Book of Abstracts

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October 14-20, 2020

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INVITED SPEAKERS

Id-291

Synthesis and Characterizations of Different Catalysts for Alkaline Fuel Cells

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Abstract: The need for electrical energy and transportation systems is rising globally and burning fossil fuels is the primary method to generate power for electrical purposes. The increased use of fossil fuels is increasing pollution. Combating pollution requires increasing and developing the use of clean energy. Fuel cells are one of the renewable electricity sources. This study is related to the intensively developing research in the field of fuel cells and nanomaterials and is devoted to the search of new effective materials, whicht can be used for development and design of direct alkaline fuel cells. Catalysts are an important part of the fuel cell and can enhance the working range of a fuel cell by up to 46% by increasing the power density. This work includes the discussion of 1) the different support (Ti or Cu) for fabrication of catalysts; 2) different methods for synthesis of catalysts – electrochemical, electroless metal deposition and galvanic displacement techniques, etc.; 3) characterization of the prepared catalysts and investigation of their electrocatalytic properties; 4) the performance of the different catalysts in direct borohydride fuel cell test. Electrochemical and electroless metal deposition methods were used for deposition of Co coating that has a fiber-like structure and smooth, respectively, on the surface of Ti or Cu (Co_{fiber}/Cu, Co/Ti and Co/Cu). Then, Au crystallites in size of 10-20 nm were deposited on the Co/Ti, Co/Cu and Co_{fiber}/Cu electrodes by their immersion into the Au(III)-containing solution for 30 s, leading to the AuCo/Ti, AuCo/Cu and $AuCo_{fiber}$/Cu catalysts. The catalysts were prepared with different Au loadings in the range of 4.2 up to 10.9 $\mu g_{Au} cm^{-2}$. Direct alkaline $NaBH_4$-H_2O_2 single fuel cell tests were carried out by employing the prepared AuCo/Ti, AuCo/Cu and $AuCo_{fiber}$/Cu catalysts as the anode and a Pt sheet as the cathode. The anolyte was composed of an alkaline mixture of 1 M $NaBH_4$ + 4 M NaOH and the catholyte contained 5 M H_2O_2 + 1.5 M HCl. The performance of the fuel cell was evaluated by recording the cell polarisation curves. The fuel cell displayed an open circuit voltage of ca. 1.9 V. It has been found that the highest peak power density up to 175 mW cm^{-2} was attained at a temperature of 25 ºC using the AuCo/Cu catalyst with the Au loading of 9.3 µg cm^{-2} as the anode. The highest specific peak power density of 40.2 mW μg_{Au}^{-1} at a temperature of 25 °C was attained using AuCo/Ti with the Au loading of

4.2 μg cm^{-2} as an anode. The AuCo/Ti, AuCo/Cu and $AuCo_{fiber}$/Cu catalysts are promising materials and can be used as anodes in direct sodium borohydride fuel cells.

Keywords: Alkaline Fuel Cells, Anode Catalysts, Gold, Cobalt, Nanoparticles.

INVITED SPEAKERS

Id-293

Wood-Derived Carbon Materials for Fuel Cells

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Abstract: Fuel cells are actively investigated as an attractive alternative energy sources for cleaner power generations, but the main problem is the high cost of fuel cells from what the main cost-deriver is the platinum (Pt). In order to improve the performance of fuel cells and to decrease their costs the main attention is focused on the search and development of novel Pt-free catalysts. Nowadays, nanocarbon based materials derived from biomass are relatively cheap and the synthesis methods are also quite simple, which in turn favours the widespread use of these materials. Herein, we report a facile strategy to synthesize a cheap and electrochemically active nano-carbon material from the renewable and biological resource, wood biomass. Carbonaceous materials have been obtained from alder charcoal as the biological waste, thermochemically activated with sodium hydroxide and doped with nitrogen using a cheap precursor - dicyandiamide at high temperatures. The obtained nitrogen-doped wood-derived carbon materials that have a graphene-like structure exhibit surprisingly high electro-catalytic activity for the electro-reduction of oxygen (ORR), which is similar to that of the commercial Pt/C (20 wt% Pt/C) in alkaline media. In order to improve the activity of the obtained nitrogen-doped wood-derived carbon materials not only for ORR, but also for the electro-oxidation of various fuels, such as hydrazine, sodium borohydride, ethanol, etc., which are used in direct liquid-fed fuel cells (DLFFCs), have been modified with metal nanoparticles (Co, Mn, Au, etc.) using the chemical reduction and microwave synthesis methods. The obtained metal nanoparticles supported nitrogen-doped wood-derived carbon materials provide a high activity towards the electro-oxidation of hydrazine, sodium borohydride, ethanol, etc. Data based on the ORR and the electro-oxidation of hydrazine, sodium borohydride, ethanol, etc. under various conditions are compared and discussed on the basis of electrochemical data. The proposed

synthetic strategy may offer a novel, simple and green route to prepare low-cost and high efficiency nitrogen-doped wood-based derived carbon materials and those modified with metal nanoparticles as the next generation catalysts for the fuel cells.

Keywords: Carbon, Biomass, Catalysts, Fuel Cells, Oxygen Reduction.

INVITED SPEAKERS

Id-297

Research Progress of 650-700℃ Ultra Supercritical Coal-fired Power Generation Technology in China

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Abstract: The advanced 700℃ ultra-supercritical (A-USC) power generation is the most important developing direction of power generation technology due to the highest efficiency and great potential for energy conservation. The major coal-fired power plant countries in the world are striving to achieve the target of more than 50% of net efficiency for power plant. Generally speaking, when the temperature and pressure of steam reaches around 700℃ and 30MPa respectively, the power station efficiency can be further improved and closed to 50% when using double reheat technology. China has made great strides in the USC power generation technology since 2005. At present, the highest efficiency of USC coal-fired power plant using double reheating technology is Laiwu 1000MW_e power plant, the efficiency of power generation is approximate 48.12%. Until now, there are almost around 400 USC power plant units with the capacity of 600-1000MW_e used in China, which lays a good foundation for developing the advanced 700℃ A-USC power generation technology. In 2005, China began to implement the research program of 700℃ ultra supercritical power generation, which including the properties of nickel-based materials, the optimization of 700℃ USC thermal system and the key design and manufacturing technologies for 700^0C USC boiler and turbine etc. With the improvement of unit parameters, the allowable temperature margin of high-temperature materials becomes smaller, the wall temperature safety of materials, especially for the operating conditions under variable loads, is particularly becoming the most important issue and a key problem for the design and operation of 700℃ USC boiler. To solve the above problem, we have studied the heat transfer characteristics coupling with hot flue gas and working fluid in tube under 700℃ USC condition in a 700℃ USC boiler test facility. And the coupled calculation method on predicting tube wall temperature with more accuracy, which considering both fire-side and working fluid-side has been built up based on the relevant basic experimental data. In addition, the 650℃ USC power generation technology based on austenitic steel was also studied to

provide a necessary accumulation and support for the demonstration of 700℃ USC power generation in the near future.

Keywords: 700℃ Ultra-Supercritical, Power Generation, Heat Efficiency, Materials, Thermal Safety.

INVITED SPEAKERS

Id-299

Role of Additives on the Kinetic and Thermodynamic Properties of $Mg(NH_2)_2$+ LiH Reactive Hydride Composite

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Abstract: The hydrogen storage properties of the Li-Mg-N-H system composed of $Mg(NH_2)_2$ and LiH are investigated. In the last decade, the Li-Mg-N-H system attracted increasing attention due to its high hydrogen storage capacity (5.5 wt.%), favourable dehydrogenation enthalpy ($\Delta H \approx 40$ kJ·mol$^{-1}H_2$) and good reversibility. Theoretical calculations show that the thermodynamic properties allow a dehydrogenation reaction temperature of 90℃ at a pressure of 1 bar of H_2, which is close to the operating temperature of proton exchange membrane fuel cells (PEMFCs). However, sufficient operating dehydrogenation rates are obtained only at temperatures higher than 220℃, due to kinetic constrains. In this work, a thorough study of the effect of two selected additives (i.e. K-modified $Li_xTi_yO_z$ and $LiBH_4$) on the material kinetic properties is carried out. The effect of lithium titanates ($Li_xTi_yO_z$) on the Li-Mg-N-H system is studied, to the best of my knowledge, for the first time. Their modification with potassium leads to the formation of K_2TiO_3 species, which act as catalyst and accelerate both absorption and desorption kinetics without altering the rate-limiting step. The second part of the thesis is devoted to the study of the Li-Mg-N-H system in combination with $LiBH_4$. $LiBH_4$ stabilizes the dehydrogenation product $LiNH_2$ forming the $Li(BH_4)(NH_2)_3$ phase at the interface of amide-hydride particles. During hydrogenation, the highly ionic conductive $Li_4(BH_4)(NH_2)_3$ supports the diffusion of small ions through the interfaces of the amide-hydride matrix. This work opens a new path to design appropriate additives to enhance the kinetic properties of Li-Mg-N-H systems for solid-state hydrogen storage.

Keywords: Amides, Destabilized Hydride System, Hydrogen Storage, Reactive Hydride Composites, Titanates.

POSTER SESSIONS

Id-295

Flexible-Fiber Shaped Cobalt Modified with Au-Mn Nanoparticles for Formic Acid Electro-Oxidation

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Abstract: In this study, flexible catalysts have been prepared via facile electrochemical approach with the aim to use them as the anode material in direct formic acid fuel cells (DFAFCs). A fiber-shaped cobalt coating has been electroplated on the copper-coated polyimide surface (labeled as Co_{fiber}/Cu/PI). For comparison, the cobalt layer that has the smooth structure has been also electrodeposited on the flexible Cu/PI surface (labeled as Co_{smooth}/Cu/PI). Additionaly, the fabricated flexible catalysts have been modified with gold (Au), manganese (Mn) or gold-manganese (Au-Mn) nanoparticles via electrochemical deposition. The morphology, structure and composition of the fabricated flexible catalysts have been characterized using scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD) and inductively coupled plasma optical emission spectroscopy (ICP-OES). The activity of catalysts has been investigated with respect to the electro-oxidation of formic acid in an alkaline medium using cyclic voltammetry and chrono-techniques. It was found that the deposition of Au, Mn or Au-Mn nanoparticles on Co_{fiber}/Cu/PI and Co_{smooth}/Cu/PI results in significantly enhanced electrocatalytic activity of latter catalysts towards the electro-oxidation of formic acid in an alkaline medium. Moreover, the prepared flexible catalysts seem to be a promising anode material for DFAFCs.

Keywords: Cobalt, Gold, Manganese, Formic Acid, Oxidation.

POSTER SESSIONS

Id-309

How to Maximize Energy Harvesting on a Piezoelectric Stuck for Aircraft Application?

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Abstract: Phononic crystals (PC) manufactured on piezoelectric materials are interesting for electrical energy recovery from mechanical vibrations conversion, thanks to the physical characteristics of piezoelectric materials. Many example of using piezoelectric material are available in industry, especially on aircraft where piezoelectric materials play a major role on electrical and sensors applications. Phononic crystals (PC) are periodic structures in the acoustic point of view. They exhibit frequency ranges where the acoustic waves are strongly attenuated called stop-bands. The frequency localization of the stop-bands depends on the mechanical and geometrical properties of the PC. Control the propagation of acoustic waves through a PC means to make a change on its band structure. The feasibility of controlling (modifying) the dispersion curves of a PC have been demonstrated in several works. Exploring the variation of geometrical properties on the dispersion curves, the delocalization of elements in a two dimensional PC constituted of square elements allows controlling the frequency position of the stop-bands. Also, the creation of a localized default in a cylindrical PC results in a local resonance inside the gap-band of the dispersion curves. The tunability of PC can be achieved by using specific materials (magnetostrictive, piezoelectric, …etc), which mechanical properties are sensitive to an external solicitation. Particularly, due to the piezoelectric constitutive equations, the electrical boundary conditions imposed on their electrodes could lead to changing their effective mechanical parameters. The electro-mechanical properties of piezoelectric elements are thus affected by their electric boundary conditions imposed by the electric impedance load. In this paper, we propose to study the propagation of longitudinal acoustic waves in a one dimensional PC, including piezoelectric elements. A new complex impedance load is connected to the electrodes of the piezoelectric elements. Using the Bloch-Floquet relation, the dispersion curves of the PC are calculated according to the value of the impedance load, highlighting the interactions between the electric boundary conditions and the acoustic waves. Numerical simulation of transmission through a piezoelectric PC are performed according to studied cases. The results of that control are used to demonstrate in the restitution

of electrical energy by implementing the studied cases with an aircraft structure. The studies details the large possibility to control the dispersion curve of a piezoelectric PC in which a new transmission band is created inside the stop band (hybridization). The results show that the frequency of this stop band is used to convert mechanical energy into electrical energy for aircraft application.

Keywords: Phononic Crystal, Piezoelectric Material, Electrical Circuit, Energy Harvesting.

POSTER SESSIONS

Id-329

Development of a Semi-Indusrial Low-Cost Magnetic Induction Separator for The Recovery of Domestic and Industrial Waste

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Abstract: In Algeria the production of municipal solid waste is valued at around 14 million tons per year In due to urbanization, population growth and the economy, so it will reache 20 million in 10 years, with an urbanization reaching 88% in 2028. This growth will be a challenge for the Algerian authorities to invest in collection facilities, transport and processing and move away from scenarios reserved for sites landfill. It is in this context that separation to known magnetic induction by eddy current separation can play an important role in recovery and material extraction metal as well as minimization of the use of resources. This technique allows separating granular mixtures comprising insulating particles, ferrous and non-ferrous of different sizes, by allowing the realization of a magnetic field distribution, which acts selectively on articles presenting a differential magnetization with respect to environment of existence. The result of the operation is to collect the ferrous particles (Al, Co, Zn ..) projected from a sufficient distance from the active zone of the conveyor thus allowing them to be separated from the insulating particles (plastic, wood, glass .....) which fall in free fall without which they undergo an ejection while the ferrous particles remain stuck on the conveyor belt until they fell due to the weakening of the magnetic field produced by the permanent magnet drums. The waste treatment in African countries is a real problem and suffers from developmental delay in cost reason of such equipment. As a result a new semi-industrial prototype with conveyor belt was developed, this one can ensure the sorting of objects from different size varying from centimeter to ten centimeters. Endowed with a large number of permanent magnets that produce a very intense magnetic induction ensures an efficient separation, and obtain well separated products. The separator could be able to separate products as big as a can of soda and even of the order of

magnitude a bottle of water. The weak cost of designing for such installation compared to the international market, is an economic opportunity allowing us to reuse secondary subjects in several industrial fields in order ensure materials relatively rare with reasonable prices. The Use of eddy current separators in the metal recycling non-ferrous conductors is a revolution that will have a very important impact on economy.

Key words: Permanent Magnet, Non-Ferrous, Magnetic Induction, Eddy Current Separation.

POSTER SESSIONS

Id-331

Contribution to the Numerical Modelling of Heat Exchange in the Steam Generator of a Small Modular Reactor (SMR)

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Abstract: Research and studies concerning small and simpler units for generating electricity from nuclear power, and for process heat should help to better understand the concept, operation and utility of these units. These facilities, called small modular reactor (SMR), are defined as advanced reactors that produce electricity up to 300 MWe per module. They are considered as a better option to fulfil the energy needs in a wide range of applications and can replace ageing fossil fuel-fired power plants. SMRs exhibit improved safety performance through inherent and passive safety features, provide better accessibility of initial investment cost. In addition, they can combine with other alternatives energy sources (Solar, Hydraulic...), and offer options for remote areas with less developed infrastructure. The PHYSOR project conducted by ALTRAN TECHNOLOGY is part of the research and development theme of new SMR concepts. An innovative project aims to improve the performance, design and safety of an SMR installation by integrating new technologies. In the SMR facilities, the steam generator (SG) plays an important role in the transmission of energy between the primary circuit and the secondary circuit of the reactor. For this we have interested in this work to study the thermo-hydraulic behavior of steam generator. The aim of this paper is to develop a numerical model to simulate the heat exchange within the SG. The two primary and secondary steam generator circuits have been studied. The results concerning temperature contours and velocity profiles for the two circuits were studied for different cases.

Keywords: Numerical Simulation, Heat Exchange, Small Modular Reactor (SMR), Steam Generator, Nuclear Power.

POSTER SESSIONS

Id-335

Structure and Transport Phenomena of Non-Aqueous Electrolyte in Al Ion Batteries -Study by Molecular Dynamics-

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Abstract: Li-ion batteries are widely used as power sources for smart phones and batteries for electric vehicles. However, Li is unevenly distributed on the earth and there is a concern about stable supply. Therefore, development of a secondary battery using an alternative element is required. Secondary batteries using aluminum ions have various advantages such as not only abundant Al as a raw material but also higher safety than lithium ion batteries. For this reason, it is drawing attention as a next-generation secondary battery. However, when water is used as an electrolytic solution, it is decomposed and hydrogen is generated. Therefore, various organic solvents have been studied as electrolytes. There are many MD studies of molecular liquids, but to our knowledge, there are not many simulations assuming the electrolyte of ion batteries. In recent years, we have systematically carried out MD studies of multicomponent aqueous solutions. In addition, we have conducted research on aqueous solutions of glycolic acid and lactic acid used in biofuel cells. As a part of a series of solution research so far, this study will perform MD simulations of molecular liquids as electrolytes for Al-ion batteries. First, the shape and charge of the molecule used for MD of the electrolyte are determined by density functional theory (DFT) using Gaussian.

Keywords: Molecular Dynamics, Al-Ion, Secondary Battery, Non-Water Electrolyte, Molecular Liquids.

POSTER SESSIONS

Id-340

Microalgae Culture for Biodiesel Production Using Agricultural Residues as Culture Medium

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Abstract: Cultures of microalgae Scenedesmus dimorphus and Neochloris oleoabundans were established to bioremediate effluent agribusiness and analyze the algal biomass to determine whether optimal for the production of biofuels. To this aqueous extracts poligástrico manure of cattle, rabbit and chicken vermicompost and the leachate were prepared, they were irradiated with UV light for 48 h. Microalgae strains were obtained from the laboratory of Applied Phycology UAM Iztapalapa and climbed up biorrectores 16 l. Cell growth was determined by counting in Neubauer chamber. Oil extraction was performed with a Soxhlet using hexane as solvent, at reflux for 16 h. Methanol was used together with potassium hydroxide as catalyst and oil to separate the triglycerides and glycerin obtain methyl esters for alkaline transesterification. The fatty acid profile was analyzed by chromatography. Following this heat index tests they were performed in a calorimeter Parr Model 6400 to know the potential it has with respect to diesel. Culture media used were found to be efficient for the production of algal biomass, which is proposed as an alternative low-cost and environmentally beneficial for the purification of the organic load of the effluents.

Keywords: Microalgae, Biodiesel, Agricultural Residues.

ALL SUBMISSIONS & TOPICS

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