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Journal of Power Sources

LEAD ACID**6071642****METHOD FOR MANUFACTURING A BATTERY COVER WHICH IS AT LEAST PARTIALLY ELECTRICALLY CONDUCTIVE**

Gerhard Pospiech; Eberhard Nann; Hermann Hester; Werner Hampe; Franz-Josef Kohaupt; GERMANY assigned to Accumulatorenwerke Hoppecke

A method for manufacturing a battery cover includes applying electrically conducting elements to at least a portion of a surface of the cover so as to span the surface. The electrically conducting elements are connected to one another and to at least one of the battery poles for dissipating electrical charge.

6074774**SEALED RECHARGE BATTERY PLENUM STABILIZED WITH STATE CHANGEABLE SUBSTANCE**

Michael G. Semmens; Ajoy Datta; Fardad Forouzan; UNITED STATES assigned to Electrosources Inc.

A lead-acid battery including a case, a plurality of negative and positive electrode plates arranged in the case, a plurality of separators interposed between the negative and positive electrode plates, and a plenum stabilization material disposed within the case to maintain the positions of the electrode plates relative to one another and to other components within the case. The plenum stabilization material includes a compound that (i) is solid during normal operation of the battery and (ii) can undergo reversible physical change in state from solid to liquid when the battery is subjected to or is operated under abnormal conditions.

6074782**LEAD STORAGE BATTERY CONTAINING A NEGATIVE ELECTRODE ACTIVE SUBSTANCE INCLUDING A NEGATIVE ELECTRODE ADDITIVE**

Muneharu Mizutani; Katsumi Yamada; Takaki Kamio; Masanobu Kawamura; JAPAN assigned to Aisin Seiki Kabushiki Kaisha, Nippon Paper Industries Company Ltd.

A lead storage battery comprising a positive electrode and a negative electrode. The negative electrode contains a negative electrode active substance to which a negative electrode additive is added. The negative electrode additive is a phenol-aminobenzene sulfonic acid-formaldehyde condensate. The above-structured lead storage battery provides a prolonged cycle life and excellent charging performance.

6077623**BIPOLAR LEAD-ACID BATTERY PLATES AND METHOD OF MAKING SAME**

Victor L. Grosvenor; Naum Pinsky; UNITED STATES

Electrodes, particularly useful in bipolar plates of lead-acid batteries, include a metal-containing substrate, an

electrically conductive material secured to the first side of the substrate, an electrically conductive layer including a polymer secured to the second side of the substrate; and a metallic layer secured to the electrically conductive layer so that the electrically conductive layer is located between the metallic layer and the substrate. Bipolar plates are provided and include an electrically conductive electrode element, a grid spaced apart from the electrode in proximity to the first side of the electrode element, positive active material in contact with the first side or second side of the electrode element and negative active material in contact with the first side or second side of the electrode element which is not in contact with the positive active material.

FUEL CELL**6074692****METHOD OF MAKING MEA FOR PEM/SPE FUEL CELL**

Jay S. Hulett; UNITED STATES assigned to General Motors Corporation

A method of making a membrane-electrode-assembly (MEA) for a PEM/SPE fuel cell comprising applying a slurry of electrode-forming material directly onto a membrane-electrolyte film. The slurry comprises a liquid vehicle carrying catalyst particles and a binder for the catalyst particles. The membrane-electrolyte is preswollen by contact with the vehicle before the electrode-forming slurry is applied to the membrane-electrolyte. The swollen membrane-electrolyte is constrained against shrinking in the "x" and "y" directions during drying. Following assembly of the fuel cell, the MEA is rehydrated inside the fuel cell such that it swells in the "z" direction for enhanced electrical contact with contiguous electrically conductive components of the fuel cell.

6074772**HIGH TEMPERATURE FUEL CELL, HIGH TEMPERATURE FUEL CELL STACK AND METHOD FOR PRODUCING A HIGH TEMPERATURE FUEL CELL**

Gerhard Hofer; Belinda Bruckner; Wilhelm Kleinlein; Harald Schmidt; GERMANY assigned to Siemens Aktiengesellschaft

A high temperature fuel cell and a method for producing the same include at least one interconnecting conducting plate which is associated with at least one electrode. A contact layer is disposed between the interconnecting conducting plate and the electrode. The contact layer is produced from an oxide mixed crystal powder which has a spinel structure and also contains, in addition to chromium, a divalent element selected from the group Ti, V, Mn, Fe, Co and Cu. The contact layer has high thermodynamic stability in addition to sufficient electrical conductivity.

A high temperature fuel cell stack includes a number of the high temperature fuel cells.

6074773

IMPREGNATION OF MICROPOROUS ELECTROCATALYST PARTICLES FOR IMPROVING PERFORMANCE IN AN ELECTROCHEMICAL FUEL CELL

David P. Wilkinson; Stephen A. Campbell; Joy A. Roberts; CANADA assigned to Ballard Power Systems Inc.

A method is provided for treating electrocatalyst particles and using the treated electrocatalyst for improving performance in an electrochemical fuel cell. The treatment method comprises impregnating pores of the electrocatalyst particles with an impregnant wherein the pores comprise micropores which have an aperture size less than 0.1 μm . The impregnant is preferably ion-conducting and may comprise an organic acid, an inorganic acid, or a polymer. Alternatively, or in addition, the impregnant has an oxygen permeability greater than that of water. The method of impregnating the electrocatalyst particles preferably comprises the steps of contacting the electrocatalyst particles with an impregnant and subjecting the electrocatalyst particles to a vacuum and/or an elevated pressure above atmospheric pressure. The treated electrocatalyst particles are incorporated into an electrochemical fuel cell. The impregnant improves the mass transport properties for the movement of reactants and reaction products within the micropores of the electrocatalyst particles, thereby improving electrocatalyst utilization and electrochemical fuel cell performance for a fixed amount of electrocatalyst.

6077620

FUEL CELL SYSTEM WITH COMBUSTOR-HEATED REFORMER

William Henry Pettit; UNITED STATES assigned to General Motors Corporation

A fuel cell system including a fuel reformer heated by a catalytic combustor fired by anode effluent and/or fuel from a liquid fuel supply providing fuel for the fuel cell. The combustor includes a vaporizer section heated by the combustor exhaust gases for vaporizing the fuel before feeding it into the combustor. Cathode effluent is used as the principle oxidant for the combustor.

6080503

POLYMER ELECTROLYTE MEMBRANE FUEL CELLS AND STACKS WITH ADHESIVELY BONDED LAYERS

Ottmar Schmid; Johann Einhart; GERMANY assigned to Ballard Power Systems Inc.

An electrochemical cell stack comprises a plurality of membrane electrode assemblies interposed between pairs

of separator plates. The stack comprises adhesively bonded layers. Preferably each membrane electrode assembly is adhesively bonded to the adjacent pair of separator plates. The adhesive bond between the plate and membrane electrode assembly preferably provides a substantially gas and liquid-tight seal around the perimeter of the electrochemically active area of the membrane electrode assembly and around any fluid manifold openings formed therein. Alternatively, or in addition, adjoining pairs of separator plates in an electrochemical cell stack may be adhesively bonded together. Such pairs of adhesively bonded plates may define cooling spaces between neighboring cells. Stacks comprising a plurality of individual cell modules may be formed, each module comprising a membrane electrode assembly bonded to a pair of separator plates.

6083636

FUEL CELL STACKS FOR ULTRA-HIGH EFFICIENCY POWER SYSTEMS

Michael S. Hsu; UNITED STATES assigned to Ztek Corporation

A system and method for producing electricity with a fuel cell power system. The power system includes an assembly of fuel cell stacks that operate at different temperatures, which vary between two or more of the fuel cell stacks. The fuel cell stack can have multiple temperature regions formed axially along the stack, or a plurality of spatially separated fuel cell stacks can be employed to heat a reactant from an input temperature to a desired temperature. The fuel cell stacks have operating temperatures in the range between about 20 and about 2000°C.

6083637

FUEL CELL ENERGY GENERATING SYSTEM

Hans Frieder Walz; Detlef zur Megede; GERMANY assigned to Daimler Chrysler AG

A fuel cell energy generating system which includes a reformate generating device that contains a hydrocarbon reforming reactor and produces a high-hydrogen reformate, has a fuel cell arrangement to which reformate generated by the reformate generating device can be fed on the inlet side by way of a reformate supply line, having at least one reformate-quality-indicating sensor arranged in the reformate flow path, and having a control unit. A valve is provided in the reformate supply line which can be controlled by the control unit such that it releases or interrupts the feeding of the reformate supplied by the reformate generating device into the fuel cell arrangement as a function of the output signal of the at least one reformate-quality-indicating sensor.

6083638**FUEL CELL**

Shunsuke Taniguchi; Akira Hamada; Yasuo Miyake; Minuro Kaneko; JAPAN assigned to Sanyo Electric Company Ltd.

A current collector includes a thin porous substrate and a hydrophilic material, where the hydrophilic material is provided to holes of the thin porous substrate or surfaces of skeleton elements of the porous substrate so that hydrophilic areas formed by the hydrophilic material successively pass through the thin porous substrate between both surfaces of the thin porous substrate. In the current collector, water is let out through the hydrophilic areas and does not stay on an interface between an electrode and the current collector so that reaction gas is not hampered and is supplied, unlike a conventional current collector. When the current collector is applied to a polymer electrolyte fuel cell, water is supplied with reliability through the hydrophilic areas to a polymer electrolyte membrane so that the polymer electrolyte membrane is effectively humidified. The current collector applied to a cathode achieves a profound effect because reaction product water tends to stay around a cathode of any types of fuel cells. The current collector also includes gas flow paths which are surrounded by particles of a hydrophobic material and pass through the thin porous substrate between both surfaces of the thin porous substrate. As a result, gas permeability of the current collector is maintained with reliability.

6093500**METHOD AND APPARATUS FOR OPERATING A FUEL CELL SYSTEM**

Paul R. Margiott; Zakiul Kabir; Vincent M. Callaghan; UNITED STATES assigned to International Fuel Cells Corporation

Method and apparatus for changing the state of operation of a fuel cell, such as starting the fuel cell up or shutting the fuel cell down, are disclosed. An idle load is applied to the fuel cell when the cell temperature is between about normal operating temperature and a transition temperature, and fuel and oxidizer are supplied to the fuel cell commensurate with the power delivered to the idle load. Below the transition temperature, purging/passivation procedures known in the art can be followed, and an open or dummy load applied to the fuel cell. At normal operating temperature or above a service load is applied to the fuel cell.

6093501**FUEL CELL USING AN AQUEOUS HYDROGEN-GENERATING PROCESS**

John Werth; UNITED STATES assigned to H Power Corporation

An improved fuel cell system that utilizes hydrogen and air. The hydrogen of the fuel cell is derived from a

hydrogen-generating process wherein H₂O is passed over a bed of iron material. The hydrogen generating process uses a catalyst, or freshly-ground iron material, or both, and generates the hydrogen for the fuel cell in situ at lower-than-normal temperatures when the H₂O reacts with the iron material. The fuel cell can be used to power a stationary system or a land vehicle, such as an automobile. The bed of iron material can be replenished periodically or continuously.

6093502**FUEL CELL WITH SELECTIVE PRESSURE VARIATION AND DYNAMIC INFLECTION**

Charles M. Carlstrom Jr.; William B. Maynard; UNITED STATES assigned to Plug Power Inc.

In one aspect, a fuel cell assembly may include one or more (e.g. PEM-type) fuel cell(s). Fluid(s) service(s) for the fuel cell assembly may include reactant fluid(s) service(s) such as service(s) of fuel(s) and/or oxidant(s), along with humidification service(s). A pulsator may be positioned at any entrance and/or exit for the fluid manifolds. Such pulsator(s) may serve to introduce pressure variation(s) along part(s) of flow path(s) extending in the fuel cell assembly. In one example, with respect to an anode side of a fuel cell, the pressure variation(s) may serve to purge a nitrogen blanket from the anode side of the MEA so reformat including hydrogen may be supplied for electrochemical reaction. With respect to a cathode side of the fuel cell, the pressure variation(s) may serve to remove a nitrogen and/or carbon dioxide blanket and product fluid from the cathode side of the MEA so air containing oxygen may be supplied for the electrochemical reaction. Also, excess humidification fluid may be removed. A greater power density may be obtained. Pressure variation(s) may be configured to dynamically inflect the MEA to assist mechanical mixing(s) in promoting flow field fuel service(s) and/or increasing power density.

6096448**METHOD AND APPARATUS FOR OPERATING AN ELECTROCHEMICAL FUEL CELL WITH PERIODIC FUEL STARVATION AT THE ANODE**

David P. Wilkinson; Clarence Y.F. Chow; Derek E. Allan, deceased; Patricia Joanne Allan, administrator; Erik P. Johannes; Joy A. Roberts; Jean St-Pierre; Cindy J. Longley; John K.K. Chan; CANADA assigned to Ballard Power Systems Inc.

A method and apparatus is provided for operating an electrochemical fuel cell with periodic momentary fuel starvation at the anode. It is believed that such momentary periodic fuel starvation conditions cause the anode potential to increase, resulting in the oxidation and removal of electrocatalyst poisons from the anode electrocatalyst and improved fuel cell performance. In a preferred method,

while successive localized portions of the fuel cell anode are momentarily periodically fuel starved, the remainder of the fuel cell anode remains electrochemically active and saturated with fuel such that the fuel cell is continually available to generate power.

6096449

FUEL CELL AND METHOD FOR CONTROLLING SAME

William A. Fuglevand; Peter D. DeVries; Greg A. Lloyd; David R. Lott; John P. Scartozzi; UNITED STATES assigned to Avista Labs

The present invention relates to an improved fuel cell and method for controlling same having an anode and a cathode which produces an electrical current having a given voltage and current output and which includes a controller electrically coupled with the fuel cell and which shunts the electrical current between the anode and the cathode of the fuel cell. The invention also discloses a method for controlling the fuel cell having an anode, a cathode and a given voltage and current output and which includes determining the voltage and current output of the fuel cell; and shunting the electrical current between the anode and cathode of the fuel cell under first and second operational conditions.

6096450

FUEL CELL ASSEMBLY FLUID FLOW PLATE HAVING CONDUCTIVE FIBERS AND RIGIDIZING MATERIAL THEREIN

Michael M. Walsh; UNITED STATES assigned to Plug Power Inc.

A fluid flow plate is preferably formed with three initial sections, for instance, two layers of conductive (e.g. metal) fibers and a barrier material (e.g. metal foil) which is interposed between the two layers. For example, sintering of these three sections can provide electrical path(s) between outer faces of the two layers. Then, the sintered sections can be, for instance, placed in a mold for forming of flow channel(s) into one or more of the outer faces. Next, rigidizing material (e.g. resin) can be injected into the mold, for example, to fill and/or seal space(s) about a conductive matrix of the electrical path(s). Preferably, abrading of surface(s) of the outer face(s) serves to expose electrical contact(s) to the electrical path(s).

6096451

SOLID-ELECTROLYTE FUEL CELL

Akira Shiratori; Michiaki Iha; Hiroshi Takagi; JAPAN assigned to Murata Manufacturing Company Ltd.

A solid-electrolyte fuel cell stack comprises three-layered films and separators alternately stacked with each other. Each of the three-layered films comprises a solid-electrolyte

film, a fuel electrode and an air electrode with the solid-electrolyte film interposed between the fuel electrode and the air electrode. The three-layered film and the separator are bonded together with a glass bonding agent and a ceramic bonding agent separately interposed therebetween.

BATTERY MATERIALS

6071641

GLASS FIBER SEPARATORS AND BATTERIES INCLUDING SUCH SEPARATORS

George C. Zguris; UNITED STATES

A lead acid battery having a glass fiber separator material is disclosed. The separator material is a mass of intermeshed glass fibers produced by suspending glass fibers in a gaseous medium, and collecting the suspended glass fibers on a foraminous material. The mass of fibers suspended in the gaseous medium has a BET surface area of from 0.2 to 5 m²/g. A battery having a glass fiber separator material with added cellulose fibrils is also disclosed, as is a battery having a glass fiber separator material with added particulate material such as silica.

6071650

BATTERY ELECTRODE SUBSTRATE AND PROCESS FOR PRODUCING THE SAME

Keizo Harada; Kenichi Watanabe; Shosaku Yamanaka; JAPAN assigned to Sumitomo Electric Industries Ltd., Matsushita Electric Industrial Company Ltd.

A battery electrode substrate which is constituted of a porous metallic body structure having communicating pores at a porosity of at least 90% and an Fe/Ni multilayer structure wherein the skeletal portion of the porous metallic body is composed mainly of Fe and has an Ni covering layer on the surface thereof while pores communicating with the inside and outside of Fe skeletal portion exist in the Fe skeletal portion and the inside of the pores is covered with Ni. The electrode substrate is produced by applying an iron oxide powder of at most 20 μm in an average particle size on a porous resin core body; heat treating the core to remove an organic resin component while simultaneously sintering Fe to obtain a porous Fe body; and then covering the Fe skeletal portion with Ni by electroplating. In this process, the iron oxide can be used in combination with carbon powder. Further, a nickel porous sintered body can also be produced using nickel oxide in place of iron oxide.

6071651

RESILIENT BATTERY SEPARATOR MEDIA AND A BATTERY INCLUDING THE RESILIENT SEPARATOR MEDIA

Don August Forte; Joseph Rumiesz Jr.; Michael John Cusick; Phillip Charles Martin; UNITED STATES assigned to Johns Manville International Inc.

A resilient battery separator, especially suited for use in a starved electrolyte battery, is made of an air laid fibrous mat of randomly oriented, entangled microfibers having a mean diameter between 0.5 and 2.0 μm . The air laid mat weighs between 50 and 450 g/m^2 and has a thickness between 0.01 and 0.5 in. The fibrous mat may be essentially uniform in density throughout its thickness or may include one or two relatively high density, high tensile strength fibrous surface layer(s) and a relatively low density, more resilient fibrous layer integral with and, in one embodiment, intermediate the two surface layers. The microfibers in the surface layer(s) are more entangled than the microfibers in the resilient layer. In a starved electrolyte battery, the separator has a thickness, when subjected to a loading of 1.5 psi, that is equal to or greater than the spacing between the electrode plates of the battery and, preferably, at least 110% of the spacing between the electrode plates of the battery.

6074776

**POLYMERIZABLE ADDITIVES FOR MAKING
NON-AQUEOUS RECHARGEABLE LITHIUM
BATTERIES SAFE AFTER OVERCHARGE**

Huanyu Mao; David Stanley Wainwright; CANADA assigned to E-One Moli Energy (Canada) Ltd.

After undergoing overcharge abuse, non-aqueous rechargeable lithium batteries can be left in a relatively hazardous state of charge, representing a safety concern with respect to subsequent thermal or mechanical abuse. Electrolyte additives which electrochemically form conductive polymers can be used to create a short circuit inside the battery as a result of overcharge abuse and automatically discharge the battery internally. The invention is particularly suitable for batteries equipped with electrical disconnect devices which cannot be discharged externally after the disconnect has activated. Aromatic compounds such as biphenyl are particularly suitable additives.

6074783

**HYDROGEN STORAGE ALLOYS FOR USE IN
RECHARGEABLE ELECTROCHEMICAL CELLS,
AND METHODS OF PRODUCING THEM**

Mark Gaydos; Philip D. Trainer; UNITED STATES assigned to Duracell Inc.

An AB_5 -type hydrogen absorbing alloy composition for use in an electrochemical cell includes between ~ 0.001 and 0.01 mol% of zirconium and/or titanium dispersed throughout the alloy. Methods of producing the alloy are also disclosed. The levels of these elements have been selected to maintain low hydrogen equilibrium pressure, high capacity, and acceptable activation characteristics, along with improved storage characteristics and improved cycle life from reduced corrosion.

6077627

**POLYMER ELECTROLYTE AND METHOD
FOR PREPARING SAME**

Peter Bauerlein; GERMANY assigned to Varta Batterie Aktiengesellschaft

The invention relates to a method for preparing polymer electrolytes for rechargeable lithium intercalation cells which contain a dissociable lithium salt dispersed in a polymeric matrix, the polymeric matrix being a self-supporting film of a copolymer of vinylidene difluoride and hexafluoropropylene, in which the plasticizer is exchanged for a solution of the dissociable lithium salt, so that the polymeric electrolyte 20–70 wt.% of the solution of the dissociable lithium salt, and is characterized in that a plasticizer is used which is stable under the electrochemical conditions of a rechargeable lithium intercalation cell and is selected from the group consisting of hexylene carbonate, octylene carbonate or tributyl phosphate.

6077628

**NONAQUEOUS ELECTROLYTIC SOLUTION FOR
BATTERY AND NONAQUEOUS ELECTROLYTIC
SOLUTION BATTERY**

Kensuke Takechi; Akihiko Koiwai; Tohru Shiga; JAPAN assigned to Kabushiki Kaisha Toyota Chuo Kenkyusho

A nonaqueous electrolytic solution for a battery, which contains a supporting electrolyte which reacts with water to produce an acid; and a complex-forming compound which forms an inert complex by reacting with water and a supporting electrolyte to prevent acid generation.

6077897

**POLYMERIC COMPOSITE ELECTROLYTE AND
PROCESS FOR PRODUCING SAME**

Ten-Chin Wen; Tsung-Tien Cheng; HONG KONG

A process for producing a WPU-PEO based composite electrolyte is disclosed. The process includes steps of (a) providing a polyurethane material as a matrix material; (b) dispersing the matrix material in a first solvent and mixing PEO in the same solvent to form a dispersion solution; (c) drying the dispersion solution to form a thin composite film of WPU-PEO as a matrix of the polymeric electrolyte; and (d) adding a component of an anhydrous liquid electrolyte into the matrix to form the WPU-PEO based composite electrolyte. The fabricated thin film electrolyte has a good conductivity (up to 10^{-2} – 10^{-3} S/cm at room temperature) and can be suitably used in cells, e.g. lithium ion batteries, lithium batteries, and electrochromic devices. The feasibility of the use of a mixture of various WPU, cross-linked WPU, and WPU based composite electrolytes in lithium ion batteries, lithium batteries, and electrochromic devices is also disclosed.

6080282**ELECTROLYTIC SOLUTION FOR USE AS GEL ELECTROLYTE AND PROCESS FOR MAKING THE SAME**

Eric S. Kolb; Martin Van Buren; Marina Sherman; UNITED STATES assigned to Mitsubishi Chemical Corporation

The present invention is directed to both an electrolyte solution for use as a gel electrolyte in an electrolytic cell, and a process for making both the electrolyte gel and the electrolytic cell. The electrolyte solution comprises a polymerizable electrolyte material and a reinforcement polymer. The reinforcement polymer preferably consists of at least poly(methyl methacrylate), while the polymerizable electrolyte material comprises at least a solvent, a monomer, a polymerization initiator, and an ionic conductor. The use of a reinforcement polymer increases the homogeneity and thus the coatibility of the electrolytic solution, while also improving the mechanical properties of the cured electrolyte gel.

6080507**TRILAYER BATTERY SEPARATOR**

Ta-Hua Yu; UNITED STATES assigned to Celgard Inc.

A trilayer shutdown battery separator is provided having two strength layers sandwiching a shutdown layer that is made by a particle stretch method. The preferred method of making such a trilayer separator comprises: making microporous strength layers; forming a microporous shutdown layer by a particle stretch method; and bonding two microporous strength layers and one microporous shutdown layer into the trilayer battery separator wherein the first and third layers are strength layers, and the second membrane is a microporous shutdown layer made by a particle stretch method.

LITHIUM BATTERIES**6071489****METHODS OF PREPARING CATHODE ACTIVE MATERIALS FOR LITHIUM SECONDARY BATTERY**

Yang-Kook Sun; Young-Roak Kim; Kyu-Sung Kim; Dong-Won Kim; SOUTH KOREA assigned to Samsung Display Device Company Ltd.

The $\text{Li}_x\text{Mn}_2\text{O}_4$ powder for cathode active material of a lithium secondary battery of the present invention is prepared by a method of comprising the steps of mixing an acetate aqueous solution using Li acetate and Mn acetate as metal precursors, and a chelating agent aqueous solution using PVB, GA, PAA or GC as a chelating agent; heating the mixed solution at 70–90°C to form a sol; further heating the sol at 70–90°C to form a gel precursor; calcining the produced gel precursor at 200–900°C for 5–30 h under

atmosphere. The cathode active material, $\text{Li}_x\text{Mn}_2\text{O}_4$ powder for a lithium secondary battery in accordance with the present invention has a uniform particle size distribution, a high crystallinity and a pure spinel-phase, and a particle size, a specific surface area, a lattice of a cubic structure and the like can be controlled upon the preparing conditions. The present invention also provides a method of preparing $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ powder, which comprises the steps of providing a gel precursor using PAA as a chelating agent and hydroxide, nitrate or acetate of Li, Co and Ni as metal precursors; heating the gel precursor at 200–900°C for 5–30 h to form a powder. The $\text{Li}_x\text{Mn}_2\text{O}_4$ and $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ powder of the present invention can be used for a cathode active material of a lithium secondary battery such as a lithium ion battery or lithium polymer battery.

6071645**LITHIUM ELECTRODE FOR A RECHARGEABLE ELECTROCHEMICAL CELL**

Philippe Biensan; Damien Gallet; Bernard Simon; FRANCE assigned to SAFT

The present invention concerns an electrode for a rechargeable lithium cell, containing an electro-chemically active material with general formula where M is at least one transition metal selected from nickel, cobalt, manganese, and iron, A is selected from magnesium and calcium, and D is at least one element selected from the elements of groups 4b to 5a of the periodic classification.

6071646**SPINEL COMPOUNDS AS CATHODES FOR LITHIUM MATERIALS**

Hideyuki Noguchi; Hiroyuki Tabata; Noriko Anan; JAPAN assigned to Kyushu Ceramics Industry Company Ltd.

The invention relates to a method of preparing spinel structure lithium manganese oxides as cathode for lithium batteries. The spinel compounds are obtained by the reacting of MnO_2 with a particle size of less 10 μm and Li_2CO_3 . The cell containing above cathode material provides improved capacity and good rechargeability. The method described in the present invention is much closer to industrial scale produce.

6071647**LITHIUM AND MANGANESE DOUBLE OXIDES FOR THE POSITIVE ELECTRODES OF ELECTROCHEMICAL DEVICES, PREPARATION THEREOF, AND ELECTRODES INCLUDING SUCH OXIDES**

Nadine Treuil; Josik Portier; Guy Campet; Josette Ledran; Jean-Claude Frison; FRANCE assigned to France Telecom

The invention relates to a method of preparing an oxide of formula $\text{Li}_x\text{Mn}_y\text{O}_z$, in which x lies in the range 0–2, y lies in

the range 1–3, and z lies in the range 3–4.5, x , y , and z being such that the oxide has a composition close to LiMn_2O_4 . According to the invention, the method comprises the following steps: (a) a polymer complex of lithium and of manganese is prepared in the form of a gel or of a xerogel by causing a reducing polymer, copolymer or polymer mixture possessing complexing functions for lithium and manganese to react in a common solvent with an oxidizing lithium salt and with an oxidizing manganese salt, and by evaporating off the solvent, partially or in full; and (b) the resulting lithium and manganese polymer complex is mineralized by the explosive oxidation–reduction technique to recover fine amorphous particles of the oxide of formula $\text{Li}_x\text{Mn}_y\text{O}_z$.

6071648

NON-AQUEOUS ELECTROLYTE SECONDARY BATTERIES

Shoichiro Watanabe; Noriko Tanaka; Toshitada Sato; Takayuki Shirane; Shigeo Kobayashi; JAPAN assigned to Matsushita Electric Industrial Company Ltd.

A positive electrode made of lithium contained metal oxide and a negative electrode made of a carbon material as active material are separated by a separator impregnated with organic electrolyte solution or a solid electrolyte layer. In particular, the carbon material is added with the metal oxide which can electrochemically be reduced by charge to generate a metal. The metal oxide consists mainly of a mixture of the carbon material and at least one metal oxide selected from a group of TiO_2 , Cr_2O_3 , MnO_2 , Fe_3O_4 , CoO , $\text{Company}_2\text{O}_3$, $\text{Company}_3\text{O}_4$, NiO , Ni_2O_3 , Ag_2O , PbO , Sb_2O_3 , Bi_2O_3 , SeO_2 , and TeO_2 .

6074784

LITHIUM BATTERIES

Junichi Maruta; JAPAN assigned to Japan Storage Battery Company Ltd.

A compound represented by chemical formula: $\text{H}_x\text{Li}_y\text{NiO}_2$ ($0 < x \leq 1$; $0 \leq y < 1$; and $0.25 \leq (x + y) \leq 2$) is used as a positive active material of a lithium battery. The average oxidation number of nickel of the compound varies within a range of from 2.0 to 3.75 with charges and discharges of the battery.

6077463

PROCESS FOR PRODUCING GRAPHITE MATERIAL FOR NEGATIVE ELECTRODE USED IN LITHIUM SECONDARY BATTERY

Yasuyuki Takai; Tetsuji Takemura; Mikio Watanabe; JAPAN assigned to Petoca Ltd.

A process for producing graphite materials for a negative electrode used in a lithium secondary battery which process includes the steps of packing carbon materials having an average particle diameter of 5–50 μm in a plurality of boxes,

placing the boxes in a graphitization furnace, subjecting the graphite materials to graphitization treatment, and thereafter subjecting the resultant graphite materials to uniformization treatment by mixing and agitation. The above process is capable of decreasing the influence on the qualitative variation of graphite materials ascribed to packing operation into boxes for graphitization, to the position of the materials in a graphitization furnace, and to bubbling phenomenon or the like through graphitization treatment, and is also capable of stabilizing the qualities of the resulting graphite materials and increasing the productivity.

6077624

LITHIUM ION CELLS WITH IMPROVED THERMAL STABILITY

Porter H. Mitchell; Jeremy Barker; Tracy E. Kelley; UNITED STATES assigned to Valence Technology Inc.

The methods and compositions of the invention provide two solutions to reduce the reactivity of VDF-based copolymers to lithiated graphite. The two approaches can be used separately or combined. In one embodiment, the relative proportion of the VDF and the other fluorinated monomer (OFM, i.e. HFP) in the copolymer is significantly reduced below conventional formulations in order to reduce the reactivity of the copolymer. In a second approach, the reactivity of the copolymer, over a broad range of monomer VDF:OFM molar ratios, is reduced by deactivating the reactive sites on the copolymer, thereby blocking the ability to undergo undesired reaction during cell operation. These methods and compositions have heretofore not been proposed and are of primary importance in preventing large exothermic reaction which can lead to thermal runaway when conventional polymer formulations are utilized in batteries in the presence of reactive components such as lithiated graphite.

6081097

METHOD FOR CHARGING LITHIUM SECONDARY BATTERY

Hajime Seri; Yoshinori Yamada; Kenichi Takeyama; JAPAN assigned to Matsushita Electric Industrial Company Ltd.

A method for charging a secondary battery is disclosed. The method comprises the steps of detecting an impedance of the battery; charging the battery with a substantially constant first current having a value smaller than a predetermined current value if the detected impedance of the battery is equal to or greater than a predetermined impedance value; charging the battery with a substantially constant second current having a value equal to or greater than the predetermined current value if the detected impedance is less than the predetermined impedance value; and terminating charging the battery with the first and second constant currents when the closed circuit voltage of the battery reaches a predetermined voltage value.

6083643**ACTIVE MATERIAL FOR A CATHODE OF LITHIUM ION BATTERY AND A METHOD FOR PREPARING THE SAME**

Jae-phil Cho; Geun-bae Kim; SOUTH KOREA assigned to Samsung Display Devices Company Inc.

A process for preparing an active material for a cathode of a lithium ion battery comprising the steps of: dissolving lithium hydroxide, manganese acetate as starting materials into water to form a solution; adding a chelating agent into the solution; producing gel or liquid phase by evaporating the solution; and producing a powder by raising temperature at the rate of 5–20°C/min, combusting and calcinating the gel or liquid phase at 300–400°C during 2–3 h is disclosed.

6083644**NON-AQUEOUS ELECTROLYTE SECONDARY BATTERY**

Shunji Watanabe; Shinichi Takasugi; Tsugio Sakai; Kensuke Tahara; Akifumi Sakata; Hideharu Onodera; JAPAN assigned to Seiko Instruments Inc.

A 1.5 V non-aqueous electrolyte secondary battery having high energy density, excellent charge and discharge characteristics and long cycle life is provided. The non-aqueous electrolyte secondary battery uses, as the negative electrode active material, lithium-containing silicon oxide represented by the compositional formula Li_xSiO_y and defined such that the lithium content x and oxygen amount y are satisfied with $1.5 \leq x \leq 4.5$ and $0 < y < 2$, respectively, and also uses, as the positive electrode, lithium-containing titanium oxide represented by the general formula $\text{Li}_x\text{Ti}_y\text{O}_4$ wherein $0 \leq x \leq 3$ and $1.6 \leq y \leq 2.2$ or lithium-containing iron sulfide represented by the general formula Li_xFeS_y wherein $x \leq 1.1$ and $0.5 \leq y \leq 2.5$, so that a secondary battery of about 1.5 V having high energy density, less inner resistance and excellent charge and discharge characteristics can be obtained. The non-aqueous electrolyte secondary battery has high charge and discharge efficiency, does not cause defect such as inner short-circuit due to formation of dendrite, and it is very stable with a long cycle life.

6083645**SECONDARY BATTERY USING SYSTEM AND MATERIAL FOR NEGATIVE ELECTRODE OF SECONDARY BATTERY**

Seiji Takeuchi; Hidetoshi Honbo; Takeo Yamagata; Tatsuo Horiba; Yasushi Muranaka; JAPAN assigned to Hitachi Ltd.

A lithium secondary battery suitable for use as a power source for a secondary battery using system such as an electric automobile, motor bicycle or portable equipment includes a negative electrode composed of a carbon material including carbon particles carrying fine particles of a metal which forms an alloy with lithium. The carbon particles have

a face-to-face dimension which is 3.354–3.369 Å and a crystal grain size in a *C*-axis direction which is ≥ 300 Å. The metal forming an alloy with lithium has a particle size which is equal to or smaller than 1000 Å. With the use of the charge/discharge capacity of an alloy of the metal and lithium, a value exceeding the theoretical capacity 372 mA h/g of graphite can be obtained. The lithium secondary battery is capable of discharge with an output energy density ≥ 350 W/kg.

6083646**NON-AQUEOUS ELECTROLYTE SECONDARY BATTERY AND METHOD FOR PRODUCING CATHODE MATERIAL**

Naoyuki Sugeno; Katsumi Mori; JAPAN assigned to Sony Corporation

The object of the present invention is to provide a non-aqueous electrolyte secondary battery which uses a lithium–manganese oxide as an cathode material but, suppressing deterioration of an cathode material and a crystalline structure caused by charge/discharge cycles, exhibits an excellent discharge load property and an excellent cycle property. The present invention also provides a method for producing an cathode material which realizes the non-aqueous electrolyte secondary battery.

6085015**LITHIUM INSERTION ELECTRODE MATERIALS BASED ON ORTHOSILICATE DERIVATIVES**

Michel Armand; Christophe Michot; Nathalie Ravet; Martin Simoneau; Pierre Hovington; CANADA assigned to Hydro-Quebec, Centre National de la Recherche Scientifique

An orthosilicate whose structure is based on SiO_4^{4-} tetranions which contains at least one transition element with at least two valence states. Lithium ingresses or egresses into or from the structure in order to compensate for a change in valency of the redox couple during electrode operation and thereby maintain overall electroneutrality.

6093503**NON-AQUEOUS ELECTROLYTE LITHIUM SECONDARY CELL**

Hirofumi Isoyama; Hisanao Kojima; Satoru Suzuki; Jun Hasegawa; JAPAN assigned to Nippondenso Company Ltd.

A device for protecting a cell is described comprising a cell body arranged in a container which has opening and closing means to open and close the cell body from the exterior atmosphere of the container. The device also has a sensor for sensing an impact to the cell body. When the impact is above a predetermined value, a barrier fluid is sprayed into the interior of the container. The opening and closing means of the container is operated in response to the spraying of the barrier fluid.

6093505**CATHODE MATERIAL AND NON-AQUEOUS ELECTROLYTE SECONDARY CELL USING THE CATHODE MATERIAL**

Kaoru Miura; JAPAN assigned to Sony Corporation

The present invention provides a cathode material for a lithium ion secondary cell having an excellent voltage characteristic and enabling to obtain a high capacity cell although cheaper than LiCoO_2 . The present invention uses as a cathode material a lithium compound $\text{Li}_x\text{Mn}_2\text{O}_4$ (wherein x is in the range of $0 \leq x \leq 3$) whose oxygen ions are at least partially replaced by negative ions having a greater absolute value of valence than oxygen ion. Such a lithium compound may be, for example, $\text{Li}_x\text{Mn}_2\text{O}_2\text{N}_2$.

6096454**SURFACE MODIFICATIONS FOR CARBON LITHIUM INTERCALATION ANODES**

Tri D. Tran; Kimio Kinoshita; UNITED STATES assigned to The Regents of the University of California

A prefabricated carbon anode containing predetermined amounts of passivating film components is assembled into a lithium-ion rechargeable battery. The modified carbon anode enhances the reduction of the irreversible capacity loss during the first discharge of a cathode-loaded cell. The passivating film components, such as Li_2O and Li_2CO_3 , of a predetermined amount effective for optimal passivation of carbon, are incorporated into carbon anode materials to produce dry anodes that are essentially free of battery electrolyte prior to battery assembly.

NICKEL METAL HYDRIDE BATTERIES**6074785****NICKEL/METAL HYDRIDE STORAGE BATTERY**

Yoshitaka Dansui; Fumio Kato; Kenji Suzuki; Kohji Yuasa; JAPAN assigned to Matsushita Electric Industrial Company Ltd.

The present invention provides a nickel/metal hydride storage battery using improved nickel hydroxide with an increased energy density as the active material. This invention is characterized in that the nickel hydroxide as the active material of the positive electrode constituting the battery indispensably contains as a solid solution at least one transition metal selected from the group consisting of Mn, Cr and Co in a proportion of 2–20 at.% based on the amount of the nickel hydroxide in terms of metallic nickel, and that the crystal structure of the nickel hydroxide at charged state is a hexagonal or tetragonal system which has a diffraction peak of 2θ on (0 0 1) plane of $\beta\text{-NiOOH}$ at an angle of approximately $15\text{--}19^\circ$ in X-ray diffraction using $\text{Cu K}\alpha$ as a source and has a regular array with a NaCl type structure.

6077622**RECYCLING METHOD OF NICKEL-HYDROGEN SECONDARY BATTERY**

Taketoshi Minohara; JAPAN assigned to Toyota Jidosha Kabushiki Kaisha

A method of recycling a deteriorated nickel-hydrogen battery. Concentrated sulfuric acid containing at least one of Ni ions, Co ions and La ions is poured into the deteriorated nickel-hydrogen battery and the interior thereof is cleaned with the concentrated sulfuric acid. The state of the interior of the battery is maintained at a temperature of $60 \pm 10^\circ\text{C}$, and an electric current is supplied in such a direction as to charge the nickel-hydrogen battery. Then, the interior of the nickel-hydrogen battery is cleaned and filled with an alkali electrolyte containing a reducing agent. Consequently, $\gamma\text{-NiOOH}$ changes to $\beta\text{-NiOOH}$ to restore the capacity of a positive electrode, and Mm(OH)_3 , Al(OH)_3 , Mn(OH)_2 and CO(OH)_2 dissolve in concentrated sulfuric acid to activate the surface of a negative electrode. In addition, the hydrophilic property of the separator is restored.

6077625**NON-SINTERED NICKEL ELECTRODE FOR ALKALINE STORAGE BATTERY**

Mutsumi Yano; Mitsunori Tokuda; Kousuke Satoguchi; Shin Fujitani; Koji Nishio; JAPAN assigned to Sanyo Electric Company Ltd.

Non-sintered nickel electrodes for alkaline storage batteries which can express high active material utilization efficiency not only at the time of charging at ordinary temperature but also at the time of charging in a high-temperature atmosphere are provided by using an active material powder composed of composite particles each comprising a substrate particle containing nickel hydroxide, an inner coat layer covering the substrate particle and comprising yttrium, scandium or a lanthanoid, or an yttrium, scandium or lanthanoid compound, and an outer coat layer covering the inner coat layer and comprising cobalt or a cobalt compound, or composed of composite particles each comprising a substrate particle containing nickel hydroxide, an inner coat layer covering the substrate particle and comprising cobalt or a cobalt compound, and an outer coat layer covering the inner coat layer and comprising yttrium, scandium or a lanthanoid, or an yttrium, scandium or lanthanoid compound.

6083642**POSITIVE ELECTRODE MATERIAL FOR ALKALINE STORAGE BATTERY, METHOD OF PRODUCING THE SAME, AND ALKALINE STORAGE BATTERY USING THE SAME**

Fumio Kato; Futoshi Tanigawa; Yoshitaka Dansui; Kohji Yuasa; JAPAN assigned to Matsushita Electric Industrial Company Ltd.

Disclosed is a positive electrode material which provides an alkaline storage battery having high active material utilization, wherein good capacity recovery can be obtained by charging even after standing in the state of overdischarge or short circuit, and reduction in capacity scarcely arises. This active material comprises nickel hydroxide particles and a cobalt oxide. The cobalt oxide is a higher cobalt oxide containing as a main component γ -cobalt oxyhydroxide, which belongs to any one crystal system of hexagonal, orthorhombic and monoclinic systems and has a layered structure, wherein a lattice spacing of the (0 0 3) plane is from 5.5 to 7.0 Å and an average valence of cobalt is higher than 3.0. Those which are prepared by coating the surface of nickel hydroxide particles with the higher cobalt oxide are preferable.

6094051

APPARATUS AND METHOD FOR DETECTING MEMORY EFFECT IN NICKEL CADMIUM BATTERIES

Thirumalai G. Palanisamy; Harmohan Singh; Alpesh Patel; Patrick M. Rudai; UNITED STATES assigned to Allied Signal Inc.

The invention provides for a timesaving method of determining whether a nickel cadmium (NiCd) battery is stricken with memory effect. A fully charged NiCd battery under test (test battery) is subjected to a positive sloped current charge ramp and then a negative sloped current charge ramp while continuously monitoring the battery terminal voltage. The maximum measured terminal voltage of the test battery is compared to the measured terminal voltage of a NiCd battery of the same nominal voltage and capacity and known not to have memory effect (normal battery). A NiCd battery is determined to have memory effect if the maximum voltage of the test battery exceeds the maximum voltage of the normal battery.

COMPONENTS AND/OR CHARGERS

6078165

MULTIPLEXED MODULAR BATTERY MANAGEMENT SYSTEM FOR LARGE BATTERY PACKS

Cyrus N. Ashtiani; Thomas A. Stuart; UNITED STATES assigned to Chrysler Corporation

An energy management system for monitoring an energy storage device is disclosed. The energy management system includes a plurality of cells forming the energy storage device. Each of the cells includes a line for communicating a voltage signal. A local module is connected to the cells of the energy storage device. The local module has a plurality of inputs for receiving the voltage signals generated by the cells. The local module provides a multiplexed output signal. A processor is provided for receiving the multiplexed

output signal from the local module and monitoring the voltage signals produced by the energy storage device.

6084523

NON-INTRUSIVE BATTERY STATUS INDICATOR AND INVENTORY SYSTEM

Vladimir G. Gelnovatch; Rudolf G. Buser; UNITED STATES assigned to The United States of America as represented by the Secretary of the Army

An apparatus and method of measuring and/or determining the status of battery parameters by receiving and/or decoding an RF information signal from a sensor/transceiver located in the target battery, where the RF information signal contains information regarding the status of particular parameters of the target battery. In particular embodiments, the sensor/transceiver located in the target battery is operable to measure battery parameters such as voltage and charge status, store particular battery parameters to and retrieve particular battery parameters from a memory located in the battery, and transmit RF information signals containing battery information regarding the particular battery parameters to a so called readout unit. The readout unit is operable to receive and/or decode the received RF information signal, determine the status of particular parameters based on the battery information contained in the received RF information signal, and display the status information. Advantageously, the present invention enables the determination of the status of particular battery parameters without having to make contact with the target battery itself.

OTHER BATTERIES

6077626

ALKALINE STORAGE BATTERY AND METHOD FOR CHARGING BATTERY

Mitsuzou Nogami; Mutsumi Yano; Mitsunori Tokuda; Syuichi Suzuki; Shin Fujitani; Reizo Maeda; Ikuo Yonezu; Koji Nishio; JAPAN assigned to Sanyo Electric Company Ltd.

In an alkali storage battery comprising a positive electrode, a negative electrode and an alkali electrolyte in a battery can, α -nickel hydroxide containing manganese is used as a cathode active material for the positive electrode, and the difference between a charging potential and an oxygen gas evolution potential at the positive electrode is increased, to suppress oxygen gas evolution during the charging, and the volume percentage of the cathode active material and an anode active material is set to not less than 75% in the battery can, to obtain a large battery capacity.

6080290

MONO-POLAR ELECTROCHEMICAL SYSTEM WITH A DOUBLE ELECTRODE PLATE

Andrew T.B. Stuart; Raynald G. LaChance; Chris T. Bowen; CANADA assigned to Stuart Energy Systems Corporation

The present invention relates to electrochemical cells and electrochemical systems using a one piece or unitary electrode plate hereinafter also referred to as a double electrode plate (DEP) which serves to electrically connect two adjacent cell compartments and wherein the current flow in the electrodes is parallel to the working face of the electrode. In the cell designs disclosed herein the cells are assembled as a contiguous stack of cells (cell stack) appearing similar to a filter press where the electrical connections between adjacent cells are made using the double electrode plate. In one aspect of the invention there is provided a mono-polar multiple stack electrolyzer (MSE) using double electrode plates wherein the planar double electrode plates connect cells in adjacent cell stacks. The mono-polar characteristics of the cell are maintained by the presence of an air gap isolating each adjacent stack of cells connected by each double electrode plate. In another aspect of the invention there is provided a single stack electrolyzer (SSE) utilizing a folded double electrode plate to connect adjacent cells in a single stack. An insulating wall separates compartments of adjacent electrode pair assemblies connected by the double electrode plate in the SSE.

6083647

NON-AQUEOUS ELECTROLYTE COMPRISING AN ALUMINUM COMPOUND AND A METHOD FOR THE ELECTRODEPOSITION OF ALUMINUM FROM THE ELECTROLYTE

Kazuhiro Noda; Kenichi Takahashi; Koichi Tanaka; Haruo Watanabe; JAPAN assigned to Sony Corporation

A non-aqueous electrolyte comprises an aluminum halide and a quaternary ammonium halide dissolved in a non-aqueous solvent. A non-aqueous electrolytic cell is also described, which comprises an anode made of Al or its alloy, a cathode and the non-aqueous electrolyte provided between the anode and the cathode. The non-aqueous electrolyte is suitable for electrodeposition of aluminum from the electrolyte. Because aluminum is reversibly electrodeposited from and dissolved in the electrolyte, the electrolyte is usable for making secondary cells having good charge and discharge characteristics and a high energy density.

6094788

METHOD OF MAKING A MULTI-ELECTRODE DOUBLE LAYER CAPACITOR HAVING SINGLE ELECTROLYTE SEAL AND ALUMINUM-IMPREGNATED CARBON CLOTH ELECTRODES

C. Joseph Farahmandi; John M. Dispennette; Edward Blank; Alan C. Kolb; UNITED STATES assigned to Maxwell Energy Products Inc.

A method of making a double layer capacitor includes first and second flat stacks of electrodes adapted to be housed in a closeable two-part capacitor case which includes only a

single electrolyte seal. Each electrode stack has a plurality of electrodes connected in parallel, with the electrodes of one stack being interleaved with the electrodes of the other stack to form an interleaved stack, and with the electrodes of each stack being electrically connected to respective capacitor terminals. A porous separator is positioned against the electrodes of one stack before interleaving to prevent electrical shorts between the electrodes. The electrodes are made by folding a compressible, low resistance, aluminum-impregnated carbon cloth, made from activated carbon fibers, around a current collector foil, with a tab of the foils of each electrode of each stack being connected in parallel and connected to the respective capacitor terminal. The height of the interleaved stack is somewhat greater than the inside height of the closed capacitor case, thereby requiring compression of the interleaved electrode stack when placed inside of the case, and thereby maintaining the interleaved electrode stack under modest constant pressure. The closed capacitor case is filled with an electrolytic solution and sealed. A preferred electrolytic solution is made by dissolving an appropriate salt into acetonitrile (CH₃CN). In one embodiment, the two arts of the capacitor case are conductive and function as the capacitor terminals.

6096453

POLYMERIC THIN-FILM REVERSIBLE ELECTROCHEMICAL CHARGE STORAGE DEVICES

Yaron Grunwald; UNITED STATES assigned to Adven Polymers Inc.

An electrochemical energy storage device is described. The electrochemical energy storage device includes: (1) a polymer electrode having (A) an organic conjugated compound; and (B) an ionically conductive polymer electrolyte, wherein the organic conjugated compound and the ionically conductive polymer electrolyte form a bicontinuous interpenetrating network, in which the organic conjugated compound and the ionically conductive polymer electrolyte form distinct continuous phases and an average phase size of the organic conjugated compound in the bicontinuous interpenetrating network is in the order of nanometers; and (2) a separator that is electronically non-conductive and contacts the polymer electrode such that the separator facilitates the transport of ions to and from the polymer electrode. Another electrochemical energy storage device is also described. This electrochemical energy storage device includes a surfactant in the polymer electrode to form a bicontinuous interpenetrating network of nanometer scale phase size. Yet another electrochemical energy storage device is also described. This electrochemical energy storage device includes a conjugated compound having a side-chain that has an affinity to a polymer electrolyte and as a result, the conjugated compound and polymer electrolyte form a more compact bicontinuous interpenetrating network.