernavaca México

XI International

Hydrogen Congress

an event of The Mexican Hydrogen Society

Cuernavaca...
The Endless Spring

General Program and Book of Abstracts



Renewable Hydrogen

The Scientific Committee and

The Organizing Committee



Welcome to the 11th edition of the Hydrogen congress of the Mexican Hydrogen Society. In this occasion we are honoring *Renewable*

Hydrogen, as this clean fuel is becoming more and more important as an option for energy storage of intermittent renewable primary sources. As renewable energy technologies get a larger participation in the electricity generation, in particular through PV solar and wind energy, dispatching installed capacity is of paramount importance. Hydrogen can be one way to resolve such challenge and could become a parallel energy vector to electricity.

His 2011 edition will see technical contributions of all aspects of hydrogen energy, from its generation, its storage to its application. We will also have proposals presenting renewable energy systems and their related studies. As an effort of the Mexican Hydrogen Society and the organizers for the promotion of the technology transfer of scientists and engineers dedicated to work on hydrogen and renewable energy, we will have a one-day course on Technology Transfer. Don't miss this opportunity to understand the complexities of bringing an invention to commercial reality.

We hope you will enjoy this event and will find it not only technically interesting but also enjoyable from the social point of view, as we will have a cultural surprise on Wednesday 21 and we will share at dinner on Thursday 22 with traditional Mexican music.

Please make this an opportunity to renew old friendship with your colleagues and make new friends in sunny Cuernavaca. Welcome to the Endless Spring and help spread Renewable Hydrogen benefits...!

The Organizing Committee

September 20-23, 2011
City of Cuernavaca México

XI International

Hydrogen Congress

an event of The Mexican Hydrogen Society

Cuernavaca...

The Endless Spring

OUR SPONSORS

A special thanks goes to the Energy Network from the Mexican Council for Science and Technology for their generosity during the organization of this meeting.

Red de Fuentes de
Energía del CONACYT



We are also very grateful to the following local authorities SECTUR, FITUR and INAH, CCYTEM in Morelos for their assistance in different facets of the social and cultural parts of this event.



The following are also crucial sponsors participating of this XI International Hydrogen Congress:



We want to thank the two host institutions that took part of the main organization of this event, Instituto de Investigaciones Eléctricas and Centro de Investigaciones en Energía:



Cuernavaca, México The Endless Spring

20 – 23 September, 2011

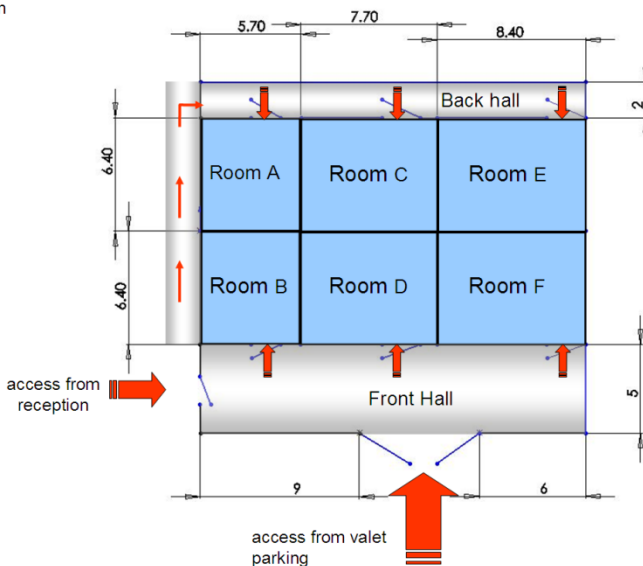
Renewable Hydrogen

Local Map

- Technical Parallel Sessions will take place in Rooms E and F.
- Plenary Talks and Poster Session will be held in Room C-D (see general program for time schedule) *
- Industry Expo Stands are located in Rooms A-B and Front Hall

Congress Rooms

scale 1:1m



Please note that lunch will be served in the Hotel's Restaurant

*Please follow instructions from organizers for other events or any change.

FULL PROGRAM

Technology Transfer Workshop

Tuesday 20 of September, 2011.

Room C-D

| TIME | TUESDAY 20 |
|---------------|------------------------------|
| 08:00 | ON-SITE REGISTRATION |
| 09:00 – 10:00 | TECHNOLOGY TRANSFER WORKSHOP |
| 10:00 – 11:00 | |
| 11:00 – 11:20 | COFFEE BREAK |
| 11:20 – 13:00 | TECHNOLOGY TRANSFER WORKSHOP |
| 13:00 – 14:00 | LUNCH |
| 14:00 – 15:00 | TECHNOLOGY TRANSFER WORKSHOP |
| 15:00 – 16:00 | |
| 16:20 – 17:40 | COFFEE BREAK |

Energy Network Meeting

Room C-D

| | |
|---------------|------------------------|
| 17:40 – 19:40 | ENERGY NETWORK MEETING |
|---------------|------------------------|

Red de Fuentes de
Energía del CONACYT

Terrace

| | |
|-------|------------------|
| 19:40 | WELCOME COCKTAIL |
|-------|------------------|

International Hydrogen Congress

Wednesday 21 of September, 2011

| | | |
|----------------------|--|------------------------------------|
| 08:00 | COFFEE AND REGISTRATION | |
| | Room C-D | |
| 09:00 | OPENING CEREMONY | |
| 09:30 | PLENARY SESSION 1 | |
| | Room E | Room F |
| 10:30 | Energy Strategies and Studies ID 15 | Hydrogen Storage ID 32 |
| 10:50 | Energy Strategies and Studies ID 34 | Hydrogen Storage ID 37 |
| 11:10 | Renewable Energy ID 66 | Hydrogen Storage ID 47 |
| 11:30 | COFFEE BREAK | |
| 11:40 | Energy Strategies and Studies ID 36 | Fuel Cells Components ID 38 |
| 12:00 | Energy Strategies and Studies ID 68 | Fuel Cells Components ID 39 |
| 12:20 | Renewable Energy ID 17 | Fuel Cells Components ID 93 |
| 12:40 | Renewable Energy ID 60 | Fuel Cells Components ID 91 |
| 13:00 | LUNCH | |
| 15:00 | PLENARY SESSION 2 (Room C-D) | |
| 16:00 | Hydrogen Systems ID 86 | Hydrogen Systems ID 31 |
| 16:20 | Fuel Cells Applications ID 22 | Hydrogen Generation ID 62 |
| 16:40 | Fuel Cells Applications ID 35 | Hydrogen Generation ID 83 |
| | | |
| 18:00 – 20:00 | CULTURAL AND SOCIAL EVENT | |

Thursday 22 of September, 2011

| | | |
|-------|--------------------------------|--------------------------------|
| 08:00 | COFFEE AND REGISTRATION | |
| | Room C-D | |
| 09:00 | PLENARY SESSION 3 | |
| | Room E | Room F |
| 10:00 | Renewable Energy ID 18 | Modeling ID 69 |
| 10:20 | Renewable Energy ID 19 | Modeling ID 84 |
| 10:40 | Renewable Energy ID 20 | Modeling ID 55 |
| 11:00 | Renewable Energy ID 41 | Fuel Cells Components ID 63 |
| 11:20 | INDUSTRY PRESENTATIONS | |
| 12:20 | Fuel Cells Components ID 40 | Hydrogen Generation ID 10 |
| 12:40 | Fuel Cells Components ID 78 | Hydrogen Generation ID 12 |
| 13:00 | Fuel Cells Components ID 79 | Hydrogen Generation ID 26 |
| 13:20 | Fuel Cells Components ID 96 | Hydrogen Generation ID 29 |
| 13:40 | LUNCH | |
| | Room C-D | |
| 15:30 | PLENARY SESSION 4 | |
| 16:30 | POSTER SESSION (Room E-F) | |
| | | |
| 20:00 | CONGRESS DINNER | |

Friday 23 of September, 2011

| | | |
|--------------|--|--------------------------------------|
| 08:00 | COFFEE AND REGISTRATION | |
| | Room C-D | |
| 09:00 | PLENARY SESSION 5 | |
| | Room E | Room F |
| 10:00 | Fuel Cells Components ID 21 | Hydrogen Generation ID 33 |
| 10:20 | Fuel Cells Components ID 23 | Hydrogen Generation ID 53 |
| 10:40 | Fuel Cells Components ID 43 | Hydrogen Generation ID 56 |
| 11:00 | Fuel Cells Components ID 67 | Hydrogen Generation ID 61 |
| 11:20 | COFFEE BREAK | |
| 11:40 | Fuel Cells Components ID 42 | Hydrogen Generation ID 95 |
| 12:00 | Fuel Cells Components ID 49 | Hydrogen Generation ID 54 |
| 12:20 | Fuel Cells Components ID 89 | Hydrogen Storage ID 80 |
| 12:40 | Fuel Cells Components ID 92 | Hydrogen Storage ID 81 |
| 13:00 | ADJOURN AND CLOSING COCKTAIL (RSVP) | |

Technical Contributions

| ID | TITLE | AUTHORS | MODE |
|----|--|---|--------|
| 9 | Production of extracellular lipase from different Fungus as catalyst for the enzymatic synthesis of biodiesel. | Lydia Toscano*1,2, Gisela Montero1, Margarita Stoytcheva1, Velizar Gochev3, Guadalupe Moreno2 | POSTER |
| 10 | CoO-TiO2 and WO3-TiO2 mixed oxide as photocatalyst for hydrogen generation | A. Pérez-Larios, A. Hernández-Gordillo, F. Tzompantzi, R. Gómez | ORAL |
| 12 | Zeolites type SBA-16 as photocatalyst for hydrogen production | A. Pérez-Lariosa*, A Hernández-Gordilloa, M. A. Guzmanb, R. Huirache-Acuñac, R. Gómeza | ORAL |
| 14 | Effect of the Pr addition to Pt/Al2O3 and Rh/Al2O3 catalysts on the hydrogen production by steam reforming of methanol | Miroslava Barrera salgado, Gloria Del Angel, Raúl Pérez Hernández | POSTER |
| 15 | Energy balance for design and optimization of a renewable hybrid system with hydrogen storage | Romeli Barbosa, Beatriz Escobar, José Hernández, Ysmael Verde | ORAL |
| 16 | Hydrogen Production by Spirulina Maxima 2342 in Different Light Intensities and quantification through a PEMFC | Alina Juantorena Ugás, Sebastian Pathiyamattom Joseph, Orlando Lastres Danguillecourt, Geovannis Hernández Gálvez, Armando Bustos Gómez | POSTER |
| 17 | Study of Wind Energy Potential in San Quintin, Baja California | Marlene Zamora Machado, Alejandro Adolfo Lambert Arista | ORAL |
| 18 | Parallel connection and sandwich electrodes lower the internal resistance of a Microbial Fuel Cell | Areli Ortega-Martínez1; Omar Solorza-Feria2; Elvira Ríos-Leal3; Katy Juárez-López4; María T. Ponce-Noyola5; Noemí F. Rinderknecht-Seijas6; Héctor M. Poggi-Varaldo1 | ORAL |
| 19 | Comparison of Variable Resistance and Linear Sweep Voltammetry methods for characterizing a mediator-less single chamber microbial fuel cell loaded with sulfate reducing biocatalysts | K. Sathish Kumar1, Omar Solorza-Feria2,1, Gerardo Vazquez-Huerta2, Héctor M. Poggi-Varaldo3,1 | ORAL |
| 20 | Electrical stress-directed evolution of biocatalysts community sampled from a sodic-saline soil | K. Sathish Kumar1; Omar Solorza-Feria2,1,*; Gerardo Vázquez-Huerta2; Marco A. Meraz-Ríos4; J. P. Luna-Arias5; Héctor M. Poggi-Varaldo3,1 | ORAL |
| 21 | Thermal Treatment Effects on Pd5Cu4Pt Electrocatalyst for Oxygen Reduction in a PEM Fuel Cell | D. C. Martínez Casillas1,* , O. A. Gil Esquivel1, O. Solorza Feria1. | ORAL |
| 22 | Hybrid Electric Vehicle (Nayaa) Fuel Cells And Batteries | A. Rodríguez-Castellanos, S. Citalán-Cigarroa, J. L. Díaz-Bernabe, O. Solorza-Feria | ORAL |

| | | | |
|----|--|--|--------|
| 23 | High catalytic activity and degree of tolerance to ethanol of low platinum-content Pt-CeOx/MWCNT in acid media | Alberto Gaona Coronado, Javier Rodriguez Varela, Juan Carlos Loyola, Iván Escalante-García , Pascual Bartolo Pérez | ORAL |
| 24 | Synthesis and characterization of novel Pd-CeOx/MWCNT electrocatalysts as ORR cathode materials for DAFCS | Alberto Gaona Coronado, Javier Rodriguez Varela, Juan Carlos Loyola | POSTER |
| 26 | Oxidative Steam Reforming of Methanol and Hydrogen production: Effect of the Cu and Ni Impregnation on CeO2 | Albina Gutiérrez-Martínez, Antonio Alba, Raúl Pérez-Hernández | ORAL |
| 27 | Platinum Deposit on WOx-C Synthesized by Different Methods As Catalyst In PEMFC | M. L. Hernández-Pichardo1,* , R. G. González-Huerta2, S. P. Paredes-Carrera1, J. A. Frías-Rojas1, E. Palacios-González3, P. del Angel3 | POSTER |
| 28 | Decontamination Of Drinking Water By A Combined Photocatalysis-Sorption Couple System At Low Energy | S.P. Paredes1, M. A. Valenzuela1, M. L. Hernández-Pichardo1, Rodríguez-Clavel I. S1. | POSTER |
| 29 | Effect of WOx Over Ni/Hydrotalcite Catalysts To Produce Hydrogen From Ethanol | J. L. Contreras1* , M.A. Ortiz1, G.A. Fuentes2 , M.Ortega3, R.Luna1, M. Gordon1,J.Salmones4, B.Zeifert4, L. Nuño1 and T. Vázquez1 | ORAL |
| 30 | SYNTHESIS AND CHARACTERIZATION OF MgTa ALLOY AND ITS POSSIBLE USE IN HYDROGEN STORAGE | José Luis Iturbe-García, Alberto Sandoval Jiménez | POSTER |
| 31 | Electrochemical Behavior of Ni-based Alloys as Negative Electrode for Nickel-Metal Hydride Batteries | Liliana Vazquez-Motaa, Karina Patlán-Olmedoa, Miguel Angel Oliver-Tolentinob, Rosa Gonzalez-Huertaa, Hector Javier Dorantes-Rosalesc, Arturo Manzo-Robledoa* | ORAL |
| 32 | Kinetics Study Of Hydrogen Storage In Mechanically Alloyed Magnesium | G. Garcia-Pacheco1*, J. G. Cabañas-Moreno2, K. Suarez-Alcantara3. | ORAL |
| 33 | Synthesis of Sb doped SnO2 (ATO) nanoparticles as support to IrO2 used to anode an electrolyzer ESP | Julio Cruz | ORAL |
| 34 | Preliminary design of hybrid Fuel Cell - Battery power systems for electric vehicles: A simple approach. | Leonardo De Silva Munoz | ORAL |
| 35 | Basic dynamic behaviour of a commercial 1 kW fuel cell system. | Leonardo De Silva Munoz | ORAL |
| 36 | Decentralized Power Planning: A Review Of Mathematical Models Used | Juan Rojas Zepa1, José Yusta Loyo 2, Carlos Ponce Corral 3 | ORAL |
| 37 | Synthesis of aluminosilicates under high pressure and using sulfur as directing agent: study of hydrogen and water adsorption. | Sandra Loera1,* , Jorge Flores1, Enrique Lima2, Heriberto Pfeiffer2, Miguel A. Olivier3, and Victor H. Lara4 | ORAL |

| | | | |
|----|---|--|--------|
| 38 | Characterization of an ultrasonic nozzle for the manufacture of Membrane-Electrode Assemblies | J. Roberto Flores Hernández1*, I. Lorena Albarrán Sánchez1 | ORAL |
| 39 | Mechanical stabilization of Nafion® membrane to facilitate the manufacture of the Membrane-Electrode Assemblies | J. Roberto Flores Hernández1*, I. Lorena Albarrán Sánchez1, Brenda Reyes Peraza2 F. Isaías Vado Martínez2 | ORAL |
| 40 | Characterization of Chitosan Proton Exchange Membrane | Molina Rojas D. S.1*, Mendoza López D. 1, Cortés Escobedo C. A. 1, Vázquez Huerta G.2, Solorza Feria O. 2, González Huerta R. G. 3 | ORAL |
| 41 | Design and characterization of a biofuel cell using a laccase electrode as cathode | Javier Martínez Ortiz1, J. Roberto Flores Hernández2*, Rafael Vazquez Dualt1 and I. Lorena Albarrán Sánchez2 | ORAL |
| 42 | SYNTHESIS AND CHARACTERIZATION OF Agn-Ptm/C CATALYST FOR PEMFC CATHODE | Andres Godínez-García, Diana C. Martínez-Casillas, J. Francisco Pérez-Robles, Omar Solorza-Feria, Luzma R. Aviles-Arellano, H. Vladimir Martínez-Tejada | ORAL |
| 43 | ORR Performance of Pt-Oxide-C Electrocatlysts Prepared By CVD | Beatriz Ruiz Camacho1*, Arturo Patiño Rojas1, Rosa Guadalupe González Huerta1, Miguel A. Valenzuela1, Roberto Vargas García2, Nicolás Alonso-Vante3 | ORAL |
| 45 | Synthesis and characterization of WO3 for its application in tandem cells | Manuel Rodríguez, Geonel Rodríguez, Gerko Oskam | POSTER |
| 47 | Hydrogen Storage In Nanocavities Of Porous Imidazoles. | Claudia Vargas, Jorge Roque, Karina Tapia, Edilso Reguera, Hernani Yee | ORAL |
| 48 | Synthesis of BiVO4 by mechanochemical reaction between Bi2O3 and V2O5 | B. Fuentes-Martínez, K.P. Padmasree, E. Mendoza-Mendoza, A.F. Fuentes | POSTER |
| 49 | ETHANOL ELECTRO-OXIDATION USING SUPPORTED MULTIMETALIC ACTIVE PHASES | L. C. Ordóñez, F. Avilés, G. Martínez, A. J. Delgado, R. L. Nolasco | ORAL |
| 50 | Synthesis And Transport Studies Of Nano-Crystalline Ce1-xBiO2-δ Systems | Siomara Martínez-Costilla1, Sagrario M. Montemayor1, Padmasree Karinjilottu Padmadas2, Antonio F. Fuentes2 | POSTER |
| 53 | Steam reforming of ethanol for hydrogen production using Ni-W/CeO2, Ni-W/γ-Al2O3 and Ni-W/HT catalysts | I.P. Hernández1, A. M. Fernández2, Y. Gochi-Ponce3 | ORAL |
| 54 | Influence of the pH on hydrogen production by SSF of paper industry wastes using anaerobic biofilms | Emma Berenice Herrera Ramírez1, Ileana Mayela María Moreno Dávila1, Leopoldo Javier Ríos González1*, Baltazar Gutiérrez Rodríguez1, Yolanda Garza García1, Jesús Rodríguez Martínez1 | ORAL |

| | | | |
|----|---|---|--------|
| 55 | A DFT Study of the Poisoning Effects of CO on PdxCu1-x (110) surface | Ernesto López-Chávez1*, Alberto García-Quiroz1, Fray de Landa Castillo-Alvarado2, Gerardo Cabañas-Moreno3, José Manuel Martínez-Magadán4 | ORAL |
| 56 | Hydrogen production in UASB reactor using enzymatic hydrolysates from paper industry wastes by anaerobic biofilms: Influence of HRT | Ileana Mayela María Moreno Dávila1, Emma Berenice Herrera Ramírez1, Leopoldo Javier Ríos González1*, Baltazar Gutiérrez Rodríguez1, Yolanda Garza García, Jesús Rodríguez Martínez1 | ORAL |
| 57 | Synthesis and characterization of sulphonated HFA-co-DABS/ISO copolyamide for Polymer Electrolytic Membranes | 1Pérez-Padilla Y., 2Smit M., 1Canche-Escamilla G., 1Aguilar-Vega M. J. | POSTER |
| 58 | Study Of Performance As Supercapacitors With Solid Electrolyte | Paola Garcia Hernández, Jose Martin Baas López, Daniella Pacheco Catalán, Mascha Smit | POSTER |
| 59 | Hydrogen production by native species of microalgae isolated from Mexico | Márquez-Reyes LA1, Sánchez Saavedra MP1, Valdez-Vazquez I1,2. | POSTER |
| 60 | Electrochemical Performance Of Supercapacitors Based On Poly(Pyrrole)-Cobalt Supported On Carbon Nanotubes | J. B. Pompeyo Duarte1, E. Morales2, M. A. Smit1 and D.E. Pacheco-Catalán1 | ORAL |
| 61 | Synthesis of GaN by hydrothermal method as promising photo-electrocatalyst for hydrogen production | Anayancy Campos Badillo1, Arturo Manzo-Robledo2, Odilón Vázquez Cuchillo1, Nora ElizondoVillareal3 and Arquímedes Cruz-López1 | ORAL |
| 62 | Synthesis And Characterization Of Ni-Mo Electrodes For The Hydrogen Evolution Reaction | Gabriel Tamayo, Diego Crespo, Marcelo Videá | ORAL |
| 63 | Dispersion of Ni and LiH on the hydriding-dehydriding kinetic in Mg based alloys for hydrogen storage | Antonio Alberto Zaldivar Cadena | ORAL |
| 64 | Modeling of the Hydriding-Dehydriding Kinetics of Pure Magnesium | Antonio Alberto Zaldivar Cadena | POSTER |
| 65 | Getting Hydrogen From NiH2 and CH4. A Theoretical Study Of The Reaction Mechanism | María Esther Sánchez-Castro, Mario Sánchez-Vázquez | POSTER |
| 66 | Performance Testing And Exhaust Emissions In A Single Cylinder Spark Ignition Using Gasoline-Anhydrous Ethanol Blends. | Jesus Antonio Camarillo Montero, Uriel González Macías, Juan José Marín Hernández, Juan Rafael Mestizo Cerón | ORAL |
| 67 | Oxygen Reduction Kinetic Pathway on Pt And Pd Compounds Synthesized By Different Methods | P. González Puente1, L. M. Leal Gámez1, B. Ruiz Camacho2, M. Valenzuela Zapata2, R. Vargas García3, Omar Solorza Feria4, R. González Huerta1 | ORAL |

| | | | |
|----|---|---|--------|
| 68 | Opportunities in the carbon market with a solar-hydrogen system | A. Yunez Cano ^{1*} , G. Contreras Puente ² , M. Tufiño Velázquez ² , D. Jiménez Olarte ² , R. González Huerta ¹ | ORAL |
| 69 | Absorption Enhanced Reforming Of Light Alcohols (Methanol And Ethanol) For The Production Of Hydrogen: Thermodynamic Modeling | Miguel A. Escobedo Bretado ¹ , Manuel D. Delgado Vigil ² , Jesús Salinas Gutiérrez ² , Miguel Meléndez Zaragoza ² , Virginia Collins-Martínez ² and Alejandro López Ortiz ² | ORAL |
| 70 | Application Of Current Pulses To Water Electrolysis Systems | A. Flores Olvera ¹ , A Rubio Rubio ¹ , R. Silva Casarin ² , Omar Solorza Feria ³ , R. González Huerta ¹ | POSTER |
| 71 | Magnesium-Iron-Zinc Alloys And Their Hydriding Properties | Angel Palacios-Lazcano, Karina Suárez-Alcántara, Gerardo Cabañas-Moreno | POSTER |
| 72 | Fuel Cells Stack Desing And Construction Implementing A Dc/Dc Convertor | E. Escobedo ^{*1} , O. Antonio ² , Z. Martínez ² , J. Polanco ³ , F.I. Chan Puc ⁴ M.A. Smit ¹ | POSTER |
| 73 | Hydrogen Production From Esr Reaction Over Rh Supported Catalysts: Effect Of Support. | Oscar Arturo Gonzalez Vargas, Jose Antonio De Los Reyes Heredia, Armando Tonatiuh Avalos Bravo | POSTER |
| 75 | Electrochemical Caracterization Of Polymeric Eletrolytes For Fuel Cells | Roberto Benavides | POSTER |
| 76 | Mathematical Model To Simulate Fuel Cell Performance | Roberto Benavides | POSTER |
| 77 | Potentiometric Titration Of Polymeric Electrolytes Used As Membranes In Fuel Cells | Gledir Martins ³ , Márcio A. Fiori ¹ , Roberto Benavides ² , Bruno Szpoganicz ³ , Marcos Marques da Silva Paula ¹ , Luciano da Silva ^{1,4} | POSTER |
| 78 | Synthesis Of Polymeric Electrolytes For Their Use As Membranes In Fuel Cells | Roberto Benavides | ORAL |
| 79 | Composite Membranes Based on Micro and Mesostructured Silica: A Comparison of Physicochemical and Transport Properties | Alejandra Alvarez López, Carlos Guzmán, Janet Ledesma García, Luis Gerardo Arriaga Hurtado | ORAL |
| 80 | Biomass Catalytic Steam Gasification: Thermodynamics Analysis and Reaction Experiments in a CREC Riser Simulator | Enrique Salaices, Benito Serrano, Hugo Delasa | ORAL |
| 81 | Steam Gasification of a Cellulose Surrogate over a Fluidizable Ni/ α -Alumina Catalyst: A Kinetics Model | Enrique Salaices, Benito Serrano, Hugo Delasa | ORAL |
| 82 | Hydrogen absorption properties of Mg _{1.95} Ti _{0.05} Ni _{0.95} Cu _{0.05} modified magnesium composite, prepared by ball-milling. | Juan Bonifacio Martínez | |

| | | | |
|----|---|--|--------|
| 83 | A Kinetic-Mechanistic Study of the Hydrogen Evolution Reaction In Sulfuric Acid Solutions With Different Electrode Materials | J.C. FUENTES-ACEITUNO1* And G.T. LAPIDUS2. | ORAL |
| 84 | Thermodynamic Analysis Of The Absorption Enhanced Steam Reforming (Aesr) Of Bio-Oil Model Compounds | Miguel A. Escobedo Bretado1, Manuel D. Delgado Vigil2, Jesús Salinas Gutiérrez2, Miguel Meléndez Zaragoza2, Virginia Collins-Martínez2 and Alejandro López Ortiz2 | ORAL |
| 85 | Electrical Conductivity Studies On Y3+ And Mg2+ Co-Doped Ceria Electrolyte System | Raúl Alberto Montalvo-Lozano1, Sagrario Martínez Montemayor1, Padmasree Karinjilottu Padmasdas2, Antonio Fernandez Fuentes2 | POSTER |
| 86 | Hydrogen as Additive in Cars with Internal Combustion Engines. | Jaime Lorenzo Fonseca Ruiz, José Ramón Armendáriz Gutiérrez, Eduardo Florencio Herrera Peraza | ORAL |
| 89 | Oxygen Reduction Studies On Carbon | R. Hernández Maya1, A.J. Armenta González1,2, O. Ugalde1, M.T. Oropeza Guzmán2, P. Roquero1 | ORAL |
| 90 | Adsorption of H2 and O2 onto Pd-Cu(110) alloy Surfaces: New material for PEMFC | Alberto García-Quiroz ¹ , L. César de la Portilla-Maldonado ² , Ernesto López-Chávez ¹ , Fray de Landa Castillo-Alvarado ^{3,1} , Gerardo Cabañas-Moreno ⁴ . | POSTER |
| 91 | Development of ultrasonic gas humidification systems for fuel cell stacks | T. Romero*, L. De Silva, R. Mijarez | ORAL |
| 92 | Hydrogen-crossover evaluation of graphite bipolar plates and membrane-electrodes assemblies, used in PEMFC. Hardware development and methodology implementation | Félix Loyola, Ulises Cano, Irma Lorena Albarrán, Tatiana Romero | ORAL |
| 93 | Channel length and air flow rate effect on the PEM fuel cell overall performance | Félix Loyola, Ulises Cano | ORAL |
| 94 | Stirring method and temperature: its effect on the synthesis of metallic (M) and bimetallic (M-Pt) nanostructures | Nora Mayté Sánchez-Padilla1, Sagrario M. Montemayor1*, F.J. Rodríguez Varela2 | POSTER |
| 95 | Production of H2 from Ethanol Using Pt/Hydroxalcite Catalysts Stabilized With WOx | J. L. Contreras1, M.A. Ortiz1, G.A. Fuentes2, R.Luna1, M. Gordon1, J.Salmones3, B. Zeifert.3 and T. Vázquez1 | ORAL |
| 96 | Effect of the addition of benzimidazole ionic liquid in ABPBI/H3PO4 proton exchange membranes | Rubí A. Hernández Carrilloa, Juan Antonio Asenciob, Pedro Gómez Romerob, Eduardo M. Sánchez Cervantesa | ORAL |



9

PRODUCTION OF EXTRACELLULAR LIPASE FROM DIFFERENT FUNGUS AS CATALYST FOR THE ENZYMATIC SYNTHESIS OF BIODIESEL

Lydia Toscano^{*1,2}, Gisela Montero¹, Margarita Stoytcheva¹, Velizar Gochev³,
Guadalupe Moreno²

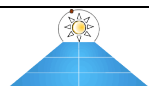
The lipase production activity of six different fungal strains belonging to genera *Aspergillus niger*, *A. oryzae*, *A. awamori*, *Trichoderma* sp., *T. reesei* and *Penicillium chrysogenum* was studied in a submerged fermentation batch. The Morphology and cultural characteristics of the producing strains were investigated microscopically to evaluate the physiological state and purity of the fungal cultures during the fermentation process. The cultivation was carried out in a nutritive modified Reese and Mandels medium containing olive oil as a sole carbon source in a rotary shaker for 120 h at 29±1°C.. *P. chrysogenum* and *A. niger* have shown the highest lipase activity among the studied fungal species: 3.5 and 4.3 U/ml, respectively. The maximum activity fo lipase corresponded to the end of exponential and the beginning of stationary phase of strain development. The optimum pH and temperature for enzymatic activity on *P.chrysogenum* and *A. niger* lipases were pH = 8.0, 40°C and 45°C respectively. The selected fungi are a good prospective for the development of industrial biotechnology in the process of biodiesel production.

10

CoO-TiO₂ and WO₃-TiO₂ mixed oxide as photocatalyst for H₂ generation

A. Pérez-Larios, A. Hernández-Gordillo, F. Tzompantzi, R. Gómez

In this work we studied titanium dioxide modified with different percent of mixed oxide either CoO or WO₃ (1.0, 3.0, 5.0 wt.%). The solids were characterized by nitrogen physisorption (BET) and porosity (BJH), XRD patterns and UV-Vis and Raman spectroscopy. The photoactivity was evaluated in an Pyrex reactor of 200 ml using a solution ethanol-water (1:1 molar ratio) and 0.1 g of catalyst using a high pressure Hg lamp (with a wavelength of 254 nm and an intensity of 2.2 mW/cm² encapsulated in a quartz tube. The results showed materials with specific surface areas among 89 to 95 m²/g and 41 to 91 m²/g respectively with mesoporosity characteristics. The XRD patterns show the formation of the crystalline anatase phase. The band gap energy (E_g) for the materials were obtained with UV-Vis spectroscopy, the E_g values for both mixed oxide were less to 3.2 eV. In the water splitting reaction samples modified with 5 wt.% of either Co or W present the highest hydrogen production with 1,000 µmol/h and 950 µmol/h respectively.





ZEOLITES TYPE SBA-16 MODIFIED WITH PHOSPHOROUS AS PHOTOCATALYST FOR HYDROGEN PRODUCTION.

12 A. Pérez-Larios^a, A Hernández-Gordillo^a, M. A. Guzman^b, R. Huirache-Acuña^c, R. Gómez^a

In this work we studied zeolites type SBA-16, whit different percent of P (0, 0.5, 1.0, 1.5 and 2 %). The solids were characterized by; nitrogen adsorption (BET) and porosity (BJH), XRD patterns and UV-Vis spectroscopy. The photoactivity was evaluated using a Pyrex reactor of 200 ml using a solution ethanol-water (1:1 molar ratio) and 0.1 g of catalyst using a high pressure Hg lamp (with a wavelength of 254 nm and an intensity of 2.2 mW/cm² encapsulated in a quartz tube. The results showed materials with specific surface area among 942 to 755 m²/g and mesopority characteristics. The XRD patterns show that a low angle is present the peak in 0.91° (110) is characteristic of cubic structure of this mesoporous material. The UV-Vis spectroscopy shown that regardless of the incorporation of phosphorus the catalysts have absorption at 500 nm. In the photodescomposition of ethanol:water, the evaluation has 800 µmol/h in the hydrogen.

14 Effect of the Pr addition to Pt/Al₂O₃ and Rh/Al₂O₃ catalysts on the hydrogen production by steam reforming of methanol

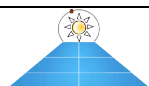
Miroslava Barrera salgado, Gloria Del Angel, Raúl Pérez Hernández

The present work is a study of the effect of Pr addition on Rh/Al₂O₃ and Pt/Al₂O₃ catalysts for the hydrogen production from methanol reforming. In Pt serie the Pt/APr10 was the most active catalyst. All the Pt catalyst getting 100% of methanol conversion at 350°C, and showed more of 60% of selectivity to H₂. However, only Rh/A catalyst showed selectivity to hydrogen (10%), on the contrary no selectivity to hydrogen was obtained in any of the Rh/APr catalysts, the products detected were CO, CO₂ and CH₄. The presence of Pr inhibits the activity of the Rh particles, probably due to a higher interaction of the Rh with the Al₂O₃-Pr support, which modifies the reactant or intermediates adsorption on the Rh surface. Methanol, reforming, praseodymium

15 Energy balance for design and optimization of a renewable hybrid system with hydrogen storage

Romeli Barbosa, Beatriz Escobar, José Hernández, Ysmael Verde

In the present research work, hourly wind speed and solar radiation measurements by a meteorological monitoring station in Cancún, México, was analyzed to assess the feasibility of using hybrid wind/photovoltaic/H₂ energy conversion systems. The key of the successful of the hydrogen hybrid system compared with array solar photovoltaic and/or wind turbine is that they can store efficiently the energy by transforming it in hydrogen, which could be the fuel supplied to the fuel cell. Electric power is generated by the array solar photovoltaic and wind turbine. Surplus energy is supplied continuous power to residential applications as stand-alone loads. After meeting the requirements of the load, surplus energy is supplied to an electrolyzer to generate hydrogen, which is consumed by the fuel cell stack to partially support the power requirement during the energy deficit hours. Operation of fuel cells produces electrical energy, which is used to





satisfy part or all of the consumer needs. The wind and array solar photovoltaic are used as main energy sources while the fuel cell is used as secondary or back-up energy source. An energy balance analysis is made of the different components of the system, calculating efficacy subsystems, and proposing future improvements to increase the efficiency of the use of the surplus energy produced by the wind/ photovoltaic/H₂ system. The simulation is based on the electrical component models and variable irradiance/wind data. keywords: Hybrid system, Optimization, Analytical model, Weather data

16

HYDROGEN PRODUCTION BY *Spirulina maxima* 2342 IN DIFFERENT LIGHT INTENSITIES AND QUANTIFICATION THROUGH A PEMFC

A.U. Juantorena¹, P. J. Sebastian ², O. Lastres ³, Hernández, G ² A. Bustos.⁴

Research in hydrogen production by biological means has shown the problems and potential of biotechnology hydrogen industrial development as a future energy, allowing considering it as a serious practical possibility. In this work, the hydrogen photosynthetic production for *Spirulina maxima* 2342 microorganisms is determined under different experimental conditions, for the same biomass property (concentration) and three different light intensities (150, 112 and 75 $\mu\text{E}/\text{m}^2\cdot\text{s}$) through the Proton Exchange Membrane Fuel Cell (PEMFC) electricity generation. The highest hydrogen flow ratio to the entrance of the PEMFC (kg/h) per biomass (g) was obtained at higher intensity light, 150 $\mu\text{E}/\text{m}^2\cdot\text{s}$, with a value of 1.54×10^{-8} .

WIND ENERGY POTENTIAL STUDY IN SAN QUINTÍN, BAJA CALIFORNIA

17

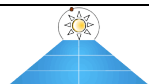
Marlene Zamora Machado^{1*}, Alejandro Adolfo Lambert Arista²

This work shows a study of the wind characteristics, taking into account its direction and speeds, of the city of San Quintín, Baja California. The analysis is based in the information obtained from the local weather station, for an evaluation period from 2004 to 2007. Weibull statistical parameters were calculated and wind roses were generated for each month, to observe temporary wind variations and, specially, sea breezes. Additionally, the estimated mechanical energy extracted from the wind was calculated, usable energy and electric energy produced by a wind turbine of small power. These estimations were compared against a simulation made using the HOMER software for the same wind conditions and same turbine. Such results may be useful to extract wind energy in the zone, where there are seven locations that do not have electric energy.

PARALLEL CONNECTION AND SANDWICH ELECTRODES LOWER THE INTERNAL RESISTANCE OF A MICROBIAL FUEL CELL

Arelis Ortega-Martínez¹, Omar Solorza-Feria², Elvira Ríos-Leal³, Katy Juárez-López⁴, María T. Ponce-Noyola⁵, Noemí F. Rinderknecht-Seijas⁶, Héctor M. Poggi-Varaldo¹.

18





The internal resistance (R_{int}) is one of the main factors that have an impact on microbial fuel cell (MFC) performance. The objective of this work was to design and characterize a novel, multiface parallelepiped MFC in the perspective of decreasing the R_{int} and increasing the volumetric power (P_v) output. The cell was fitted with a 'sandwich' cathode-membrane-anode assemblage, and possessed a ratio electrode surface area-to-volume ξ (csi).

The R_{int} was determined by the polarization curve method. MFC-P characterization was first carried out with the five faces connected in series and second with faces connected in parallel. Microbial fuel cell was loaded with sulfate-reducing inoculum and the substrate was a stock of short-chain organic acids and solvents representative of the leachate generated in dark fermentation of organic wastes.

When the 5 faces of the MFC-P were connected in series, the R_{int} was 600 Ω with a voltage of 0.52 V. Characterization of the cell with the 5 faces connected in parallel gave a R_{int} of 60 Ω with a voltage of 0.5 V. This result was ascribed to the changes in cell architecture, decrease of the inter-electrode distance as well as the parallel connection. The P_v of the new MFC-P achieved values of 62 and 570 mW/m^3 for series and parallel connection, respectively.

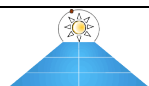
COMPARISON OF VARIABLE RESISTANCE AND LINEAR SWEEP VOLTAMMETRY METHODS FOR CHARACTERIZING A MEDIATOR-LESS SINGLE CHAMBER MICROBIAL FUEL CELL LOADED WITH SULFATE REDUCING BIOCATALYSTS

K. Sathish Kumar¹, Omar Solorza-Feria^{2,1}, Gerardo Vazquez-Huerta²,

19

Héctor M. Poggi-Varaldo^{3,1*}

A single-chamber microbial fuel cell (SCMFC) with a carbon supported Pt-cathode for the oxygen reduction reaction (ORR), and a sulfate reducing bacterial consortium as biocatalyst in the anodic chamber was characterized by polarization of variable resistance (VR) and linear sweep voltammetry (LSV). From VR a maximum power density of 16 $\text{mW m}^{-2} \pm 4.06$ was attained at a current density of 75.5 $\text{mA m}^{-2} \pm 13.55$ and voltage of 0.21 V ± 0.105 . The LSV method gave a maximum power density of 20.2 $\text{mW m}^{-2} \pm 80.09$ at current density of 202 $\text{mA m}^{-2} \pm 27.24$ at the potential of 0.10V ± 0.17 . Internal resistance values were 764 Ω and 884 Ω , determined by VR method and electrochemical impedance spectroscopy, respectively. Reasonable agreement values of electrochemical characteristics of the SCMFC between both methods were found, although the maximum power densities determined by LSV were 20% higher than that obtained by resistance methods.





ELECTRICAL STRESS-DIRECTED EVOLUTION OF BIOCATALYSTS COMMUNITY SAMPLED FROM A SODIC-SALINE SOIL FOR MICROBIAL FUEL CELLS

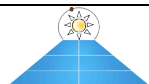
20 K. Sathish Kumar¹; Omar Solorza-Feria^{2,1,*}; Gerardo Vázquez-Huerta²; Marco A. Meraz-Ríos⁴; J. P. Luna-Arias⁵; Héctor M. Poggi-Varaldo^{3,1}

Anode-respiring bacteria (ARB) perform an unusual form of respiration in which their electron acceptor is a solid anode. The focus of this study was to characterize the electrical stress direct evolution of biocatalysts as a way of enriching the community with ARB for microbial fuel cell. The original microbial consortium was sampled from a sodic-saline soil (Texcoco Lake). Interestingly, the most probable number of iron (III) reducing bacteria in the original consortium was 8500 ± 15 MPN/100 mL, since iron (III) is reported to be associated to anode-respiring capabilities. Cyclic voltammetry studies of electrochemical stressed biofilm-ARB were conducted at 135th day, and an irreversible electron transfer reaction of alkaliphilic cytochrome, due to the electrode fouling was found. The electrochemical impedance spectroscopy results revealed that the resistance of the biofilm-ARB decreases with the time, associated to the adaptability of electroactive biofilm on the graphite electrode surface. Confocal microscopy revealed that the biofilm-ARB attained ~ 40 μm thickness. Electrical stressed-ARB gave a maximum power density of 79.44 mW/m^2 , which was greater than that obtained by the chemical stressed-ARB (48.48 mW/m^2) in a single-chamber microbial fuel cell (SCMFC).

THERMAL TREATMENT EFFECTS ON Pd₅Cu₄Pt ELECTROCATALYST FOR THE OXYGEN REDUCTION REACTION IN A PEM FUEL CELL

21. D. C. Martínez Casillas^{1,*}, O. A. Gil Esquivel¹, O. Solorza Feria¹.

The research is aimed to study the thermal treatment effects in the electrochemical activity of Pd₅Cu₄Pt catalyst for the oxygen reduction reaction, ORR, as well as on its performance as cathode electrode in a single proton exchange membrane fuel cell, PEMFC. The electrocatalyst was synthesized by chemical reduction of PdCl₂, CuCl₂ and H₂Cl₆Pt•6H₂O with NaBH₄ in THF. Annealing in H₂ atmosphere was performed at 200 and 300 °C. The electrocatalysts were characterized by X-ray diffraction and scanning electron microscopy. Cyclic voltammetry (CV) and rotating disc electrode (RDE) were performed for electrochemical characterization in a 0.5 M H₂SO₄ at 25 °C. Results of thermal treatment showed the growth of nanocrystallite particles and an enhancement of the crystallinity of the electrocatalyst. Notorious shifts towards positive XRD 2 θ values are associated to the incorporation of elements inside the crystalline structure of the sample. The electrochemical results showed a decrease in the electrocatalytic activity as the temperature of the annealing increase. The maximum power density, W_{max} , was 350 mW cm^{-2} was achieved using Pd₅Cu₄Pt without thermal treatment with 0.8 mg cm^{-2} catalyst loading as cathode in a PEMFC. These results are attributed to the formation of new inactive-ORR phases with the thermal treatment.





HYBRID ELECTRIC VEHICLE (NAYAA) BATTERIES – FUEL CELL

22 A. Rodríguez-Castellanos, S. Citalán-Cigarroa, J. L. Díaz-Bernabe, O. Solorza-Feria

Worldwide, the automobile sector emits 25 %of CO₂ .This will be increase up to 50% in 2030 and more than 80% in 2050, according to the International Energy Agency (IEA, info. 2009).

The use of hybrid vehicles can significantly reduce the amount of polluting gases in the atmosphere. A hybrid electric vehicle (HEV) has two or more power sources on board and depending on system configuration; two or more sources of energy are used to drive the vehicle. The interest of our research is to reduce the automobile emission of pollutants gases in the atmosphere. This has created the need to develop and build a wide variety of systems and devices.

Our experimental work presents the design, construction and performance evaluation of a hybrid electric vehicle (Nayaa), powered by a generator with PEM fuel cells and / or rechargeable batteries. The generator design was done using AutoCAD software. Construction of fuel cells was carried out by CNC router and CNC laser cutter.

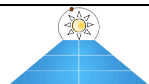
The fuel cells characterization was performed by potentiostatic polarization tests. The operation conditions of generator with fuel cells were: feeding the fuel (H₂) and oxidant (air) at room temperature and a pressure of 0.1 atm (1.5psi), operating temperature varied from 20 °C to 70 °C. This experimental work presents the commissioning of the hybrid electric vehicle, which weighs was 80 kg, made of aluminum.

23 High catalytic activity and degree of tolerance to ethanol of low platinum-content Pt-CeOx/MWCNT in acid media

Alberto Gaona Coronado, Javier Rodriguez Varela, Juan Carlos Loyola, Iván Escalante-García , Pascual Bartolo Pérez

We report the evaluation of a Pt-CeOx/MWCNT electrocatalysts with low-platinum content. The cathode material was synthesized by the microwave-assisted polyol process. The Pt-CeOx/MWCNT cathode showed a high mass specific catalytic activity for the oxygen reduction reaction (ORR) and high degree of tolerance to ethanol. EDAX analysis indicated that the weight content of Pt in the composite cathode was 3.8 wt %. Meanwhile, XPS characterization of ceria revealed a material with a predominant Ce+3 oxidation state. The catalytic activity for the ORR and enhanced tolerance properties of Pt-CeOx/MWCNT to ethanol were indeed ascribed to the presence of the Ce₂O₃ phase in the composite cathode.

24 Synthesis and characterization of novel Pd-CeOx/MWCNT electrocatalysts as ORR cathode materials for DAFCs





Alberto Gaona Coronado, Javier Rodriguez Varela, Juan Carlos Loyola

Novel Pd-CeOx/MWCNT cathode electrocatalysts were synthesized in a tubular furnace under H₂ atmosphere. The Pd:Ce ratio was 1:1 (w/w). XRD analysis demonstrated the fcc characteristics of Pd and the appearance of reflections indexed to CeO₂ (1 1 1), (2 0 0) and (3 1 1) planes at $2\theta = 28, 33$ and 56° . The rotating disc electrode measurements showed a high mass specific catalytic activity of the Pd-CeOx/MWCNT cathodes for the ORR. Moreover, the novel materials showed a high selectivity in ethanol containing acid electrolyte, indicating their potential for DAFCs applications. novel electrocatalysts, Pd-ceria cathodes, ORR, tolerance to ethanol

26 Oxidative Steam Reforming of Methanol and Hydrogen production: Effect of the Cu and Ni Impregnation on CeO₂

Albina Gutiérrez-Martínez, Antonio Alba, Raúl Pérez-Hernández

Cu and Ni were supported on CeO₂ by the impregnation method. The surface area of the catalysts were close regardless the order in which the metals were added to cerium oxide. TPR profiles of the Cu/Ni-base catalysts showed differences; between them the Cu/CeO₂ sample had the lowest reduction temperature among all the catalysts. The reactivity of the Ni/CeO₂ catalyst for oxidative steam rearing of methanol to hydrogen production showed the best catalytic activity in the range of 200-400 °C. The reactivity of catalysts followed the next order: Ni/CeO₂ > Cu-Ni/CeO₂ > Ni/Cu/CeO₂ > Cu/Ni/CeO₂ > Cu/CeO₂.

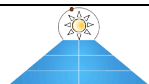
PLATINUM DEPOSIT ON WO₃-C SYNTHESIZED BY DIFFERENT METHODS AS CATALYST IN PEMFC

27 M. L. Hernández-Pichardo^{1*}, R. G. González-Huerta², S. P. Paredes-Carrera¹, J. A. Frias-Rojas¹,
E. Palacios-González³, P. del Angel³

Practical catalysts for low-temperature fuel cells are typically in the nano-size range and are typically deposited on high-surface-area supports. Pt/C is the most commonly used catalyst for both cathode and anode in proton exchange membrane fuel cells (PEMFCs), however, some other catalysts such as Pt/MoO_x and Pt/WO_x are also considered promising, and therefore, this work is focused on the synthesis and characterization of nanostructured Pt/WO_x-C as both cathode and anode electrocatalysts for PEMFCs. The Pt deposit on the surface of the support is a crucial step in the synthesis of the catalytic materials, so then different synthesis methods were probed in order to find the conditions for the higher dispersion and accessibility of Platinum over the WO_x-C support and to improve the PEMFC cathode stability. The catalysts were prepared by UV and ultrasound assisted approaches, and characterized by Transmission Electron Microscopy and lineal and cyclic voltammetry.

DECONTAMINATION OF DRINKING WATER BY A COMBINED PHOTOCATALYSIS-SORPTION SYSTEM AT LOW ENERGY

28 S.P. Paredes¹, M. A. Valenzuela¹, M. L. Hernández-Pichardo¹, Rodríguez-Clavel I. S.¹.





A photocatalysis-sorption coupled system was studied to degrade and reduce organic and inorganic contaminants from drinking water. The pollutants contained in water of Mexico City was identified, quantified and classified. A photocatalytic annular reactor was designed, built and tested. It was found that the photo-reactor was able to degrade up to 200 ppm of organic contaminants, using TiO_2 supported on glass beads as catalyst. The remnants of degradation were treated by sorption. The sorption procedure developed was capable to remove organic pollutants and reduce the concentration of metal cations and anions. The calcined hydrotalcite with nitrate as interlaminal component and synthesized by ultrasonic irradiation is the best option to remove anionic species. In the case of cationic species the activated carbon, in all cases, was a better material than bentonite or natural zeolite. Finally, both systems were coupled into a photocatalytic-sorption assembly.

29

EFFECT OF WO_x OVER Ni/HYDROTALCITE CATALYSTS TO PRODUCE HYDROGEN FROM ETHANOL

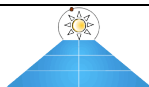
J. L. Contreras^{1*}, M.A. Ortiz¹, G.A. Fuentes², M.Ortega³, R.Luna¹, M. Gordon¹, J.Salmones⁴, B.Zeifert⁴, L. Nuño¹ and T. Vázquez¹

The effect of WO_x over Ni-hydrotalcite catalysts to produce H_2 by ethanol steam reforming was studied. The catalysts were characterized by N_2 physisorption (BET area), X-ray diffraction, and Infrared and UV-vis spectroscopies. The W concentration ranged from 0.5 to 3 wt%. As W concentration increased, the intensity of XRD reflections of the Ni catalysts decreased. The porous structure of the materials consisted of parallel layers with a monomodal mesoporous distribution. The surface groups detected by IR were: -OH, Al-OH, Mg-OH, W=O and CO_3^{2-} . UV-vis results suggested that Ni^{2+} ions were substituted by W ions. The catalytic evaluations were made in a fixed bed reactor using a water/ethanol mol ratio of 4 at 450°C . Catalysts with low loadings of W (0.5 and 1%) showed the highest H_2 production and stability. W promoted the conversion of ethanol towards hydrogen in the case of the Ni-hydrotalcite catalysts. The reaction products were; H_2 , CO_2 , CH_3CHO , CH_4 and C_2H_4 . The catalysts did not produce CO.

30 Synthesis And Characterization Of MgTa Alloy And Its Possible Use In Hydrogen Storage

José Luis Iturbe-García, Alberto Sandoval Jiménez

Abstract The synthesis and characterization of intermetallic MgTa and their possible use in hydrogen storage is presented. The elements of Mg and Ta with purity of 99,8% were used to prepare the intermetallic compound. The mechanical alloying technique was utilized for to prepare the alloy with a high energy mill type spex, for which the milling time was 5 and 10 hours. The material was first characterized by scanning electron microscopy (SEM) and X-ray diffraction





(XRD). Hydrogenation tests were carried out in a micro-reactor with varying pressure, temperature and reaction time. The material was analyzed with a thermogravimetric system before and after the hydrogenation process. The preliminary results of X-ray diffraction analyses demonstrated that the hydrides formed and identified with the hydrogenation process were the phases of tantalum (Ta₂H and TaH_{0.5}). The results will be discussed. Keywords: MgTa intermetallic, mechanical alloying, XRD and SEM, absorption/desorption hydrogen process, thermogravimetric analysis.

31

Electrochemical Behavior of Ni-based Alloys as Negative Electrode for Nickel-Metal Hydride Batteries

Liliana Vazquez-Mota^a, Karina Patlán-Olmedo^a, Miguel Angel Oliver-Tolentino^b, Rosa Gonzalez-Huerta^a, Hector Javier Dorantes-Rosales^c, Arturo Manzo-Robledo^a

Nickel-based alloys (Ni_{0.8}Co_{0.1}Zn_{0.05}MnO_{0.02}Ti_{0.01}Y_{0.01}Al_{0.01} (M1), NiO_{0.8}Co_{0.1}Zn_{0.05}MnO_{0.02}Ti_{0.01}Y_{0.01}Al_{0.01} (M2) and NiO_{0.6}Co_{0.35}Zn_{0.025}Ti_{0.025} (M3)) were synthesized from high purity powders by means of high-energy mechanical milling. The hydrogen evolution reaction (HER) kinetic-performance of the as-prepared materials was evaluated using linear sweep voltammetry at alkaline conditions and room temperature. According to kinetic parameters calculated from Tafel slopes, the major activity for the HER was obtained in the sample M2. These results suggest that the surface state in the material play an important role in the proton-adsorption kinetic as demonstrated by SEM, open circuit potential transients and cyclic voltammetry techniques.

KINETICS STUDY OF HYDROGEN STORAGE IN MECHANICALLY ALLOYED Mg ALLOYS

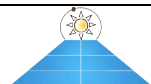
32 G. Garcia-Pacheco^{1*}, J. G. Cabañas-Moreno², K. Suarez-Alcantara³.

The present work is aimed to the study of the kinetic mechanisms of hydrogen storage and release in mechanically alloyed Mg_{97.4}Fe_{2.6} and Mg₉₀Ni₁₀ powders, at three different temperatures (275, 300 and 350°C), and particle sizes in the range of 1-7 µm. At each temperature, the powders were subjected to two complete cycles of hydriding and dehydriding by exposure to an atmosphere of hydrogen under alternate pressures of 3 and 0.01 MPa, respectively.

The experimental data of transformation fraction of hydrogen captured (or released) *versus* time were analyzed using the Johnson-Mehl-Avrami model (JMA). Fitting of the data to the JMA model was best performed using only one set of kinetic parameters (*k*, *n*).

The calculated values of the JMA exponent *n* are remarkably different among the two different alloyed powders. However, in most cases it is difficult to reconcile such calculated values of *n* with the physical mechanisms expected to operate during the hydriding and dehydriding processes in Mg alloys. Only with supporting microstructural observations of partially transformed samples it will be possible to demonstrate whether the description of transformation kinetics with a given model is fortuitous or true.

33 Synthesis of Sb doped SnO₂ (ATO) nanoparticles as support to IrO₂ used to anode an electrolyzer ESP





Julio Cruz

Sb doped SnO₂ (ATO) nanoparticles was synthesized by a colloidal technique and heat treatment and used to anodic support material in a solid polymeric electrolyzer (SPEE). This support was characterized by the techniques of X-ray Diffraction (XRD), X-ray fluorescence (XRF), transmission electron microscopy (TEM) and Brunauer Emmet Teller (BET). Was mixed physically with IrO₂ (30 wt. %) synthesized with appropriate characteristics to carry out the oxygen evolution reaction and deposited onto a Nafion membrane 115. Which was used to as anode in a SPEE. The electrochemical characterization was carried out in half-cell and single cell. Using the techniques of electrochemical impedance spectroscopy, cyclic voltammetry, linear voltammetry and chronoamperometry.

34 Preliminary design of hybrid Fuel Cell - Battery power systems for electric vehicles: A simple approach.

Leonardo De Silva Munoz

Fuel cell systems in electric vehicles are generally designed as hybrid power systems using batteries and/or supercapacitors as energy buffers that allow a better dynamic response of such vehicles in order to power demand changes and cover longer distances per charge. When an optimal performance is required, designing hybrid power systems can be a complex task that needs to consider the vehicle's specifications, power demand cycles, power management control schemes, and the dynamic response characteristics of the fuel cells, batteries and supercapacitors to be used. Nevertheless, simpler approaches can be implemented for preliminary design of such systems where there is a large number of unknown variables. In the present work, hybrid Fuel Cell

35 Basic dynamic behaviour of a commercial 1 kW fuel cell system.

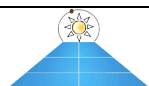
Leonardo De Silva Munoz

Fuel cells are one of the most promising technologies for future clean energy generation. One of the most popular configurations in commercial fuel cells is the air breathing design, where atmospheric air is transported along fuel cell channels by natural or forced convection. The performance of air breathing polymer electrolyte membrane fuel cells (PEMFC) is very sensitive to environmental conditions as well as to the operation history of the system. In order to determine the dynamic performance of a 1 kW commercial air breathing PEMFC system, tests were performed using an electronic load. Fuel cell stack voltage, current, hydrogen consumption and temperature were recorded during the tests. With the experimental steady and dynamic data, polarization curves, transient behavior and stack efficiency were determined. Results show that the load regime for the fuel cell stack has an important effect on its overall performance.

DECENTRALIZED POWER PLANNING: A REVIEW OF MATHEMATICAL MODELS

36

Juan Rojas Zepa¹, José Yusta Loyo², Carlos Ponce Corral³





A description of the mathematical models used in decentralized energy planning is made in order to examine the models applied, their limitations, applications and trends. After the 90's, the literature showed a clear change of paradigm in the decentralized power planning. This new paradigm is characterized by the inclusion of more than one criteria or objective evaluation, which makes the planning a multidimensional process. In this regard, we found evidences to demonstrate the relevance of Multi-criteria Decision Making models for decentralized energy planning.

37

Synthesis of aluminosilicates under high pressure and using sulfur as directing agent: study of hydrogen and water adsorption.

Sandra Loera^{1,*}, Jorge Flores¹, Enrique Lima², Heriberto Pfeiffer², Miguel A. Olivier¹, and Victor H. Lara¹

In the present work we have investigated the use of aluminosilicates with sulphur as potential hydrogen storage materials. Two aluminosilicates were prepared under hydrothermal conditions. Silica, sodium aluminate, sodium sulfide and sulfur were used as raw materials. Starting with similar reacting mixtures, analcime (zeolite, $\text{Na}(\text{Si}_2\text{Al})\text{O}_6 \cdot \text{H}_2\text{O}$) and beidellite (clay, $\text{Na}_{0.3}\text{Al}_2(\text{Si},\text{Al})_4\text{O}_{10}(\text{OH})_2 \cdot 2\text{H}_2\text{O}$) were synthesized varying pressure, 2 kbar and 1 kbar, respectively. Sulphur was present in both aluminosilicates's surfaces, which confer to them particular adsorption properties. Additionally, water adsorption isotherms, under dynamic conditions, were obtained. Fractal dimension values and SEM micrographs reveal very different textural and morphological properties of two prepared aluminosilicates. Hydrogen adsorption capacities were measured at 77 K and low pressure (until 1 bar). The results showed that hydrogen uptake in aluminosilicates are strongly dependent on framework and sulphur content.

38

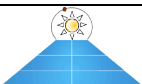
CHARACTERIZATION OF AN ULTRASONIC NOZZLE FOR THE MANUFACTURE OF MEMBRANE-ELECTRODE ASSEMBLIES

J. Roberto Flores Hernández^{1*}, I. Lorena Albarrán Sánchez¹,

One of the principal goals in the manufacturing of Membrane-Electrode Assemblies (MEAs) is to obtain a uniform and homogeneous distribution of the catalyst ink during its deposition on the membrane. When the spraying technique is used to manufacture the MEAs is very important to maintain the stability of the catalyst ink in a dispersion solution during the manufacturing process. Unfortunately most of the catalyst inks have a tendency to clump and are difficult to keep evenly dispersed in solution, due to this fact it is very common the occurrence of clogging of the air brush during the spraying process. One alternative to avoid this problem is the use of an ultrasonic nozzle which has also been reported in the literature. The characterization of an ultrasonic nozzle, that was carried out to find the optimal parameters of operation, is presented in this work.

39 MECHANICAL STABILIZATION OF NAFION® MEMBRANE TO FACILITATE THE MANUFACTURE OF THE MEMBRANE-ELECTRODE ASSEMBLIES

J. Roberto Flores Hernández^{1*}, I. Lorena Albarrán Sánchez¹, Brenda Reyes Peraza²
F. Isaías Vado Martínez²





During the fabrication of Membrane–Electrode Assemblies (MEAs), the ambient temperature and the humidity have a great influence on the Nafion® membrane generating folds and irregularities on it. As a result, it is normal to obtain a MEA with some folds or wrinkles in the interface of the catalyst layer and on the membrane or on the area of the membrane that was not coated with the catalyst ink. These deformations can cause serious sealing problems in the integration of a fuel cell stack. In this paper a method to stabilize mechanically the Nafion® membrane is presented. This method was applied successfully to Nafion® 117 and 212 membranes. The comparison results of the MEAs manufactured with membranes treated and without are also presented.

CHARACTERIZATION OF CHITOSAN PROTON EXCHANGE MEMBRANE

Molina Rojas D. S.^{1*}, Mendoza López D.¹, Cortés Escobedo C. A.¹, Vázquez Huerta G.²,
Solorza Fera O.², González Huerta R. G.³

40

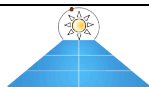
The proton exchange membrane is a fundamental part of the fuel cell. Up to now only Nafion® from D upont® is the best membrane because of its conduction properties, so it becomes necessary to develop new materials improving its conduction, but also mechanical and absorption properties. On this work the use of a biopolymer called chitosan is proposed as a less-expensive and environmentally-friendly alternative membrane for proton exchange membrane fuel cells. The evaluation of chitosan membranes with different molecular weight was made using Nafion® 117 as control, the variables for the biopolymer were: high, medium, low and practical grade, all with sulfite groups like proton conductors from activation with H₂SO₄, this evaluation included thermal stability, proton conductivity and water absorption. Results indicate proton conductivity increases with molecular weight and thermal stability shows temperature at which the material is completely decomposed. The molecular weight difference is the energy used to break bonds, while the weight lowers the peaks decrease, it applies to all weight except for the medium which was the smallest. The water absorption was the same for the different molecular weight.

41 DESIGN AND CHARACTERIZATION OF A BIOFUEL CELL USING A LACCASE ELECTRODE AS CATHODE

Javier Martínez Ortiz1, J. Roberto Flores Hernández2*, Rafael Vazquez Dualt1 and I.
Lorena Albarrán Sánchez2

The wide and increasing demand of energy of our modern world makes it almost impossible that only one technology satisfies such demand in a sustainable and economic way. For this reason several researcher groups investigate new technologies in order to obtain technologies that can supply specific ranges of power in a sustainable and economic way. This is the case of biofuel cells that are promising devices for flexible, compact and inexpensive micropower systems operating at “mild” conditions. As a result of a collaboration between the Instituto de Biotecnología (UNAM) and the Instituto de Investigaciones Eléctricas, a biofuel cell using a laccase enzyme electrode as cathode was designed and characterized. In this paper, the preparation of laccase electrodes, the performance of such electrodes and the stability in operation of a biofuel cell is presented.

42 Synthesis And Characterization Of Agn-Ptm/C Catalyst For PEMFC Cathode





Andres Godinez-Garcia, Diana C. Martínez-Casillas, J. Francisco Perez-Robles, Omar Solorza-Feria, Luzma R. Aviles-Arellano, H. Vladimir Martínez-Tejada

AgnPt_m carbon supported catalyst was prepared using a colloidal solution and high intensity ultrasound. The colloidal nanoparticles in solution were characterized by optical techniques such as dynamic light scattering (DLS) and UV-vis spectrophotometer. After drying the obtained electrocatalyst powders were characterized by X-Ray Diffraction (XRD), Scanning Electron Microscopy and High resolution electron transmission microscopy (HRTEM). Activity of the prepared catalyst for the oxygen reduction reaction (ORR) was examined in 0.5M H₂SO₄ by cyclic voltammetry, rotating disk electrode (RDE) and also in a membrane-electrode assembly, MEAs, for a single PEMFC. The AgnPt_m/C catalyst exhibited high current density and low overpotential for the ORR like pure platinum. Activity can be attributed to a possible formation of Ag @ Pt core-shell nanoparticles.

43

ORR PERFORMANCE OF Pt-OXIDE-C ELECTROCATALYSTS PREPARED BY CVD

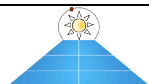
Beatriz Ruiz Camacho^{1,*}, Arturo Patiño Rojas¹, Rosa Guadalupe González Huerta¹, Miguel A. Valenzuela¹, Roberto Vargas García², Nicolás Alonso-Vante³.

Low durability of Pt/C electrocatalysts in the polymer electrolyte membrane fuel cells (PEMFC) caused by, e.g., carbon oxidation to CO₂ in acid medium has been recognized as one of the most important drawbacks for long term stability. The additions of different semiconductor oxides, such as TiO₂, SnO₂ or WO₃, confer stability to metal center on carbon-composites, and improve PEMFC performance. In this work, a series of 10%Pt-C and 10%Pt-5%oxide-carbon composites using three oxides (TiO₂, SnO₂, ZnO) has been prepared by a chemical vapor deposition method (CVD). The physical and electrochemical properties were investigated by XRD, hydrogen chemisorption, TEM, CO stripping, cyclic and linear voltammetry as characterization techniques. The prepared materials were electrochemically evaluated in the oxygen reduction reaction (ORR) in acid medium at room temperature. XRD results show a Pt crystalline structure in the different materials synthesized. The average particle size of Pt was determined by hydrogen chemisorption. The size and morphology of Pt nanoparticles were confirmed by TEM. 10%Pt-5%TiO₂-C electrocatalyst showed the higher electrochemical active surface area and the better activity results for the ORR compared with 10%Pt-C, 10%Pt-5%SnO₂-C and 10%Pt-5%ZnO-C materials.

45 Synthesis and characterization of WO₃ for its application in tandem cells

Manuel Rodríguez, Geonel Rodríguez, Gerko Oskam

To establish an economy based on hydrogen hinges on 3 challenges: production, storage and efficient use. The current commercial methods for H₂ production, water electrolysis, gasification and gas reforming, usually require a large consumption of energy from non-renewable sources. New technologies for H₂ production are needed, where oxygen and hydrogen are produced by water dissociation using solar energy as renewable source. For this purpose,



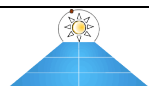


photoelectrochemistry using nanostructured metal oxide electrodes is a promising method. In general, it appears necessary to use tandem cells with two photo-active systems in order to achieve water splitting. In this work, we present a study of the synthesis of WO₃ nanoparticles from the thermal dehydration of tungstic acid (H₂WO₄•2H₂O). The starting material was deposited in film form, by employing the screen-printing and electrodeposition methods. The WO₃ films obtained are used as photo-anodes for oxygen production, and we evaluate the efficiency of oxygen production as a function of the film morphology. In order to obtain water splitting, WO₃ half-cell is combined with a dye-sensitized solar cell, which provides the electrons for hydrogen evolution.

47 Hydrogen Storage In Nanocavities Of Porous Imidazoles.

Claudia Vargas, Jorge Roque, Karina Tapia, Edilso Reguera, Hernani Yee

In this work the hydrogen storage in nanoporous imidazoles and derivatives is discussed. This family of materials are formed by the assembling of molecular blocks from imidazole and its derivatives, through transition metal (M) ions. In the coordination to the metal centers participate both the pyridinic and pyrrolic nitrogen atoms of the involved molecular blocks. The N-M-N bridge angle is 145°, the typical O-Si-O angle for zeolites. The pore topology for that family of porous molecular solids is also similar to that observed in zeolites but, with certain advantages related to the relatively low weight of imidazoles, a larger length for the bridge group, the possibility of using different derivatives with a high variety of substituent groups. For hydrogen storage, their main attractive is related to the possibility of having flexible porous frameworks where the hydrogen molecule can be adsorbed at high pressure and then released at low pressure. In this study we are reporting the synthesis and structural and thermal study of a series of imidazoles and their derivatives followed of a systematic evaluation of the hydrogen storage in the porous framework. The adsorption forces for hydrogen in this family of porous solids are dominated by dispersive type interactions; however, the recorded adsorption isotherms show a step-like behavior typical of structural changes for the porous framework related to the applied pressure and the amount of uptake hydrogen. Acknowledgment: This work was partially supported by the Project SEP-CONACyT-2009-129048 keywords: imidazoles, hydrogen storage, adsorption





SYNTHESIS OF BiVO_4 BY MECHANOCHEMICAL REACTION BETWEEN Bi_2O_3 AND V_2O_5

48 B. Fuentes-Martínez, K.P. Padmasree, E. Mendoza-Mendoza, A.F. Fuentes

Bismuth vanadate (BiVO_4) based compounds have many fascinating and multifunctional properties for potential applications in a wide variety of areas. The different properties exhibited by this material depend strongly on the crystalline form and microstructure. In this work we report the selective synthesis of nanocrystalline bismuth vanadate powders of monoclinic phase through a mechanochemically assisted metathesis route. The metathesis pathway of forming the desired product is confirmed by the presence of NaNO_3 after milling the mixtures for different time periods of 15, 30 and 60 min. The crystallization process and thermal behavior of the BiVO_4 phase obtained at different milling times were studied by both differential thermal analysis (DTA) and thermo gravimetric analysis (TGA), and X-ray powder diffraction (XRD) methods. XRD patterns of the product after washing showed the formation of the BiVO_4 phase with monoclinic structure for different milling times, the structure which exhibit higher photocatalytic activity under visible light irradiation and superior coloristic properties over the other forms.

49 Ethanol Electro-Oxidation Using Supported Multimetallic Active Phases

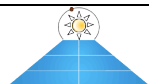
L. C. Ordóñez, F. Avilés, G. Martínez, A. J. Delgado, R. L. Nolasco

Recently, there has been an increasing interest for the development of direct ethanol fuel cells (DEFC) because they have an acceptable electrochemical activity and ethanol can be produced from organic raw material by fermentation and distillation. Nowadays, the major challenge for DEFC is the creation of sufficiently active and selective anode electrocatalysts. The complex ethanol oxidation reaction in DEFC forms intermediate species that adsorb strongly and poison the catalytic active sites of the typical carbon supported Pt electrode. In this work we propose two alternatives to improve the catalytic performance of the anode: the addition of multimetallic promoting phase and the incorporation of carbon nanotubes as support. PtRuMo , PtRuSn and PtMoRuSn materials supported on carbon Vulcan or carbon nanotubes were prepared by the chemical reduction of the metal salts using formic acid solutions. Samples were characterized by cyclic voltammetry, steady state voltammetry and Electrochemical Impedance Spectroscopy. Physical characterization included SEM-EDX, and XRD. Lower electronic transfer resistances were obtained we the carbon nanotubes materials and the tetrametallic active phase.

50

SYNTHESIS AND TRANSPORT STUDIES OF NANO-CRYSTALLINE $\text{Ce}_{1-x}\text{Bi}_x\text{O}_{2-\delta}$ SYSTEMS

Siomara Martinez-Costilla¹, Sagrario M. Montemayor¹, Padmasree Karinjilottu Padmadass²,
Antonio F. Fuentes³





In this work, a series of nano-crystalline solid solutions $(\text{CeO}_2)_{1-x}(\text{Bi}_2\text{O}_3)_x$ (where $0 \leq x \leq 1$, in steps of 0.2) were synthesized by Pechini method. The polymeric precursors were characterized by fourier transform infra red (FTIR) spectroscopy, and differential thermal analysis (DTA) and thermogravimetric analysis (TGA). The obtained solid solutions were studied by x-ray diffraction (XRD) and impedance spectroscopy (IS). All the prepared solid solutions exhibit a single phase cubic fluorite structure and the average crystallite size calculated using the Scherrer formula from the XRD spectra of all compositions treated from 400 to 800 °C were between 5.4 and 19.9 nm. Oxygen ion conductivity increased with the increase of dopant concentration and maximum is obtained for $\text{Ce}_{0.4}\text{Bi}_{0.6}\text{O}_{2.5}$ system. The Bi^{3+} doped ceria exhibit an ionic conductivity of the order of 10^{-3}S/cm at 600°C and is due to the presence of more oxygen vacancies introduced into the system with doping.

“Steam reforming of ethanol for hydrogen production using Ni-W/CeO₂, Ni-W/ γ -Al₂O₃ and Ni-W/HT catalysts”

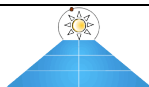
53 I.P. Hernández¹, A. M. Fernández², Y. Gochi-Ponce³

Ni-W catalysts supported on CeO₂, Al₂O₃ and Hydrotalcite (HT) were studied in the steam reforming of ethanol at 500-650°C. The CeO₂ and HT were synthesized by impregnation and direct coprecipitation methods, respectively. Commercial Al₂O₃ was used. Nickel content was varied from 10, 15 and 30% with 1% W. 10% Ni-W/HT was the catalyst that presented the highest catalytic activity and selectivity to hydrogen. Conversion to ethanol was 100% and selectivities to H₂, CH₄, CO₂ and CO were 75, 5.78, 0.37 and 18.85% respectively, at a temperature of 500°C. Moreover, these catalysts showed good stability with respect to carbon deposition and low selectivity towards C₂H₄ production. These are desirable features for catalysts to be used in hydrogen production for fuel cell applications.

54

INFLUENCE OF THE pH ON HYDROGEN PRODUCTION BY SSF OF PAPER INDUSTRY WASTES USING ANAEROBIC BIOFILMS

Emma Berenice Herrera Ramírez¹, Ileana Mayela María Moreno Dávila¹, Leopoldo Javier Ríos González^{1*}, Baltazar Gutiérrez Rodríguez¹, Yolanda Garza García¹, Jesús Rodríguez Martínez¹.





The present research studies the influence of pH in the fermentative hydrogen production in batch reactors, by simultaneous saccharification and fermentation (SSF) from paper industry wastes using anaerobic biofilms. Paper industry wastes contain: lignin (22.6%), hemicellulose (42%) and cellulose (35.06%). The milled and mashed paper waste that was used had an average particle diameter of 710 μ . The hydrolysis conditions of the commercial enzyme were verified (temperature, pH and speed of agitation). Results of optimal conditions were as follows: temperature 45 $^{\circ}$ C, pH of buffer 5.5 and 100 rpm. Studies of the influence of the pH were investigated by experimental design in fermentative production of the hydrogen with pH values of: 4, 5 and 6, and taking optimal conditions of hydrolysis process: 100 rpm, temperature 45 $^{\circ}$ C and concentration of enzyme 10 FPU (filter paper assay) U mL $^{-1}$, and using anaerobic biofilms developed in spheres of ixtle fiber, obtaining a production of hydrogen of : 1.88, 1.63, 1.78 mol of H $_2$ for 6, 5 and 4 at 288 h of reaction.

55

A DFT STUDY OF THE POISONING EFFECTS OF CO ON Pd $_x$ Cu $_{1-x}$ (110) SURFACE

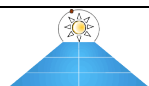
Ernesto López-Chávez^{1,*}, Alberto García-Quiroz¹, Fray de Landa Castillo-Alvarado², Gerardo Cabañas-Moreno³, José Manuel Martínez-Magadán⁴.

CO contaminants play a significant role in modifying the performance of proton exchange membrane fuel cells (PEMFC). The most common catalyst being used in the PEMFC is Pt. Recently however it has been found that using Pd alloys such as Pd-Cu can increase the fuel cell efficiency versus the pure Pt catalyst. In this work, we examine the adsorption of CO onto Pd $_x$ Cu $_{1-x}$ (110) surfaces, with different values of x, in order to improve the CO tolerance. Understanding how molecules interact with such surfaces is one the first steps to understanding catalytic reactions. We use CASTEP, a computational code based on the density functional theory plane-wave pseudopotential method. In the present study, we optimize the surfaces structure of Pd $_x$ Cu $_{1-x}$ (110) and then calculated, energy density of states, energies of repulsion and chemisorption for CO on Pd $_x$ Cu $_{1-x}$ (110). The results indicate that chemisorption energies of CO on Pd $_x$ Cu $_{1-x}$ are highly dependent on the concentration x of the alloy, and the catalyst poisoning arises from the loss of Pd $_x$ Cu $_{1-x}$ (d) electrons upon CO adsorption. In addition, density of states analysis indicate that the poisoning effect is a mechanism partially due to the loss of Pd-Cu(d) electrons upon CO adsorption.

56

HYDROGEN PRODUCTION IN UASB REACTOR USING ENZYMATIC HYDROLYSATES FROM PAPER INDUSTRY WASTES BY ANAEROBIC BIOFILMS: INFLUENCE OF HRT

Ileana Mayela María Moreno Dávila¹, Emma Berenice Herrera Ramírez¹, Leopoldo Javier Ríos González^{1*}, Baltazar Gutiérrez Rodríguez¹, Yolanda Garza García, Jesús Rodríguez Martínez¹.





The present study examines the effect of hydraulic retention time (HRT) in a 4-L upflow anaerobic sludge blanket (UASB) reactor using enzymatic hydrolysates obtained of paper industry wastes by anaerobic biofilms for hydrogen production. Paper industry wastes contain: lignin (22.6%), hemicellulose (42%) and cellulose (35.06%). The milled and mashed paper wastes had an average diameter corresponding to 710 μ . Three hydraulic retention times were tested in a reactor UASB: 1, 3, 6 h using mineral medium with glucose concentration of 20 g L⁻¹, by anaerobic biofilms developed in spheres of itxle fiber to pH 5.0. Enzymatic hydrolysis of 50 g L⁻¹ of paper industry wastes with a particle size of 710 μ to 125 rpm in 4 L of citrates buffer pH 4.8, temperature 45 °C and enzyme concentration of 5 mg mL⁻¹ was performed. Enzymatic hydrolysates (3.1 L, pH 7) were initially tested at HRT 1, there was no hydrogen production. Subsequently the HRT was decreased to 0.5 h, reaching a cumulative hydrogen production of 1.15 mol at 101 h of reaction.

57

SYNTHESIS AND CHARACTERIZATION OF SULFONATED HFA-co-DABS/ISO COPOLYAMIDES FOR POLYMER ELECTROLYTIC MEMBRANES

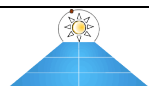
¹Pérez-Padilla Y., ²Smit M., ¹Canche-Escamilla G., ¹Aguilar-Vega M. J.

A series of sulfonated copolyamides with different sulfonation degrees were synthesized from 4,4'-(hexafluoroisopropylidene)dianiline, *HFA* and 2,4-diaminobenzenesulfonic acid, *DABS*, by direct polycondensation using Isophthalic acid, *ISO*, as comonomer. Thin films of the sulfonated copolyamides were prepared by the solution method using dimethylacetamide, DMAc. The structure of the resulting sulfonated polyamides was confirmed by ¹H RMN, which evidenced the presence of amide and sulfonic groups in the proposed concentrations. Their Mechanical properties, inherent viscosities, Ionic Exchange Capacity, IEC, water uptake, W_u and proton conductivity, σ , are also reported. The results showed that membranes present good Ion Exchange Capacity and water uptake. The value of proton conductivity was similar to the one of Nafion tested under the same conditions.

58 Study Of Performance As Supercapacitors With Solid Electrolyte

Paola Garcia Hernández, Jose Martin Baas López, Daniella Pacheco Catalán, Mascha Smit

In this work, supercapacitors were developed based on solid electrolyte. Electrodes were prepared by screen printing method on carbon cloth, his method yielded higher amount of active material per area. The active material quantities of 40 mg/cm² were obtained in each of the supercapacitors. Electrodes were assembled symmetrically in the middle of Nafion® 115 as electrolyte. Supercapacitors were evaluated electrochemically by cyclic voltammetry at different scan rates, cycle galvanostatics with limit of potential from 0 to 1 V, also was realized EIS. From these results, was determined the specific capacitance, energy and specific power. Values of specific capacity were about at 100 F/ g. As expected, using activated carbon as the active





material, only observes the effect of double layer as storage process, while hybrid materials based of carbon / PPY/Co presented therefore faradaic and non-faradaic processes, in other words, pseudocapacitance. In the results we can see that in addition to the double layer effect have a slightly visible contribution pseudocapacitance by PPY and Co. However, due to the small amount of polymer present, is not significantly reflected in the charge storage capacity. Nevertheless, the hybrid materials showed greater stability over time. Key words: supercapacitors, solid electrolyte, hybrid materials, conducting polymers

59

Hydrogen production by native species of microalgae isolated from México

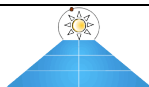
Márquez-Reyes LA¹, Sánchez Saavedra MP¹, Valdez-Vazquez I^{1,2}.

Hydrogen production from biological processes as biophotolysis is an environmental friendly alternative for biofuel production. It has been reported that some microalgae are able to produce hydrogen under stress conditions induced by a sulfur lack in the culture medium. In this work, microalgae isolated from Mexico were grown anaerobically under sulfur deficiency to define their potential as hydrogen producers. Four green microalgae were used for the bioscreening, *Chlamydomonas mexicana*, *C. gloeopara*, *Chlorella vulgaris* and *Scenedesmus obliquus*. The strains were maintain in 125 mL Erlenmeyer flasks with medium 'f' modified at 100 and 300 $\mu\text{E m}^{-2}\text{s}^{-1}$ and 20°C. For anaerobic induction of gas production, biomass was recovered and transferred into sealed containers with a sulfur-limited medium and a septum for gas recollection. The cultures were monitored daily for cellular growth, specific growth rate, duplication time and gas production. At the first stage for biomass generation, *Scenedesmus obliquus* developed the highest biomass. However in the second stage for gas production at the end of 3 days, the higher gas producers were in descending order *Chlorella vulgaris* > *Chlamydomonas gloeopara* > *Scenedesmus obliquus* > *C. mexicana*.

60

ELECTROCHEMICAL PERFORMANCE OF SUPERCAPACITORS BASED ON POLY(PYRROLE)-COBALT SUPPORTED ON CARBON NANOTUBES

J. B. Pompeyo Duarte¹, E. Morales², M. A. Smit¹ and D.E. Pacheco-Catalán^{1*}





Supercapacitors are electrochemical devices that store electrical energy by means of non-faradic and faradic processes, with the advantage of rapid charge/ discharge and high power density. The development of hybrid materials such as carbon nanotubes/polymer/metal, allows increasing the cyclability of the supercapacitor and obtaining higher specific capacitance (Fg^{-1}), through the contribution of faradic processes of polymer and metal.

In this work, electrodes were developed based on intrinsic conductive polymers poly(pyrrole) (PPy), synthesized onto carbon nanotubes (MWCNT) and modified with cobalt. Supercapacitors were fabricated with these electrodes and characterized by cyclic voltammetry and galvanostatic charge/discharge cycles.

The modification of MWCNT with poly(pyrrole) increased capacitance values by increasing the double layer capacitance, up to $12.58 \text{ F}\cdot\text{g}^{-1}$, while charge/discharge times remained unchanged. This sample also contained highest percentage of polymer and showed a decrease of 12% in cyclic stability, compared to the support material and a reduction of 8% compared to devices modified with cobalt.

61

Synthesis of GaN by hydrothermal method as promising photo-electrocatalyst for hydrogen production

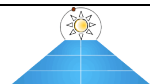
Anayancy Campos Badillo¹, Arturo Manzo-Robledo², Odilón Vázquez Cuchillo¹, Nora Elizondo Villareal³ and Arquimedes Cruz-López^{1,*}

Gallium nitride (GaN) has been successfully synthesized using a hydrothermal method at 240°C during 72 h. In order to increase the crystallinity grade, solid was calcined at 900°C under nitrogen atmosphere. X-Ray powder diffraction (XRD) confirms the characteristic reflection of wurtzite phase [050-079]. The images by Screening Electron Microscopy showed agglomerated particles in the range of 0.5 micrometre, however Transmission Electron Microscopy (TEM) reveals that particles are composed by hexagonal nanoparticles with a size below 20 nanometers. The measured interplanar distance confirms that microstructure corresponds to wurtzite phase. From the point of view of superficial properties GaN has showed $64 \text{ m}^2\cdot\text{g}^{-1}$, however after thermal treatment the specific surface area drop to $48 \text{ m}^2\cdot\text{g}^{-1}$. IR analysis only showed important signals for metallic bond for underwaves below 1000 nm. These results promise interesting performance on hydrogen production by electrochemical and photogalvanic methods.

62

SYNTHESIS AND CHARACTERIZATION OF NI-MO ELECTRODES FOR THE HYDROGEN EVOLUTION REACTION

Gabriel Tamayo, Diego Crespo, Marcelo Videá*.





Following the line of previous investigation that proved that Ni-Mo deposits show potential as electrocatalyst, Nickel-Molybdenum alloys were electrodeposited using current pulse of variable intensity and duration on vitreous carbon to measure their catalytic activity in the electrocatalysis of the hydrogen evolution reaction (HER) in water electrolysis. In this work the electrocatalytic activity of particles deposited using current pulses from 15 mA to 400 mA/cm² and pulse times of 1 to 5 seconds from a solution of NiSO₄ and Na₂MoO₄ was investigated. The deposited material was characterized for the HER using Cyclic Voltammetry in a 0.78 M solution of H₂SO₄. The material deposited with a current pulse of 71 mA/cm² has the highest activity for the production of hydrogen; with a value of exchange current during the HER of 1.82x10⁻³ A/cm² at -0.9Volts (vs. Hg/Hg₂SO₄) compared to an exchange current density of 2.31x10⁻⁵ A/cm² observed when using a glassy carbon electrode. Cyclic voltammograms revealed that two types of materials with different electrocatalytic activities, oxidation potentials and electrochemical stability were present in the deposit. Each possesses different electrocatalytic activity for the HER and completely different oxidation potentials and electrochemical stability. The material that shows the greatest catalytic activity has also the disadvantage of being highly unstable; the elimination of the most active material reduce the activity during HER almost 90%. The next step of the research will focus in the characterization of the deposits to identify the morphology, composition and size of the two different materials present in the deposit of Ni-Mo.

63 Dispersion of Ni and LiH on the hydriding-dehydriding kinetic in Mg based alloys for hydrogen storage

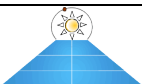
Antonio Alberto Zaldivar Cadena

Powder mixtures of Mg-5%Ni, Mg-20%Ni, Mg-5% Ni- 4 at.% LiH and Mg-5%Ni- 8 at.%LiH have been prepared by mechanical alloying in an ongoing investigation for hydrogen storage applications. The dispersion of nickel and LiH within the magnesium powder particles were studied using milling times of 10 and 30 hours in a planetary high-energy ball mill. SEM-EDS, XRD, XPS and ImageJ® software have been used to characterize the microstructure and composition of the powders. Hydriding experiments were performed as batch-type tests at 200, 250 and 300 °C and under 2 MPa H₂ pressure during 30 minutes. These experiments resulted in varying amounts of MgH₂ in the hydride powders, depending on composition and hydriding conditions. Additional experiments in a gravimetric apparatus indicated fast hydriding kinetics down to 200 °C in mixtures containing LiH, although the dehydriding process occurred reasonably fast only at temperatures of 250 and 300 °C. The hydriding-dehydriding behavior is influenced by the tendency to form the Mg₂Ni phase in the mechanically alloyed powders. This tendency is promoted by higher Ni content, longer milling times and higher hydriding temperatures. The best kinetic results point to an optimum Ni dispersion, which in turn depends on Ni content and milling time. LiH additions have shown a tendency to decrease the hydriding temperature in the Mg-5%Ni-LiH mixtures. XPS and XRD techniques were used to identify Li phases formed during the mechanical alloying and hydriding processes. Key words: Magnesium, Hydrogen Storage, Kinetic, Characterization.

64 Modeling of the Hydriding-Dehydriding Kinetics of Pure Magnesium

Antonio Alberto Zaldivar Cadena

One of the most important materials for hydrogen storage is magnesium because of its high gravimetric capacity. However, it is known that its hydriding-dehydriding kinetics are slow and many investigators are using different catalysts to accelerate the reaction kinetics. Nevertheless, it is important to know the kinetic behavior of pure magnesium without the application of a catalytic





agent so that the effect of the latter can be better assessed. In this work, different theoretical models have been used to fit experimental data provided by PCT curves of pure magnesium. The results have shown that the Johnson-Mehl-Avrami (JMA) model usually provides the best fit to the experimental data. However, a sound physical interpretation of these results is not always available. Key words: Magnesium, Hydrogen Storage, Kinetic, Simulation.

65 Getting Hydrogen From NiH₂ And CH₄. A Theoretical Study Of The Reaction Mechanism

María Esther Sánchez-Castro, Mario Sánchez-Vázquez

There is much debate on how to carry out the formation of molecular hydrogen (H₂) over heterogeneous nickel catalysts, particularly the way in which the C-H bond, from methane molecules, is activated to form C-Ni and Ni-H bonds. Due to the importance of this process, is required to know in detail the mechanism of how the C-H bond is activated. We used in our studies the interaction of two methane molecules and nickel hydride as shown in the following equation: 2CH₄(g) + NiH₂(s)

66 Performance Testing And Exhaust Emissions In A Single Cylinder Spark Ignition Using Gasoline-Anhydrous Ethanol Blends.

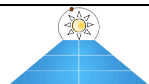
Jesus Antonio Camarillo Montero, Uriel González Macías, Juan José Marín Hernández, Juan Rafael Mestizo Cerón

This work shows the effect of using gasoline-anhydrous ethanol fuel blends (0-40% v/v) on performance and exhaust emissions of a single cylinder spark ignition engine by AVL model 5401. Performance tests were developed at a steady speed of 2000 rpm, varying the lambda terms at typical operation values of an automobile. There were measured the indicated power and specific fuel consumption, while the exhaust emissions were measured carbon monoxide (CO), carbon dioxide (CO₂), unburned hydrocarbons (HC) and oxides of nitrogen (NO_x). The results show an enleanment effect in the fuel while increasing the ethanol content, causing a marginal reduction in the indicated power (less than 2%) and increasing fuel consumption considerably. E20 present the best performance in the analysis of exhaust emissions, dramatically reducing contents of CO (2-4%), HC (6-10%) and NO_x (5-9%), remaining practically constant CO₂ emissions (less than 1% reduction).

OXYGEN REDUCTION KINETIC PATHWAY ON PT AND PD COMPOUNDS SYNTHETIZED BY DIFFERENT METHODS

P. González Puente¹, L. M. Leal Gámez¹, B. Ruiz Camacho², M. Valenzuela Zapata²,
R. Vargas García³, Omar Solorza Fera⁴, R. González Huerta^{1*}

67





Proton exchange membrane fuel cells (PEMFCs) are electrochemical power sources with different applications where vehicular, portable devices and stationary systems are included. The oxygen reduction reaction (ORR) is a sluggish complex cathodic reaction that proceeds via consecutive or parallel elementary steps. The aim of this work is to study the kinetics of the ORR on carbon supported Pd and Pt electrocatalyst synthesized by borohydride reduction (Pd/C) and liquid phase photodeposition (Pt/C-photo) methods. Rotating ring-disk electrode (RRDE) technique was used to evaluate the kinetics and selectivity of the ORR and elucidate the pathway reaction in acid media. Results conducted to establish that the best electrocatalyst was Pt/C-Photo because favor 96.5 % conversion of O_2 to water formation instead of 95.3 % on Pd/C. In both cases the kinetics occurs via a multielectron charge transfer process, *i.e.*, $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$.

OPPORTUNITIES IN THE CARBON MARKET WITH A SOLAR-HYDROGEN-SYSTEM

A. Yunez Cano^{1*}, G. Contreras Puente², M. Tufiño Velázquez²,
D. Jiménez Olarte², R. González Huerta¹

68

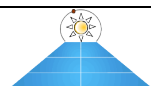
The implementation of sustainable energy generation applied to a house, not only brings the benefit of environmental care, but also it generates the possibility to be involved in the carbon credits market. Currently, México ranks fifth worldwide in implementing projects of Clean Development Mechanism that form the carbon credits market (CCM) established in the Kyoto Protocol. China has the first place with 57% of projects, México with 1.4% of projects is not intended to be outdone, and it has the prospect to grow in the coming years as reported by SEMARNAT.

This paper describes how to build a sustainable system for the carbon credits market; it also details how the design and installation of a solar system in a house was carried out in the first stage of the project. This project can contribute to the Mexican position in the CCM, as the proposal of a hybrid power generation comprising solar system, electrolyzer and fuel cells can enter the CCM. If such system is applied to 1000 houses with 1 kW solar installed and 5 effective hours of sunshine, it may stop the emission of 292 tons of CO_2 per year into the atmosphere that could be generated in a thermal power plant, generating 292 carbon credits.

ABSORPTION ENHANCED REFORMING OF LIGHT ALCOHOLS (METHANOL AND ETHANOL) FOR THE PRODUCTION OF HYDROGEN: THERMODYNAMIC MODELING

Miguel A. Escobedo Bretado¹, Manuel D. Delgado Vigi², Jesús Salinas Gutiérrez²,
Miguel Meléndez Zaragoza², Virginia Collins-Martínez² and Alejandro López Ortiz²

69





Thermodynamic modeling of the steam reforming of light alcohols using CaO , CaO^*MgO , Na_2ZrO_3 , Li_2ZrO_3 and Li_4SiO_4 as CO_2 absorbents was carried out to determine promising operating conditions to produce a high hydrogen production ratio (HR) and concentration (% H_2) gas product. Light alcohols studied were ethanol and methanol at 300-850°C and 1 atm. Steam to alcohol (S/COH) molar feed ratio varied from 1:1 (stoichiometric) to 6:1 for methanol and from 3:1 (stoichiometric) to 6:1 for ethanol. Thermodynamic simulation employed the Gibbs free energy minimization technique to obtain equilibrium compositions. Results indicate no carbon formation at $\text{S/COH} \leq$ stoichiometric. Methanol reforming at 600°C and $\text{S/COH} = 6$, without CO_2 absorbent (WOA), produced a hydrogen ratio (HR) of 2.76 (mols H_2 /mol CH_3OH fed) and 73.5% H_2 . At the same conditions CaO , CaO^*MgO , and Na_2ZrO_3 produced a HR (% H_2) of 2.98 (98.2% H_2), 2.96 (96.4% H_2) and 2.91 (98.2% H_2), respectively. Ethanol reforming WOA generated a HR = 4.6 (69.5% H_2) at 600°C and $\text{S/COH} = 6$, while CaO , CaO^*MgO , and Na_2ZrO_3 showed a HR (% H_2) of 5.7 (96.6% H_2), 5.5 (94.1% H_2) and 5.4 (92.3% H_2), respectively. For both cases other absorbents produced lower values. In both reforming systems (methanol and ethanol) most favorable thermodynamics were obtained with CaO and CaO^*MgO as absorbents; however stability of these absorbents CaO^*MgO , and Na_2ZrO_3 must be improved. While, Na_2ZrO_3 is a promising alternate absorbent with comparable thermodynamics and greater kinetics and stability. Modeling results agreed with experimental evaluation of ethanol reforming using CaO^*MgO , and Na_2ZrO_3 .

APPLICATION OF CURRENT PULSES TO WATER ELECTROLYSIS SYSTEMS

A. Flores Olvera¹, A Rubio Rubio¹, R. Silva Casarin²,
Omar Solorza Feria³, R. González Huerta^{1*}

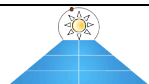
70

Hydrogen obtained from renewable energy resources is a virtually unlimited, environmentally benign energy source that could meet most of our future energy needs. The "Blow Jet" is a Wave Energy Conversion (WEC) device, which is currently being tested in a wave flume. The Proton Exchange Membrane Electrolyzer (PEME) can be coupled to WEC to obtain the necessary electricity for splitting the water. This work shows a chrono-potentiometric study. The experiments are carried out by applying the current pulse and determining the potential as a function of time. The Membrane Electrode Assemblies (MEA) were prepared from the mixture of electro-catalysts (RuO_2 and IrO_2 were used as anode and Pt/C was used as cathode) and Nafion 115 membrane. The PEME was designed and in-home built. It is connected to a galvanostat in order to obtain its response characteristics (V-t). Chrono-potentiometric experiments were recorded in the current range of 20 to 500 mA at 300s.

71 Magnesium-Iron-Zinc Alloys And Their Hydriding Properties

Angel Palacios-Lazcano, Karina Suárez-Alcántara, Gerardo Cabañas-Moreno

We report the results of an ongoing investigation to develop nanostructured magnesium alloys intended for hydrogen storage applications. Additions of Zn and Fe to Mg were made in order to promote the hydriding/dehydriding properties of Mg. Nanocrystalline alloys of these elements with magnesium have been obtained by mechanical alloying. The as-milled powder alloys were subjected to several hydriding/dehydriding tests using an automated gravimetric apparatus. These experiments confirmed the decomposition of MgH_2 produced from the magnesium alloys at





temperatures down to 250 °C in samples of nominal composition Mg98.7Fe1.3 and Mg97.4Fe2.6. However, the hydrogen storage capacity of the alloys has been limited to values lower than about 6.2 wt %, mainly because of the presence of MgO in the hydrided alloys. The fastest hydriding/dehydriding rates were found at 350 °C in a sample of composition Mg96.7Zn2Fe1.3 (0.4 and 0.2 wt% min⁻¹, respectively). The kinetics of the hydriding and dehydriding reactions of the most promising alloys have been fitted to different theoretical models. The results of this analysis are discussed in relation to the actual physical mechanisms involved in the hydriding/dehydriding properties of these materials. This work has been funded by ICyTDF and SIP-IPN. Keywords: Hydrogen storage, nanocrystalline Mg alloys, metal hydrides

FUEL CELL STACK DESIGN AND CONSTRUCTION IMPLEMENTING A DC/DC CONVERTOR

72 E. Escobedo^{*1}, O. Antonio², Z. Martínez², J. Polanco³, F.I. Chan Puc⁴ M.A. Smit¹

Fuel cells represent a great alternative for energy generation. There are many education institutes and research centers designing and developing new materials for fuel cells manufacturing; obtaining efficient topologies for control systems and power, and developing prototypes for stationary and mobile applications.

In this paper we report on the design and manufacture of an experimental fuel cell stack and the development of a conditioning power system (DC/DC converter) to supply a constant voltage output to low power systems.

The project was realized in two phases:

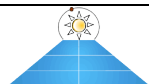
1) Design and manufacture of two fuel cell stacks; each stack using four Membrane-Electrode Assemblies (MEA). Bipolar plates with serpentine flow fields and end plates were made with a numerical control machine. The end plates were made out of aluminum; and contain the inlet and outlet of reactant gases. The current collectors were manufactured from brass. Thin silicon gaskets were designed and manufactured. MEA's were prepared using Nafion 115 and electrodes with carbon cloth as substrate for the Pt/C catalyst layer, and hot pressed.

2) A DC-to-DC boost type converter was designed, simulated and built to increase the stacks' output voltage.

73 Hydrogen Production From ESR Reaction Over Rh Supported Catalysts: Effect Of Support.

Oscar Arturo Gonzalez Vargas, Jose Antonio De Los Reyes Heredia, Armando Tonatihu Avalos Bravo

Synthesis of MCM-41 materials modified with different Ce content was carried out. The Ce was incorporated to the MCM-41 material by two methods: a) incorporation of Ce in the hydrothermal synthesis of MCM-41 (series Ce-MCM-41) or b) simple impregnation method of MCM-41 (series Ce-Im-MCM-41). These materials were characterized by XRD, CP/MAS-NMR and TEM. Subsequently, the materials were tested as catalysts supports. Synthesis of catalysts was carried out with a nominal rhodium content of 1% wt. Furthermore, the catalysts were characterized by TPR, XRD and HR-TEM. The results showed that all MCM-41 materials modified with Ce have hexagonal mesoporosity. In particular, Ce-MCM-41 materials, the Ce ions were incorporated into the framework. However, these materials lose the order of their porous structure due to the weakening of the walls for effect of a decline in Q4 species. On the other hand, Ce-Im-MCM-41





materials, the Ce ions were found in small particles dispersed onto the MCM-41 material. With respect to the catalysts, the obtained results evidenced that after of the impregnation of metallic phase and forwards thermals treatments, the high order of hexagonal pores structure of support was conserved. TEM images clearly show the formation of dispersed rhodium nanoparticles with different size. Finally, these catalysts were tested for hydrogen production from ethanol steam reforming (ESR) reaction under atmospheric pressure and several temperatures. The results of catalytic activity and selectivity to hydrogen showed that the Rh/Ce-MCM-41 catalysts were efficient for the ESR reaction. Key words: Ce-MCM-41, ESR reaction, hydrogen production, rhodium catalysts.

75 Electrochemical Characterization Of Polymeric Eletrolytes For Fuel Cells

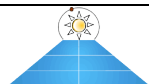
Roberto Benavides

ABSTRACT Electrochemical properties of membranes prepared from copolymers of poly(styrene-acrylic acid), poly(styrene-vinyl acetate) and poly(styrene-co-acrylic acid-phenyl tetrazol) were evaluated by means of CV (cyclic voltammetry) and EIE (electrochemical impedance spectroscopy). Electrodes were modified by deposition of the corresponding polymer solution over the electroactive surface and immediately left for solvent evaporation. Either for deposited and non deposited electrodes potential of half-way or equilibrium potential ($E_{1/2}$) was observed constant; however, for ΔE_p there was a significant enhancement for deposited electrodes comparing with the non-deposited ones. The latter indicates that the electron transfer speed for the electroactive specie from the polymer matrix is quite different for the kinetics observed in the non modified electrode. Membrane films were physically stable throughout the evaluation time while voltammetry experiments were kept up to more than 500 cycles in solution. Electrochemical impedance spectroscopy measurements showed that evaluated copolymers have electronic and ionic conductivities useful for their use in fuel cells. Comparing ΔE_p , $E_{1/2}$ and ip_c/ip_a values among only modified electrodes the best performance was observed for the poly(styrene-acrylic acid) and from impedance measurements the poly(styrene-co-acrylic acid-phenyl tetrazole) is the most promising material for future studies. Key words: Electrochemistry, copolymers, electrolytes, fuel cells.

76 Mathematical Model To Simulate Fuel Cell Performance

Roberto Benavides

A theoretical model considering mass, momentum, energy, chemical species, electrical and ionic potential conservation during fuel cell (PEMFC) operation was developed. Considering is a theoretical model based in conservation equations results were confronted with experimental results from literature and from home made experiments in order to validate it. An excellent agreement was obtained and the model was capable of predicting the most important variables for a fuel cell performance, including the liquid water fraction existent in the interior of the cell. The latter was able to be observed by using a multiphase model (two fluids) to consider formation, evaporation/condensation and transportation of liquid water. The electrochemical reaction was modeled considering the kinetic model from Butler-Volmer. The fuel cell's performance was considered for a 9 layers cell with only one channel evaluating variables as pressure, temperature and relative humidity of reagents and results observed as polarization and potential density curves. Catalyst and diffusion layers thicknesses were also evaluated with an important effect observed. The one-channel model was extended for a various channels arrange simulating a cell with 5 cm2. The proposed model validity was confirmed with the results obtained from experimental data from prototypes evaluated in the laboratory. Key words: simulation, fuel cells, polymeric electrolyte.





POTENTIOMETRIC TITRATION OF POLYMERIC ELECTROLYTES USED AS MEMBRANES IN FUELL CELLS

Gledir Martins³, Márcio A. Fiori¹, Roberto Benavides², Bruno Szpoganicz³, Marcos Marques da Silva Paula¹, Luciano da Silva^{1,4*}

77

In order to improve generation of energy from fuel cells, alternative ion exchange polymeric membranes were prepared from copolymers of sulfonated poly {styrene-co-acrylic acid} at comonomer ratios of 92:8 and 94:6 %mol. Equilibrium studies by means of potentiometric titration allowed determination of the average protonation constants of these copolymers. The materials suffered protonation and deprotonation reactions in the sulfonate and carboxylic groups and the log of equilibrium ratio values found are: for carboxylate group $[HPOLI]/[POLI] [H] = 3.65$ (for 92:8) and 3.64 (for 94:6), and for sulfonated group $[H_2POLI] / [HPOLI] [H] = 2.12$ (for 92:8) and 2.23 (for 94:6). The protonation sites are partly a result of the sulfonation procedure of these copolymers.

78 Synthesis Of Polymeric Electrolytes For Their Use As Membranes In Fuel Cells

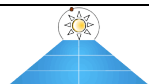
Roberto Benavides

A polymeric electrolyte has to be able to conduct ions and thermal and chemically stable to be useful as membrane in fuel cells. This work deals with the synthesis and thermal characterization for copolymers prepared from styrene and vinyl acetate and their further sulfonation. The synthetic route followed was: Monomers were added in an 85/15 w/w%, using benzoyl peroxide as initiator and left under argon atmosphere during reaction progress. For sulfonation, 20 g of copolymer was dissolved in 150 ml of chloroform and allowed to reach 45°C of temperature. Finally, 10 ml of sulfuric acid added drop by drop and left during 1 h under mechanical stirring and argon atmosphere. Copolymers before and after sulfonation were characterized by FTIR, TGA and molar mass by viscometer. FTIR shows the characteristic bands from the expected copolymer with an important distortion in bands about 2800-3500 cm after sulfonation; TGA suggests that the sulfonation method reduces considerable the thermal stability of the copolymers as can be seen in the Figure: Viscometer results indicate a molar mass value of 19,024 g/mol. Some ionic conductivity results will be presented as well. Key words: copolymers, electrolytes, fuel cells.

79 Composite Membranes Based on Micro and Mesostructured Silica: A Comparison of Physicochemical and Transport Properties

Alejandra Alvarez López, Carlos Guzmán, Janet Ledesma García, Luis Gerardo Arriaga Hurtado

The incorporation of inorganic compounds into the polymeric Nafion matrix with the aim of preparing composite membranes represents a possible solution to increase the working temperature ($T_{cell} > 100^\circ C$) of a Polymer Electrolyte Fuel Cell (PEFC) without losing the proton conductivity, water transport properties and above all improving the mechanical characteristics. Three silicon oxides having a different morphology were synthesized starting with a tetraethyl orthosilicate as a precursor via sol-gel method: SBA15, SBA15-SH and SiO₂. Successively, composite Nafion membranes were prepared using a 3% (wt/wt) of each powder through a standardized casting method. The influence of SiO₂ morphology on chemical-physical properties of the membranes was highlighted resulting in a reduction of the swelling parameters of the composite membranes if compared at $T \geq 80^\circ C$ to a recast bare Nafion membrane, used as a reference. Good proton conductivity was also observed for all composite membranes with values





of 0.144 S cm⁻¹, 0.136 S cm⁻¹, 0.090 S cm⁻¹ and 0.078 S cm⁻¹ recorded at 80°C (100% RH) for Nreicast, NSBA15, NSBA15-SH and NSiO₂, respectively. The polarisation curves carried out at 120°C (75% RH, 1.5 abs. bar) have revealed a higher stability for NSBA15 membrane after a short time-test, probably due to the silica morphology able to retain water within the polymer matrix and, in accordance to the swelling data.

80 Biomass Catalytic Steam Gasification: Thermodynamics Analysis and Reaction Experiments in a CREC Riser Simulator

Enrique Salaices, Benito Serrano, Hugo Delasa

A thermodynamic equilibrium model based on evaluations involving C, H and O element balances and various product species up to C₆ hydrocarbons is reported in this study. This model establishes the effects of biomass composition, temperature, and steam on the various gas product molar fractions. On this basis, most significant parameters determining the chemical interconversions and distribution of chemical species are identified. Based on the proposed equilibrium model and using glucose as model biomass species [C₆ H₁₂ O₆], an optimum gasification temperature close to 800 °C and a steam/biomass ratio between 0.5 and 0.7 g/g is established. This study has the special value of comparing thermodynamic equilibrium predictions with experimental data obtained in a CREC Riser Simulator using a fluidizable Ni-Al₂O₃ catalyst. Results are relevant for scaled-up gasifiers. They show that for reaction times longer than 30 seconds chemical species are essentially equilibrated and that the proposed model does provide adequate description of various product fractions. Data obtained also demonstrate the shortcomings of equilibrium models for gasifiers with reaction times shorter than 10 seconds and the need of non-equilibrium models to describe gasifier performance at such conditions. Keywords Biomass, Steam Gasification, equilibrium

81 Steam Gasification of a Cellulose Surrogate over a Fluidizable Ni/ α -Alumina Catalyst: A Kinetics Model

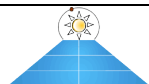
Enrique Salaices, Benito Serrano, Hugo Delasa

This study considers the catalytic steam gasification of a cellulose surrogate using a fluidizable Ni/ α -alumina catalyst. Experiments were carried out in the CREC fluidized Riser Simulator. On this basis a reaction network and a kinetic model for biomass catalytic steam gasification were proposed. This kinetic model was developed using a sound reaction engineering approach where reaction rates for various species are the result of the algebraic addition of dominant reactions. The modeling procedure also included the decoupled determination of intrinsic kinetic parameters and adsorption constants as allowed in the CREC Riser Simulator. The implemented approach eliminates overparametrization with successfully parameter correlation. Numerical regression of the experimental data led to intrinsic kinetic parameters with narrow spans showing that the proposed kinetic model satisfactorily describe the catalytic conversion of glucose under the selected gasification conditions. Keywords Kinetics, Biomass, Steam Gasification, Ni/ α -Al₂O₃ catalyst

82 Hydrogen absorption properties of Mg_{1.95}Ti_{0.05}Ni_{0.95} Cu_{0.05} modified magnesium composite, prepared by ball-milling.

Juan Bonifacio Martínez

The effect of high-energy ball-milling on the hydrogen absorption properties of the composite 85 wt. % magnesium-15 wt. % Mg_{1.95}Ti_{0.05}Ni_{0.95} Cu_{0.05} has been investigated. The obtained ball-milled powders were examined by X-ray diffraction (XRD), scanning electron microscopy





(SEM) and energy dispersion spectrometry (EDS). The composite was hydrided for 30 min at temperatures of 573, 623 and 648 K, under hydrogen pressures of 2 MPa. The maximum amount of hydrogen release for the composite was about 4.84 wt. % at 623 K without prior activation. After of the first absorption/desorption cycle under pure hydrogen atmosphere, the hydrogen capacity improved to about 5.23 wt. % and the temperature of desorption of hydrogen decreased. Modification of the surface of magnesium with Mg_{1.95}Ti_{0.05}Ni_{0.95} Cu_{0.05} accelerates the desorption of hydrogen.

A KINETIC-MECHANISTIC STUDY OF THE HYDROGEN EVOLUTION REACTION IN SULFURIC ACID SOLUTIONS WITH DIFFERENT ELECTRODE MATERIALS

83

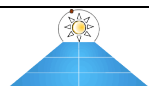
J.C. FUENTES-ACEITUNO^{1*} and G.T. LAPIDUS².

The hydrogen evolution reaction (HER) has been studied extensively due to the potential application of molecular hydrogen H₂ as a green fuel. Recently this particular reaction attracted the attention of several electrometallurgical researchers because of another promising application, in which the monoatomic hydrogen species H• (intermediate product of HER) is employed as a reducing agent for copper-sulfide minerals. Consequently, knowledge about the kinetics, mechanisms and rate determining step (rds) of HER in sulfuric acid solutions employing aluminum, copper, Inconel® or glassy carbon(GC) cathodes is necessary to determine the under and overpotential domains where H₂ and H• can be generated in a selective manner. To accomplish this, cathode polarization curves with the different electrode materials were carried out using the rotating disk electrode technique at several conditions of acidity, temperature, and applied potential, with or without ferrous ion (mineral phase reduction product). Analyses of the Tafel slopes and the charge transfer coefficients, revealed two electrical potential zones for copper, Inconel and GC, where the monoatomic hydrogen can be recombined chemically or electrochemically to H₂ as the rds. On the other hand, with aluminum, only the electrochemical recombination to H₂ occurs as the rds. A catalytic effect on the hydrogen recombination reaction was also found when ferrous ion is contained in the solution. The results of the exchange current densities for each of the tested cathode materials showed that aluminum is the most efficient electrocatalyst for producing H• and H₂, followed by inconel, copper and GC.

THERMODYNAMIC ANALYSIS OF THE ABSORPTION ENHANCED STEAM REFORMING OF BIOFUEL MODEL COMPOUNDS

84

Miguel A. Escobedo Bretado¹, Manuel D. Delgado Vigil², Jesús Salinas Gutiérrez²,
Miguel Meléndez Zaragoza², Virginia Collins-Martínez² and Alejandro López Ortiz²





Thermodynamic analysis of the steam reforming of biofuel model compounds using CaO , CaO^*MgO , Na_2ZrO_3 , Li_2ZrO_3 and Li_4SiO_4 as CO_2 absorbents was performed to determine favorable operating conditions to produce a high hydrogen ratio (HR) and concentration (% H_2) gas product. Biofuel compounds (HC's) used were: 2,4-dimethylphenol (DMP), furfural (FUR) and vanillin (VAI). Equilibrium product compositions were studied at temperature (300-850°C), steam to hydrocarbon molar feed ratio (S/HC) and type of CO_2 absorbent at 1 atm. S/HC varied from stoichiometric; 15:1 for DMP, 13:1 for VAI and 8:1 for FUR to twice and three their stoichiometric values, respectively. At stoichiometric S/HC ratios results indicate significant carbon formation with conventional reforming at $T < 600^\circ\text{C}$. However, no carbon formation was found using absorbents with any of the HC's. The use of a CO_2 absorbent resulted in an increase in HR (mols H_2 /mol HC fed) and H_2 purity of about 3 and 30% higher, respectively. For most of HC's CaO and CaO^*MgO showed similar results with an HR of 7 and 90% H_2 , Na_2ZrO_3 and Li_2ZrO_3 resulted only in slightly lower values than CaO , while Li_4SiO_4 showed significantly lower values than CaO . The order from higher to lower HR based on model molecule was: $\text{VAI} > \text{DMP} > \text{FUR}$. Na_2ZrO_3 should be considered as high potential absorbent in the system due to its superior thermal stability and kinetics.

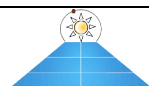
ELECTRICAL CONDUCTIVITY STUDIES ON Y^{3+} AND Mg^{2+} CO-DOPED CERIA ELECTROLYTE SYSTEM

85 Raúl Alberto Montalvo-Lozano¹, Sagrario Martínez Montemayor¹, Padmasree Karinjilottu Padmas², Antonio Fernandez Fuentes²

Doped ceria has been considered as one of the most promising electrolyte materials for intermediate temperature solid oxide fuel cell (IT-SOFC). One of the approaches to further improve the ionic conductivity and other properties is to dope ceria with two or more components. In this work we study the effect of Mg^{2+} doping on the electrical conductivity of yttria doped ceria electrolytes of general formulae $\text{Ce}_{0.9}\text{Y}_{0.1-x}\text{Mg}_x\text{O}_{2.5}$ ($x=0, 0.05$) and $\text{Ce}_{0.85}\text{Y}_{0.15-x}\text{Mg}_x\text{O}_{2.5}$ ($x=0, 0.05, 0.1$). Powder samples were synthesized by mechanical milling. The phase identification, microstructures and ionic conductivities of the samples were studied by X-ray diffraction, scanning electron microscopy and AC impedance spectroscopy. The results showed that in comparison to singly doped ceria, co-doping with appropriate ratio of Y^{3+} and Mg^{2+} showed higher conductivities and lower activation energies. The bulk, grain boundary and total conductivity of the samples increases with the addition of the dopant and maximum conductivity is obtained for the composition $\text{Ce}_{0.9}\text{Y}_{0.05}\text{Mg}_{0.05}\text{O}_{1.925}$. The electrical properties of grain boundary have a large influence due to co-doping than that of the bulk.

HYDROGEN AS ADDITIVE IN CARS WITH INTERNAL COMBUSTION ENGINES.

86 Jaime Lorenzo Fonseca Ruiz^{*1}, José Ramón Armendáriz Gutiérrez², Dr. Eduardo Herrera³.





Hydrogen can be used directly in internal combustion engines, due to small amounts of energy require, and the wide range of combustion power. The generation of hydrogen needed as an additive in the hydrocarbon is achieved through the chemical process of electrolysis, carried out using dry cells.

For a better analysis and understanding of the system, through the multi-physical program "COMSOL" and design software "SOLIDWORKS" is developing the entire system in order to display different parameters, in order to configure the system to generate hydrogen, and the same electrical system of the car to get the desired results.

The system is being tested in several vehicles with models from 1993 to 2004, reporting favorable results. We also found some problems with the system which is still under investigation.

We decided to change the type of prototype hydrogen generator and previously used an electrolytic cell completely submerged in water, now we are using a dry cell which in principle performs the same task as above.

Once the system has to generate hydrogen, is decide to inject it into the car through the air ducts. Thus begin all the necessary studies to obtain the optimal values and to configure the system to achieve higher efficiency combustion in power.

The values of oxygen-gasoline ratio that controls the brain of the vehicle will be modified to achieve better results in the efficiency of combustion power, and observe the increase in efficiency through lower demand for gasoline in the normal operation of the vehicle

OXYGEN REDUCTION STUDIES ON CARBON – SUPPORTED Pt-M CATALYSTS (M: Ru, W, Mo)

89 R. Hernández Maya¹, A.J. Armenta González^{1,2}, O. Ugalde¹, M.T. Oropeza Guzmán²,
P. Roquero^{1,*}

The activities of a series of carbon-supported bimetallic catalysts, with different active phases loadings, were tested towards the oxygen reduction reaction. Pt was used in all materials and its proportion was kept constant. Mo, W and Ru were used as promoting phases. Rotating Disk electrode experiments revealed that Pt-Ru displayed the best performance in oxygen reduction among the studied materials. The materials with the highest loadings of the second metal revealed the highest activities.

90 Adsorption of H₂ and O₂ onto Pd-Cu(110) alloy Surfaces: New material for PEMFC

Alberto García-Quiroz¹, L. César de la Portilla-Maldonado², Ernesto López-Chávez¹, Fray de Landa Castillo-Alvarado^{3,†}, Gerardo Cabañas-Moreno⁴.

Electrocatalysts play a fundamental role in the efficiency and cost of the Protonic Exchange Membrane Fuel Cell (PEMFC). Since many years ago the Pt has been utilized as catalyst material, however its cost has been a major obstacle for its application. In this work we present



preliminary theoretical studies based in the Density Functional Theory using the computational code CASTEP, of the molecular oxygen and hydrogen adsorption on Pd-Cu alloy surfaces in the (110) direction. We calculate the densities of states and the chemisorption and repulsion energies. Our results show that these alloys (they are less expensive) could be a good catalyst instead Pt.

DEVELOPMENT OF ULTRASONIC GAS HUMIDIFICATION SYSTEMS FOR FUEL CELL STACKS

91

T. Romero*, L. De Silva, R. Mijarez

The development of efficient and cost economical gas humidifiers is of main interest for the fuel cells industry. Water balance in operating proton exchange membrane (PEM) fuel cells is critical to increase performance and durability of the cell's components. An approach in fuel cells water management refers to gases humidification in order to keep the optimum moisture of the membrane without blocking the gas pathways with excess water. The challenges on humidification systems are related to the parasitic power required to operate them, the response time and the extra volume and weight they add to the power plant. This work presents the design and implementation of an ultrasonic humidification system for fuel cells based on the water requirements for a 1 kW PEM fuel cell. The humidification system prototype was manufactured including an ultrasonic mist generator. The attained results are presented in conjunction with a proposed methodology to characterize the performance of a gas humidification system.

92 Hydrogen-crossover evaluation of graphite bipolar plates and membrane-electrodes assemblies, used in PEMFC. Hardware development and methodology implementation

Félix Loyola, Ulises Cano, Irma Lorena Albarrán, Tatiana Romero

In this work, we propose a methodology to evaluate hydrogen crossover through graphite bipolar plates (BPP's) and membrane-electrodes assemblies (MEA's). The methodology development includes the design and construction of a dedicated hardware for this test and its application to a batch of 20 BPP's and 20 MEA's newly manufactured. This testing was performed as a measure in the quality control (Q.C.) of materials and manufacturing processes. The methodology is based on the classic electrochemical test for hydrogen crossover evaluation in a H₂-N₂ system, in which, the hydrogen that manages to permeate the material under test is electrochemically oxidized. The results showed that the methodology was highly effective, achieving quantitatively the evaluation of hydrogen crossover in the tested components with a high precision (standard deviation = $3.53\text{E-}5$ mL/(min-cm²)) and sensibility. The methodology does not modify the components physicochemical or mechanical properties

93 Channel length and air flow rate effect on the PEM fuel cell overall performance

Félix Loyola, Ulises Cano

In this work, the effect of gas flow field (GFF) channel length and of air flow rate on the overall performance of a 25 cm² PEM fuel cell was evaluated. For these tests, 4 cathode GFF designs



were manufactured, where the main variable was the channel length (5, 7.5, 10 and 15 cm). One additional variable tested was the cathode air flow rate associated with the convective system used. The experimental tests were carry out at 70 °C and consisted of assessing the stability for more than 30 minutes of fuel cell performance at a constant potential. During each test, electrochemical impedance spectroscopy (EIS) measurements were made as a diagnostic technique to sense the hydration level and detect mass transport problems or system evolution into a flooding state by means of comparison of in-phase and out-of-phase content. The results showed that the 5 cm channel length design, causes the fall in overall performance of the fuel cell as a consequence of the electrolyte dehydration. On the other hand, the 15 cm channel length design, does not allow the proper water removal produced by the reaction, leading to a decreased cell performance caused by flooding in the cell. For the 7.5 and 10 cm channel length designs, results showed a maximum steady state performance at a particular air flow; in both cases, operation of the fuel cell at an air flow regime above the aforementioned maximum, led to a fall of its performance by dehydration of the electrolyte.

94

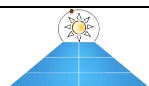
Stirring method and temperature: their effect on the synthesis of metallic (M) and bimetallic (M-Pt) nanostructures

Nora Mayté Sánchez-Padilla¹, Sagrario M. Montemayor^{1,*}, F.J. Rodríguez Varela^{2,*}

In this work, the effect of changing the stirring method and temperature on the physicochemical properties of metallic nanoparticles and bimetallic nanostructures is shown. Magnetic (MS), mechanical (UT) and ultrasonic (USS) stirring were the methods of synthesis. The effect that, temperatures between 0 and 50 °C, has on the structure and particle size of Pd, Fe and Ru nanoparticles was evaluated. The results indicate that Pd and Fe prepared by the three methods present a crystalline structure. On Fe samples, an increase of the temperature of synthesis leads to highly crystalline powders while on Pd this effect is the opposite. Meanwhile, the Ru material shows quasi-amorphous characteristics. Afterwards, Pt was deposited by the UT method on Pd (prepared by UT) and Fe (prepared by UT and USS) nanoparticles to form bimetallic Pd-Pt and Fe-Pt nanostructures. XRD characterization of the nanostructures shows crystalline patterns with peaks related to the cubic structure of Pt in all samples. The electrochemical characterization indicates a 13 or 9 times larger electrochemically active surface area of Pd-Pt related to the Fe-Pt materials, depending on method of synthesis. Furthermore, a higher catalytic activity for the ORR was measured for the Pd-Pt material compared to those of the Fe-Pt catalysts.

PRODUCTION OF HYDROGEN FROM ETHANOL USING Pt/HYDROTALCITE CATALYSTS STABILIZED WITH TUNGSTEN OXIDES.

J. L. Contreras¹, M.A. Ortiz¹, G.A. Fuentes², R.Luna¹, M. Gordon¹, J.Salmones³, B. Zeifert³ and T. Vázquez¹.





The WO_x effect on Pt/hydrotalcite catalysts to produce H₂ by ethanol steam reforming was studied. The catalysts were characterized by N₂ physisorption (BET area), X-ray diffraction, Infrared (IR), Raman and UV-vis spectroscopy. The catalytic tests were made in a fixed bed reactor. The catalysts showed porous with the shape of parallel layers with a bimodal mesoporous distribution. By IR spectroscopy it was found superficial chemical groups as: -OH, H₂O, Al-OH, Mg-OH, and CO₃²⁻. As W concentration increased, both the intensity of crystalline reflections of the catalysts and the conversion increased. Catalysts with low amount of W showed the highest H₂ selectivity and the highest stability after 7 h of reaction. The reaction products were: H₂, CO₂, CH₃CHO, CH₄ and C₂H₄. These catalysts did not produce CO and showed low selectivity to C₂H₄.

96 Effect of the addition of benzimidazole ionic liquid in ABPBI/H₃PO₄ proton exchange membranes

Rubí A. Hernández Carrillo, Juan Antonio Asencio,
Pedro Gómez Romero, Eduardo M. Sánchez Cervantes,*

This paper reports the preparation and characterization of 3-butyl-1-ethyl-benzimidazole dihydrogenphosphate (BEBz-HP) ionic liquid (IL) and its effect on the addition of phosphoric acid (H₃PO₃) and poly(2, 5-benzimidazole) or ABPBI. The new IL was prepared from the consecutive reaction of benzimidazole with ethyl and butyl bromides yielding BEBz-HP which is compatible to H₃PO₃. ABPBI was added to provide thermo-mechanical support. We present the structural characterization by infrared spectroscopy (FTIR), thermal stability by thermogravimetric analysis (TGA), electrochemical stability by cyclic voltammetry (CV) and conductivity by impedance analysis.

