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***Journal of Power Sources***



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**5944869****METHOD FOR THE RECOVERY OF LEAD FROM EXHAUSTED LEAD-ACID STORAGE BATTERIES**

Modica, Giovanni; Nannicini, Roberto; Milan, Ispra, Italy assigned to Ente per le nuove tecnologie, l'energia e l'ambiente (ENEA), Giovanni Modica

Herein is disclosed an improved method for the recovery of lead from exhausted lead-acid storage batteries, comprising removal from the storage battery of the sulphuric acid solution, the coating element, the separators between the electrodes and the metal part, i.e. grids, connectors and poles and milling of the remaining electrode paste of the storage battery to obtain an extremely fine powder (paste), characterised by the following operations: (a) treatment of the resulting powder with an aqueous saline solution, with a pH of between 0 and 8, capable of solubilising Pb(II) sulphate and oxide, leaving Pb(IV) oxide unsolubilised; (b) reduction to metal lead of the bivalent lead ion, present in the soluble fraction, using metal iron, preferably in slight excess with respect to the stoichiometric proportions; (c) reduction of the tetravalent lead oxide; and (d) recovery of the salts used in the process step (a) by elimination of the iron sulphate that has formed. Fig. 1 is a block diagram showing an embodiment of the present method for recovery of lead from exhausted lead acid storage batteries.

**5945236****LEAD-ACID BATTERY ELECTROLYTE FLUID SOLUTION ADDITIVE**

Willis, John; Germiston, South Africa

A lead-acid battery electrolyte fluid solution additive is disclosed, the fluid solution additive including aluminum sulfate, cobalt sulfate, copper sulfate, magnesium sulfate, cadmium sulfate, sodium sulfate, potassium sulfate, and deionized water sufficient to effect extended battery life.

**5948566****METHOD FOR MAKING LEAD-ACID GRIDS AND CELLS AND BATTERIES USING SUCH GRIDS**

Larsen, Steven R.; Foote, Andrew; Oakdale, St. Paul, MN, USA assigned to GNB Technologies Inc.

The use of a continuous process for making a directly cast strip to provide a thickness satisfactory for industrial cells and batteries for stationary and motive power applications is disclosed, the thickness of the strip being at least 0.060 in., and the process providing a visually crack-free surface in the transverse direction of the directly cast strip, the strip being lead or a lead-based alloy, such as, for example, calcium-tin-silver.

**5948567****BATTERY PASTE DISPERSANT**

Heller, David B.; North Wales, PA, USA assigned to Geo Specialty Chemicals Inc.

A battery paste for a lead oxide battery plate comprising lead oxide, sulfuric acid and a naphthalene sulfonic acid formaldehyde condensate, the condensate being water-soluble, and having a molecular weight of about 9000–15,000 is disclosed; methods for preparing the battery paste are also disclosed.

**5952123****ELECTRODE PLATES FOR LEAD-ACID BATTERY AND THEIR MANUFACTURING METHOD**

Hatanaka, Tsuyoshi; Takahashi, Katsuhiro; Nitta, Yoshiaki; Okamura, Kazuhiro; Fujidera, Yahara, Hirakata, Osaka, Japan assigned to Matsushita Electric Industrial Company Ltd.

Electrode plates for a lead-acid battery have an active material layer using polyvinylidene fluoride as a binder formed on both sides of a substrate. The substrate is selected from the group consisting of a foil-like sheet made of pure lead or lead alloy and a polyester film that is lead-plated or covered with a conductive coating layer containing carbon powder, whose main ingredient is graphite as a conducting agent. The method of manufacturing provides a thin electrode plate that is suitable for use as a spirally-wound type of electrode plate. The resulting plates have excellent high-rate discharge characteristics and long cycle life. The electrode plates are manufactured in a high productivity process that uses neither pore-forming agents nor pore-forming processes.

**5932146****AIR ELECTRODE COMPOSITION FOR SOLID OXIDE FUEL CELL**

Kuo, Lewis; Ruka, Roswell J.; Singhal, Subhash C.; Monroeville, Pittsburgh, Murrysville, PA, USA assigned to Siemens Westinghouse Power Corporation

An air electrode composition for a solid oxide fuel cell is disclosed. The air electrode material is based on lanthanum manganite having a perovskite-like crystal structure  $ABO_3$ . The A-site of the air electrode composition comprises a mixed lanthanide in combination with rare earth and alkaline earth dopants. The B-site of the composition comprises Mn in combination with dopants such as Mg, Al, Cr and Ni. The mixed lanthanide comprises La, Ce, Pr, and optionally, Nd. The rare earth A-site dopants preferably comprise La, Nd or a combination thereof, while the alkaline earth A-site dopant preferably comprises Ca. The use of a mixed lanthanide substantially reduces raw material costs in comparison with compositions made from

high-purity lanthanum starting materials. The amount of the A-site and B-site dopants is controlled in order to provide an air electrode composition having a coefficient of thermal expansion which closely matches that of the other components of the solid oxide fuel cell.

#### 5932365

##### **HYDROGEN CANISTER FUEL CELL BATTERY**

Lin, Chien-Liang; Cheng, Yaw-Chung; Lin, Andrew S.; Hsinchu, Taiwan assigned to Industrial Technology Research Institute

Herein is disclosed a hydrogen canister fuel cell battery including a base having at least one hydrogen distribution channel communicating with a hydrogen canister for passage of hydrogen to a fuel cell on the base. An air supply is disposed in front of the fuel cell for sending air into the fuel cell, so that oxygen and hydrogen may react electrochemically in the fuel cell to generate electricity. The present invention also provides an arrangement that utilizes fuel cells to have a larger area of contact with the ambient air so as to eliminate the use of fans and starting power devices, and thus, achieve a compact hydrogen canister fuel cell battery for use in products such as notebook computers and cellular phones.

#### 5932366

##### **SOLID ELECTROLYTE HIGH TEMPERATURE FUEL CELL**

Ringel, Helmut; Niederzier, Germany assigned to Forschungszentrum Julich GmbH

In a solid electrolyte high temperature fuel cell arrangement comprising several fuel cells arranged upright directly adjacent one another and connected in series wherein each cell is defined between opposite planar connecting plates defining there between a chamber in which a solid electrolyte element with opposite cathode and anode surfaces is disposed in spaced relationship from the side walls of the connecting plates so as to form air and fuel gas channels with top discharge openings at opposite sides of the solid electrolyte element, the planar connecting plates include flow passages for conducting at least one of the air and fuel gas to the bottom of the air and gas channels, respectively.

#### 5932368

##### **HIGH TEMPERATURE FUEL CELL WITH A THIN FILM ELECTROLYTE**

Batawi, Emad; Honegger, Kaspar; Winterthur, Wallenwil, Switzerland assigned to Sulzer Innotec AG

The high temperature fuel cell with a thin film electrolyte has an electrochemically active element which is executed as a planar multi-layer structure. At least the electrolyte and cathode layers are deposited on a porous, gas-permea-

ble carrier structure, by means of a thin film technique. The carrier structure is a sintered body of metal ceramic material which comprises a highly porous base layer as well as a fine pored cover layer of anode material placed on the base layer. The pores of the base layer are open with respect to one another and have an average diameter of the order of magnitude of at least about 300  $\mu\text{m}$ . The pores of the cover layer have diameters which are not substantially greater than 1–3  $\mu\text{m}$ . The coefficient of thermal expansion of the carrier structure is substantially the same as that of the solid electrolyte.

#### 5935643

##### **METHOD FOR MANUFACTURING ELECTRODE FOR FUEL CELL**

Song, Rak-Hyun; Shin, Dong-Ryul; Kim, Chang-Soo; Lee, Byung-Rok; Taejon, South Korea assigned to Korea Institute of Energy Research

Herein is disclosed a method for manufacturing an electrode for phosphate type fuel cells, utilizing a combination of a coating process and a rolling process. Carbon paper is waterproofed to give an electrode support. Separately, platinum-dispersed carbon powder (Pt/C) is added in a solvent and mechanically stirred to give a homogeneous mixture which is then added with a PTFE emulsion at an amount of about 40–55 wt.% and stirred. Another stirring is executed in the presence of a bridge-builder and a peptization agent, to produce an electrocatalyst layer slurry. Using a coating apparatus, the electrocatalyst slurry is coated upon the electrode support in a uniform thickness. The resulting structure is dried for 30 min in an inert atmosphere at 225°C to completely remove the solvent from the catalyst layer, passed through a rolling apparatus and subjected to sintering for 30 min in an inert atmosphere at 350°C, to produce the electrode. It exhibits the advantages of few cracks in the electrocatalyst layer and strong adhesiveness between the electrode support and the electrocatalyst layer.

#### 5935725

##### **FLOW FACILITATOR FOR IMPROVING OPERATION OF A FUEL CELL**

Dhar, Hari P.; Lewinski, Krzysztof A.; Brazos County, TX, USA assigned to BCS Technology

Herein is disclosed a fuel cell including an electrode assembly, a cell assembly mounted to the electrode assembly forming an anode and at least one cathode channel, and a flow facilitator located within each cathode channel. The flow facilitator functions as a wick during the operation of the fuel cell to drain fluid from the cathode channels. It also provides resistance to water vapor flow within the cathode channels, thereby increasing humidification of the fuel cell. Moreover, the flow facilitator increases the residence time of oxidant within the cathode channels. The

flow facilitator is preferably a thread made of any one or any combination of cotton, silk, fiberglass, nylon or polyester, and may be coated with polytetrafluoroethylene. The flow facilitator may be a single element that is weaved in specific patterns through the cathode channels or it can include a plurality of elements, one element for each of the cathode channels. A fuel cell stack includes a plurality of fuel cells, each fuel cell formed by a bipolar plate, an electrode assembly with an electrolyte, and an anode channel. Each bipolar plate includes at least one cathode channel. The flow facilitator is weaved between and into a subset of the plurality of cathode channels.

#### 5935726

### METHOD AND APPARATUS FOR DISTRIBUTING WATER TO AN ION-EXCHANGE MEMBRANE IN A FUEL CELL

Chow, Clarence Y.F.; Chan, John Ka Ki; Corless, Adrian James; Vancouver, Canada assigned to Ballard Power Systems Inc.

A method and apparatus are provided for distributing water produced by the electrochemical reaction to an ion-exchange membrane in an electrochemical fuel cell. Water distribution within a fuel cell is improved to reduce membrane dryness near the oxidant stream inlet and to also reduce saturation of the oxidant stream near the oxidant stream outlet, thereby reducing electrode flooding. The method comprises periodically reversing the flow direction of an oxidant stream through a fuel cell flow field. The apparatus comprises an oxidant stream flow switching device for periodically switching the flow direction of an oxidant stream through a fuel cell flow field. In one embodiment, the apparatus further comprises a water recycler for capturing water from the oxidant exhaust stream and returning the captured water to the oxidant supply stream when the flow direction is reversed.

#### 5935727

### SOLID OXIDE FUEL CELLS

Chiao, Yi-Hung; Midland, MI, USA assigned to The Dow Chemical Company

A fuel cell stack made from two different ceramic materials which are used to form four distinct layers of each individual fuel cell is provided. The fuel cell stack uses a ceramic ionic conductor to form the electrolyte layer and a ceramic electronic conductor to form an interconnect layer, with the anode and cathode being formed from the combination of the electronic and ionic conductor materials. The internally balanced or mirror symmetric configuration eliminates the warpage or camber problems encountered in conventional multilayer cosintering systems, and the use of common materials in adjacent layers enhances bonding across the adjoining interfaces.

#### 5939218

### POLYELECTROLYTIC FUEL CELL AND THE METHOD OF CONTROLLING THE OPERATION THEREOF

Mizuno, Seiji; Toyota, Japan assigned to Toyota Jidosha Kabushiki Kaisha

When at least either one of the output voltage and internal resistance of a plurality of stacked unit cells and the humidity of oxidizing gas being discharged has deviated from the tolerance, the supply conditions of oxidizing gas to the polyelectrolytic fuel cell are changed. Specifically, when the output voltage has decreased, when the internal resistance has increased, or when the humidity of discharge gas has increased, the flow rate of the oxidizing gas is increased, or its pressure increases, or the humidity of the oxidizing gas is reduced. As a result, moisture inside the cell is removed and flooding and the resulting falls in output voltage are prevented. In addition, the generation of hydrogen gas in the passages for oxidizing gas is contained.

#### 5939219

### HIGH-TEMPERATURE FUEL CELL HAVING AT LEAST ONE ELECTRICALLY INSULATING COVERING AND METHOD FOR PRODUCING A HIGH-TEMPERATURE FUEL CELL

Jansing, Thomas; Decker, Jens; Nurnberg, Rheinbreitbach, Germany assigned to Siemens Aktiengesellschaft

A high-temperature fuel cell has at least one electrically insulating covering. The electrically insulating covering contains at least two layers which are disposed one on top of the other and are each formed of an electrically insulating ceramic material. The composition of the ceramic material of one layer is different from the composition of the ceramic material of the other layer. This results in optimization of the insulation characteristic and the adhesion of the electrically insulating covering. A method is also provided for producing a high-temperature fuel cell having at least one electrically insulating covering.

#### 5942344

### HIGH-TEMPERATURE FUEL CELL SYSTEM AND METHOD FOR ITS OPERATION

Lehmeier, Jurgen; Reiter, Kurt; Stief, Gerald; Hannover, Erlangen, Nurnberg, Germany assigned to Siemens Aktiengesellschaft

A high-temperature fuel cell system and a method for its operation include at least one electrical heating element for heating at least one high-temperature fuel cell block. The heating element is disposed outside the high-temperature fuel cell block. As a result, the fuel cells are neither polluted nor damaged.

**5942345****HIGH PERFORMANCE ELECTROLYTES FOR MCFC**

Kaun, Thomas D.; Roche, Michael F.; New Lenox, Downers Gorge, IL, USA assigned to University of Chicago

A carbonate electrolyte of the Li/Na or CaBaLiNa system is provided herein. The Li/Na carbonate has a composition displaced from the eutectic composition to diminish segregation effects in a molten carbonate fuel cell. The CaBaLiNa system includes relatively small amounts of  $\text{Ca}_2\text{CO}_3$  and  $\text{BaCO}_3$ , and preferably equimolar amounts. The presence of both Ca and  $\text{BaCO}_3$  enables lower temperature fuel cell operation.

**5942347****PROTON EXCHANGE MEMBRANE FUEL CELL SEPARATOR PLATE**

Koncar, Gerald J.; Marianowski, Leonard G.; McHenry, Mt. Prospect, IL, USA assigned to Institute of Gas Technology

Herein is disclosed a gas impervious bi-polar separator plate for a proton exchange membrane fuel cell having at least one electronically conductive material in an amount in a range of about 50% to about 95% by weight of the separator plate, at least one resin in an amount of at least about 5% by weight of the separator plate, and at least one hydrophilic agent, where the electronically conductive material, the resin, and the hydrophilic agent are substantially uniformly dispersed throughout the separator plate.

**5942348****FUEL CELL WITH CERAMIC-COATED BIPOLAR PLATES AND A PROCESS FOR PRODUCING THE FUEL CELL**

Jansing, Thomas; Martens, Thomas; Nurnberg, Walsdorf, Germany assigned to Siemens Aktiengesellschaft

A high-temperature fuel cell has a solid electrolyte between the metal plates. The surfaces of the metal plates are at least partly coated with stabilized zirconium oxide or a similar firmly adhering gas-tight ceramic with crystal structure. The coating reduces the gap between the plates at the edge of the fuel cell and makes it possible to fill the reduced gap with a glass solder green foil or a similar solder material which forms a gas-tight lateral seal for the fuel cell during the assembly of the fuel cell. The plates are also insulated from one another. The gas conduits formed in the plates for the aggressive reaction gases may also be protected against attack by the reaction gases with a thin coating of the same material.

**5942349****FUEL CELL INTERCONNECT DEVICE**

Badwal, Sukhvinder P.S.; Foger, Karl; Zheng, Xiao G.; Jaffrey, Don; Mulgrave, Kew, Oakleigh, Grindelwald, Australia assigned to Ceramic Fuel Cells Limited

An electrical interconnect device for a planar fuel cell, comprising solid oxide electrolyte, an anode and a cathode, is described. The interconnect device comprises a plate-like chromium-containing substrate having gas-flow channels on the cathode-side and a coating on the cathode-side. The coating comprises an oxide surface layer comprising at least one metal M selected from Mn, Fe, Co and Ni, and an M, Cr spinel layer intermediate the substrate and the oxide surface layer. The intermediate spinel layer is formed by reaction of M oxide with surface chromium oxide on the substrate. The coating material may be applied as an oxide or as a salt or metal, or a mixture, and then converted to oxide. The M metal(s) may be mixed with non-M metal or be doped. Methods of application are described in which the oxide surface layer is partially reacted to form the intermediate spinel layer.

**5945229****PATTERN RECOGNITION MONITORING OF PEM FUEL CELL**

Meltser, Mark Alexander; Pittsford, New York, USA assigned to General Motors Corporation

The CO-concentration in the  $\text{H}_2$  feed stream to a PEM fuel cell stack is monitored by measuring current and voltage behavior patterns from an auxiliary cell attached to the end of the stack. The auxiliary cell is connected to the same oxygen and hydrogen feed manifolds that supply the stack, and discharges through a constant load. Pattern recognition software compares the current and voltage patterns from the auxiliary cell to current and voltage signature determined from a reference cell similar to the auxiliary cell and operated under controlled conditions over a wide range of CO-concentrations in the  $\text{H}_2$  fuel stream.

**5945231****DIRECT LIQUID-FEED FUEL CELL WITH MEMBRANE ELECTROLYTE AND MANUFACTURING THEREOF**

Narayanan, Sekharipuram; Surampudi, Subbarao; Halpert, Gerald; Altadena, Glendora, Pasadena, CA, USA assigned to California Institute of Technology

Herein is disclosed an improved direct liquid-feed fuel cell having a solid membrane electrolyte for electrochemical reactions of an organic fuel. Improvements in interfacing of the catalyst layer and the membrane and activating catalyst materials are disclosed.

**5945232****PEM-TYPE FUEL CELL ASSEMBLY HAVING MULTIPLE PARALLEL FUEL CELL SUB-STACKS EMPLOYING SHARED FLUID PLATE ASSEMBLIES AND SHARED MEMBRANE ELECTRODE ASSEMBLIES**

Ernst, William D.; Mittleman, Gary; Troy, Albany, New York, USA assigned to Plug Power LLC

A proton exchange membrane (PEM) fuel cell stack is disclosed that has multiple layers between a first end plate and a second end plate. The multiple layers define multiple fuel cell sub-stacks disposed in parallel and electrically isolated from each other intermediate the end plates. At the end plates, the fuel cell sub-stacks are electrically connected in series. At least some layers of the fuel cell stack comprise shared layers shared between multiple sub-stacks, and at least some layers of the multiple layers comprise dedicated layers for corresponding fuel cell sub-stacks. The shared layers include a fluid flow plate assembly and a membrane electrode assembly, while the dedicated layers comprise gas diffusion layers. The fluid flow plate assembly is fabricated of a non-conductive material and has multiple conductive fluid flow sub-plates, each of which aligns to a respective sub-stack of the fuel cell stack.

**5945233****PROCESS FOR PRODUCING POLYBENZIMIDAZOLE PASTES AND GELS FOR USE IN FUEL CELLS**

Onorato, Frank J.; Sansone, Michael J.; French, Stuart M.; Marikar, Faruq; Phillipsburg, Berkeley Heights, Chatham, Westfield, NJ, USA assigned to Avents Research & Technologies GmbH & Company KG

Herein is disclosed a method for producing polybenzimidazole (PBI) paste or gel useful in a fuel cell, mixing PBI polymer with a suitable amount of an acid, which permits the polymer to dissolve and form a matrix having a gel-like or paste-like consistency at room temperature.

**5952116****SOLID ELECTROLYTE HIGH TEMPERATURE FUEL CELL MODULE AND METHOD FOR ITS OPERATION**

Blum, Ludger; Greiner, Horst; Kleinlein, Wilhelm; Roth, Reinhard; Eltersdorf, Forchheim, Furth, Baiersdorf, Germany assigned to Siemens Aktiengesellschaft

In a solid electrolyte high temperature fuel cell module and a method for operating the same, a plurality of fuel cells are stacked on one another for receiving an operating medium necessary for operating the fuel cells. Heat produced in the fuel cells during a combustion process is used for heating the operating medium before it is fed into the fuel cells.

**5952118****PEM FUEL CELL WITH STRUCTURED PLATES**  
Ledjeff, Konstantin; Nolte, Roland; Krozingen, Bad; Denzlingen, Germany assigned to Fraunhofer-Gesellschaft Zur Foerderung der Angewandten

The invention relates to a PEM fuel cell comprising at least one strip membrane consisting of at least two, maximally 10,000 planar individual cells, each composed of an electrode layer applied on both sides of a membrane of a polymeric solid electrolyte, with the individual cells series-connected and with plates assembled on both sides to the said strip membrane and featuring conductive regions and nonconductive regions, the said regions being configured such that a short circuit between the individual electrodes of one membrane side is avoided.

**5952119****FUEL CELL MEMBRANE HUMIDIFICATION**  
Wilson, Mahlon S.; Los Alamos, NM, USA assigned to Regents of the University of California

A polymer electrolyte membrane fuel cell assembly has an anode side and a cathode side separated by the membrane and generating electrical current by electrochemical reactions between a fuel gas and an oxidant. The anode side comprises a hydrophobic gas diffusion backing contacting one side of the membrane and having hydrophilic areas therein for providing liquid water directly to one side of the membrane through the hydrophilic areas of the gas diffusion backing. In a preferred embodiment, the hydrophilic areas of the gas diffusion backing are formed by sewing a hydrophilic thread through the backing. Liquid water is distributed over the gas diffusion backing in distribution channels that are separate from the fuel distribution channels.

**5932373****NON-AQUEOUS ELECTROLYTE SECONDARY CELL USING CARBONACEOUS MATERIAL FOR NEGATIVE ELECTRODE**

Nagamine, Masayuki; Omaru, Atsuo; Nakajima, Naoyuki; Fukushima, Kanagawa, Japan assigned to Sony Corporation

A material for a negative electrode of a cell, which is prepared according to a process of the present invention, can provide a cell having a high true specific gravity, a high charging capacity and an excellent cycle characteristic. The process of the present invention comprises the steps of carbonizing an organic compound to form a carbide thereof, pulverizing the said carbide to form a powder having an average particle size of 10  $\mu\text{m}$ –2 mm, and sintering the said powder of the carbide at a temperature of 2000°C or higher to produce a graphite. In addition, in accordance with the present invention, also provided is a

non-aqueous electrolyte secondary cell comprising a negative electrode, which is prepared by carbonizing an organic compound to form a carbide thereof, pulverizing the carbide to form a powder having an average particle size of 10  $\mu\text{m}$ –2 mm, and sintering the powder of the carbide at a temperature of 2000°C to form a graphite.

**5932374**

**LITHIUM MAGNESIUM MANGANESE OXY-FLUORIDES FOR LI-ION RECHARGEABLE BATTERY ELECTRODES**

Amatucci, Glenn G.; Raritan, NJ, USA assigned to Telcordia Technologies Inc.

The cycling stability and capacity of Li-ion rechargeable batteries are improved, particularly in an elevated temperature range of about 55°C, by the use of lithium magnesium manganese oxy-fluoride electrode components having the general formula  $\text{Li}_{1+x}\text{Mg}_y\text{Mn}_{2-x-y}\text{O}_{4-z}\text{F}_z$ , where  $x$  is less than or equal to 0.2, 0.1 less than or equal to  $y$  less than or equal to 0.3, and 0.01 less than or equal to  $z$  less than or equal to 0.5.

**5935884**

**WET-LAID NONWOVEN NYLON BATTERY SEPARATOR MATERIAL**

Williams, Richard C.; Goettmann, James A.; Funk, Gerald L.; Gee, Linda M.; Smith, Roland; Connolly, Timothy; Mathur, Ashish; Erie, North East, Brookline, Gainesville, Franklin, Mansfield, MA, USA assigned to BBA Nonwovens Simpsonville Inc.

A nonwoven composite web suitable for use as a battery separator is formed by a wet process on a paper-making machine. The nonwoven composite material is made from a furnish of nylon binder fibers and nylon staple fibers. The web coming off the paper-making machine is dried using infra-red dryers followed by heated dryer cans. After drying, the web is thermally bonded using heated calendar rolls. The nylon binder fibers melt as the web passes through the calendar rolls and thermally bond the nylon staple fibers of the web when the melted binder fiber material fuses upon cooling. The use of dryer cans to dry and partially bond the web eliminates the need for surfactant treatment to improve potassium hydroxide absorption.

**5938798**

**CATHODIC ACTIVE MATERIAL COMPOSITION FOR DRY CELLS, METHOD FOR PREPARING THE SAME, AND ALKALINE BATTERY**

Hanawa, Kenzo; Taenaka, Sakiko; Hanzawa, Noriko; Saitama, Japan assigned to Mitsui Mining & Smelting Company Ltd.

A cathodic active material comprises a mixture of graphite particles and electrolytic manganese dioxide particles which

are composed of needle-like crystals having an aspect ratio ranging from about 2 to about 20 and an alkaline manganese dioxide cell is provided with a cathode prepared from the cathodic active material. The cathodic active material for dry cells can be prepared by mixing, in advance, carbon powder with manganese dioxide powder in a weight ratio ranging from about 1:100 to about 15:100 and then pulverizing the resulting mixture. The novel cathodic active material for dry cells permits substantial improvement of the resulting dry cell in the high load-discharge quality.

**5938910**

**ELECTROLYTIC MANGANESE DIOXIDE AND METHOD OF MANUFACTURING THE SAME**

Takehara, Hisao; Nakayama, Yoshihiro; Shimizugawa, Ryoichi; Kishikawa, Tsutomu; Murai, Takumi; Takahashi, Fumiya; Takahashi, Koh; Chuo-Ku, Takaoka, Tsukuba, Japan assigned to Japan Metals & Chemicals Company Ltd.

Electrolytic manganese dioxide having a BET specific surface area of less than 30  $\text{m}^2/\text{g}$  and a suspensiveness of less than 50  $\text{mg}/\text{l}$  is used for alkaline manganese batteries and manganese batteries to make them excellent both in initial performance and storability. The electrolytic manganese dioxide may be made by a suspension method or a clarification method.

**5944980**

**METHOD FOR PRODUCING ISOTROPIC PITCH, ACTIVATED CARBON FIBERS AND CARBON MATERIALS FOR NON-AQUEOUS SECONDARY BATTERY ANODES**

Yoshimura, Takahumi; Kanno, Koichi; Hirai, Yasuhiro; Sakai, Yukio; Koike, Nobuyuki; Takahashi, Yuzuru; Sakamoto, Hitoshi; Oishi, Jitsuo; Higashiizumi, Takaaki; Shibahara, Kyoko; Tukuba, Japan assigned to Mitsubishi Gas Chemical Company Inc.

Herein is disclosed a method for preparing a modified optically isotropic pitch comprising preparing a synthetic pitch by reacting a member selected from the group consisting of a conjugated polycyclic hydrocarbon containing a low molecular weight alkyl group or a material containing such a substituted hydrocarbon in the presence of hydrofluoric acid/boron trifluoride, and treating the synthetic pitch by passing an oxidizing gas through the synthetic pitch at elevated temperatures.

**5951919**

**METHOD OF PREPARING CATHODE MATERIAL FOR LITHIUM ION CELL**

Hwang, Kang-Seon; Kim, Dong-Hwan; Kwon, Sung-Ruyl; Taejeon, Pusan, South Korea assigned to Korea Kumho Petro Chemical Company Ltd.



Provided is a method of preparing a cathode material for lithium ion cell, which is designed to have an enhanced cycle characteristic and high initial discharge capacity, by synthesizing  $\text{LiMn}_2\text{O}_4$  powder having a stable spinel structure, vigorously agitating the powder in an aqueous solution of Li and Ni ions, dispersing the solution through a supersonic wave treatment, filtering it so that the powder adsorbs the ions, and performing a heat treatment for doping the ions.

#### 5951959

### MESOPHASE PITCH-BASED CARBON FIBER FOR USE IN NEGATIVE ELECTRODE OF SECONDARY BATTERY AND PROCESS FOR PRODUCING THE SAME

Nishimura, Yoshiyuki; Kamisu-machi, Japan assigned to Petoca Ltd.

A mesophase pitch-based carbon fiber for use as a material for a negative electrode of a secondary battery, and a process for producing the same are disclosed herein. The mesophase pitch-based carbon fiber comprises a columnar core part having a texture composed of a plurality of graphite layers extending along an axial direction and extending with minute flexures in a plane perpendicular to the axis and an outer-shell part surrounding the core part. The outer-shell part has a texture composed of a laminate of a plurality of graphite layers extending along an axial direction. The graphite layers are oriented in a plane perpendicular to the axis in a fashion such that the graphite layers extend along a circumferential direction with minute flexures while gradually receding from the center of the core part. In the carbon fiber, the graphite layers composing the outer-shell part have a laminate face forming a surface of the outer-shell part, channels permitting the entry and exit of lithium ions being formed between graphite layers at the laminate face.

#### 5952120

### METHOD OF MAKING A TRILAYER BATTERY SEPARATOR

Yu, Wei-Ching; Hux, Shawn E.; Charlotte, Gastonia, NC, USA assigned to Celgard LLC

A method of making a trilayer, shutdown battery separator has the following steps: extruding a polyethylene precursor; extruding a polypropylene precursor; forming a trilayer precursor, the trilayer precursor having the polyethylene precursor sandwiched between two polypropylene precursors; bonding the trilayer precursor; annealing the trilayer precursor; stretching the trilayer precursor; and forming thereby the battery separator.

#### 5952125

### BATTERIES WITH ELECTROACTIVE NANOPARTICLES

Bi, Xiangxin; Kambe, Nobuyuki; Kumar, Sujeet; Gardner, James T.; Pleasanton, Menlo Park, Fremont, Cupertino, CA, USA assigned to NanoGram Corporation

Batteries based on nanoparticles are demonstrated that achieve high energy densities. Vanadium oxide nanoparticles can have several different stoichiometries and corresponding crystal lattices. The nanoparticles preferably have average diameters less than about 500 nm and more preferably less than about 150 nm. Cathodes produced using the vanadium oxide nanoparticles and a binder can be used to construct lithium batteries or lithium ion batteries. The nanoparticles may have energy densities greater than about 900 Wh/kg.

#### 5955051

### SYNTHESIS OF LITHIUM NICKEL COBALT DIOXIDE

Li, Wu; Currie, John Carleton; Wolstenholme, Jack; Edmonton, Canada assigned to Westaim Technologies Inc.

A single calcination stage process for the synthesis of homogeneous crystalline lithium nickel cobalt dioxide from either a mechanical mixture of nickel and cobalt oxides, hydroxide or oxyhydroxide or a chemical precipitation of a homogeneous nickel cobalt hydroxide or cobalt nickel cobalt oxyhydroxide is provided. The reactants are calcined in the presence of lithium hydroxide and an alkali metal hydroxide under predetermined oxygen partial pressure and temperature conditions. The products of the process are characterized in having a lithium to transition metal ratio closely approximating to the desired theoretical value.

#### 5955052

### METHOD FOR MAKING LITHIATED MANGANESE OXIDE

Padhi, Akshaya Kumar; Pillai, G. Chithambarathanu; LaSalle, IL, USA assigned to Carus Corporation

The invention is a process which provides a high-purity lithiated manganese oxide ( $\text{Li}_{1+x}\text{Mn}_{2-y}\text{O}_4$ ) from chemically made  $\text{MnO}_2$ . The lithiated manganese oxide has an especially effective utility for use as a cathodic material in rechargeable batteries. The process of the invention includes blending a lithium compound with a chemically made manganese dioxide to form a manganese dioxide/lithium compound blend. The lithium compound in the blend is at least about 1 mole of lithium for every mole of manganese dioxide. The manganese dioxide and lithium compound in the blend are reacted to provide an ion-replaced product where lithium ions have replaced sodium and potassium ions in the  $\text{MnO}_2$  to form an

ion-replaced product. Thereafter, the ion-replaced product is heated or calcined to provide the lithiated manganese oxide.

**5955218**

**HEAT-TREATED SILVER VANADIUM OXIDE FOR USE IN BATTERIES FOR IMPLANTABLE MEDICAL DEVICES**

Crespi, Ann M.; Chen, Kaimin; Minneapolis, New Brighton, MN, USA assigned to Medtronic Inc.

The invention provides heat-treated silver vanadium oxide for use in the cathodes of electrochemical cells, particularly in implantable medical devices. The heat-treated silver vanadium oxide is capable of being pressed into a pellet having a pressed pellet density of about 3.10 to about 3.45 g/cm<sup>3</sup> when about 2 g of the heat-treated silver vanadium oxide are uniaxially pressed into a pellet using a 1.6 cm diameter cylindrical die with a 7500 lb force applied for 5 s.

**5939223**

**LITHIUM POLYMER ELECTROLYTE BATTERY FOR SUB-AMBIENT TEMPERATURE APPLICATIONS**

Cotte, John M.; Datta, Madhav; Shenoy, Ravindra; New Fairfield, Yorktown Heights, Santa Barbara, CA, USA assigned to International Business Machines Corporation

Herein is disclosed a primary lithium battery particularly adapted for use in self-contained self-powered devices (SSPD) for mobile communication and computing products, such as radio frequency identification tags, PCMCIA cards, and smart cards. The battery has a flexible and compact design, and utilizes a solid polymer electrolyte membrane that preferably has a polyacrylonitrile matrix. Performance of the electrolyte membrane is optimized by controlling the amount of aprotic organic solvents within the membrane within a prescribed range of ratios. In so doing, the performance characteristics of the battery closely approximate that of conventional liquid electrolytes without the safety hazards associated with the risk of liquid electrolyte leakage, and exhibit enhanced performance at sub-ambient temperatures. A further feature is that the battery's cathode is encapsulated within a polymeric matrix that eliminates the exposure hazard posed by lithium intercalation compounds used within the cathode.

**5939864**

**LITHIUM-ION BATTERY CHARGE CONTROL METHOD**

Lenhart, Stephen J.; Chang, Rebecca R.; Mountain View, Fremont, CA, USA assigned to Space Systems/Loral Inc.

A technique of operating a lithium-ion (Li-ion) battery is proposed for maximizing battery life. In a first instance,

this technique calls for charging the battery at a lower temperature than the temperature at which discharge begins. Preferably, the battery is charged at a temperature  $T_1$  in the range between about +5 and -20°C; and discharged at a temperature  $T_2$ , in the range of about +5 to +30°C,  $T_2$  being higher than  $T_1$ . In another instance proposed by the invention, the battery is charged to an elevated state of charge which is above an initial state of charge at a temperature  $T_1$  between about +5 and -20°C which is lower than the temperature  $T_2$ , in the range of about +5 to +30°C, at which discharge begins. In still another instance proposed by the invention, after the battery has been charged and discharged during the eclipse season, it is then charged to an intermediate charge level between about 40% and about 60% state of charge over a relatively long lapsed duration of time, about 1 month to about 6 months, and thereafter, the battery is maintained at this intermediate charge level.

**5948565**

**CATHODE MATERIAL FOR LITHIUM SECONDARY BATTERIES AND A PROCESS AND A PRECURSOR MATERIAL FOR THE PRODUCTION THEREOF**

Kelder, Erik Maria; Nootdorp, Netherlands assigned to Danionics A/S

A process is disclosed for the preparation of lithium secondary battery cathode active materials which are of the form  $\text{Li}_y\text{Mn}_{2-z}\text{M}_2\text{O}_4$  where M is selected from the group consisting of Co, Ni, Ti, V and Fe,  $y$  is in the range from 0 to 1.5 and  $z$  is in the range from 0 to 1. The process comprises forming a melt or saturated solution from manganese acetate, lithium hydroxide and water, keeping the melt/solution at a temperature in the range of 70–110°C for a period of from 10 min to 4 h under stirring so as to form an essentially homogeneous material, and drying the said material followed by calcination at a temperature in the range of 300–800°C.

**5948569**

**LITHIUM ION ELECTROCHEMICAL CELL**

Moses, Peter R.; Zeng, Shuming; Wang, Enoch; Wei, Guang; Windham, Norwood, Mansfield, Southborough, MA, USA assigned to Duracell Inc.

A lithium ion cell having an amount of a Group 1 element between the positive electrode and the negative electrode is described. The Group 1 element can be on a surface of an electrode separator as a deposit. The Group 1 element can increase the charging capacity of the cell, eliminate the irreversible capacity of the cell, improve the rechargeable cell cyclability, or increase the charging reversibility of the cell.

**5949218****METHODS AND APPARATUS FOR MANAGING THE CHARGING AND DISCHARGING OF A LITHIUM BATTERY**

Colles, Joseph H.; Berchtold Jean-Christophe; Child, Max A.; Bonsall, Del Mar, Fallbrook, CA, USA assigned to Conexant Systems Inc.

An apparatus and corresponding method are provided for regulating the voltage potential of a lithium ion battery based upon an operating range having an upper threshold (e.g. on the order of 4.2 V) and a lower threshold (e.g. on the order of 2.5 V) and for providing a reduction in dissipated power when the lithium ion battery is charging and when a load is drawing upon the lithium ion battery. The apparatus includes a p-minus substrate and a first p-channel enhancement Field Effect Transistor (FET) integrally formed on the p-minus substrate. The first p-channel enhancement FET is configured to limit charging of the lithium ion battery when the voltage potential of the lithium ion battery is greater than the upper threshold. A second p-channel enhancement FET is integrally formed on the p-minus substrate and connected in parallel with the first p-channel enhancement FET and configured to limit discharging of the lithium ion battery when the voltage potential of the lithium ion battery is less than the lower threshold. A third p-channel enhancement FET is integrally formed on the p-minus substrate and connected in parallel with the first p-channel enhancement FET and the second p-channel enhancement FET. The third p-channel enhancement FET encompasses a substantially larger area of the p-minus substrate as compared to each of the first p-channel enhancement FET and the second p-channel enhancement FET such that a substantially reduced resistive path is presented by the third p-channel enhancement FET relative to the resistive paths associated with the first and second p-channel enhancement FETs. The reduced resistive path provides reduced dissipated power while the lithium ion battery is charging and when the load is drawing upon the battery in the operating range.

**5952126****POLYMER SOLID ELECTROLYTE AND LITHIUM SECONDARY CELL ADOPTING THE SAME**

Lee, Doo-yeon; Sung, Sang-hyun; Hirai, Yasumasa; Doo, Seok-gwang; Uiwang, Seoul, Kyoto, Sungnam, South Korea assigned to Samsung Electronics Company Ltd.

Herein is disclosed a polymer solid electrolyte that is useable in a lithium secondary cell comprising a polymer matrix, a polymerization initiator, an inorganic salt and a solvent. The polymer matrix is composed of a copolymer of a monomer having an amide group at a side chain and a polymer with an oxyethylene repeating unit. The polymer solid electrolyte has excellent conductivity and can easily be processed due to its good mechanical property.

**5955220****LITHIUM IRON OXIDE, METHOD OF ITS SYNTHESIS, AND LITHIUM BATTERY USING THE SAME**

Takada, Kazunori; Kondo, Shigeo; Kanno, Ryoji; Nakamura, Tatsuya; Takano, Mikio; Osaka, Hirakata, Kobe, Hiroshima, Kyoto, Japan assigned to Matsushita Electric Industrial Company Ltd., Toda Kogyo Corporation

A lithium iron oxide which can be used as an electrode active material for a lithium battery is disclosed. A lithium iron oxide represented by  $\text{Li}_x\text{FeO}_2$ , where  $0 < x < 2$ , having a tunnel structure similar to  $\beta\text{-FeO(OH)}$ , can be synthesized by heating a suspension prepared by suspending  $\beta\text{-FeO(OH)}$  and a lithium compound in an alcohol at a temperature of not lower than  $50^\circ\text{C}$ , more preferably at a temperature lower than the boiling point of the alcohol used for the suspension.

**5939222****STORAGE CELL HAVING AN ALKALINE ELECTROLYTE, IN PARTICULAR A STORAGE CELL OF NICKEL-CADMIUM OR NICKEL METAL HYDRIDE**

Senyarich, Stephane; Viaud, Patrick; Mornac, Bordeaux, France assigned to Alcatel Alsthom Compagnie Generale d'Electricite

Herein is disclosed a spirally wound storage cell having an alkaline electrolyte, the storage cell being in particular of the nickel-cadmium type or of the nickel metal hydride type, and including at least one positive electrode and at least one negative electrode on either side of a non-woven separator made up of fibers made exclusively of polypropylene, the said storage cell being characterized by the fact that said separator comprises first and second superposed layers, the said first layer being obtained by the 'spun-bond' method and serving as a support, and the said second layer being obtained by needling fibers on said first layer, the needling tangling the fibers of the second layer together, and bonding them to the fibers of the first layer.

**5944977****HYDROGEN-OCCLUDING ALLOY PRETREATMENT METHOD, PRETREATED HYDROGEN-OCCLUDING ALLOY, AND NICKEL-HYDROGEN SECONDARY BATTERY EMPLOYING THE SAME AS AN ANODE**

Kim, Ki-ho; Suwon, South Korea assigned to Samsung Display Devices Company Ltd.

Herein is disclosed a method of pretreating a hydrogen-occluding alloy, by electrically plating the hydrogen-occluding alloy with a Co-V alloy or a Co-Mo alloy. A nickel-hydrogen secondary battery manufactured using the pretreated hydrogen-occluding alloy has an increased initial

activation rate and an increased high rate discharge characteristic.

**5932989**

**METHOD FOR AN ELECTRONIC DEVICE TO  
DETECT THE PRESENCE OF A BATTERY  
CHARGER**

Thandiwe, Iilonga; Pozsgay, Brian T.; Atlanta, Lawrenceville, GA, USA assigned to Motorola Inc.

A battery is connected to a host device; the host device is an electrical or electronic device, such as a cellular telephone. The battery is rechargeable, and contains a memory connected to a data line. The battery is connected to a battery charger while also being connected to the host device. The battery charger detects the battery, and reads the battery information from the battery memory. The data line is common to the battery charger, battery, and host device. The charger indicates its presence to the host device by changing the voltage level on the data line from a normal first level, such as a logic level of 1, to a second level, such as a logic level of 0, and holds the data line at the second level. The host detects the presence of the battery charger after the data line has been held at the second level for a sufficient period of time, and then may take the desired actions.

**5932990**

**CHARGING CONTROL SYSTEM FOR  
UNIFORMLY CHARGING A SERIES-  
CONNECTED BATTERY ARRAY**

Kaneko, Akira; Shirakawa, Japan assigned to Intergran Inc., Japan Tobacco Inc.

A charging control system for use with a battery charger for charging a battery array which is constituted by battery cells includes charging control units corresponding individually to the battery cells. Each unit includes a voltage-regulator circuit for generating a reference voltage corresponding to the fully charged voltage of the battery cell and a comparator for comparing the inter-electrode voltage of the battery cell with the reference voltage. When the inter-electrode voltage has reached the fully charged voltage, the comparator cooperates with an amplifier to turn ON a field-effect transistor of a bypass circuit of the unit, to thereby divert the charging current from to the battery cell to the bypass circuit. The amplifier receives a feedback voltage indicating the bypass current and operates to keep the bypass current constant, thereby preventing overcharging of the battery cell.

**5932991**

**SYSTEM AND METHOD FOR BATTERY  
CHARGING WITH ACOUSTIC EXCITATION**

Ahuja, Krisham K.; Ding, Yi; Atlanta, Smyrna, GA, USA assigned to Georgia Tech Research Corporation

The present invention is a system and method for enhancing the charging of a battery by exposing the battery to acoustic excitation while the battery is being charged. By adding acoustic excitation to the charging process, the present invention reduces the time needed to charge the battery, reduces the energy needed for charging, and increases the battery's cycle life. The present invention may be used to charge new and used batteries and to rejuvenate dead batteries.

**5933010**

**DEVICE TO DETECT CHARGING CONDITION OF  
A STORAGE BATTERY**

Moreno, Gil G.; Tampa, FL, USA

This relates to a device consisting of a first plurality of light sources that light only when the voltage of a storage battery in a storage battery-generator system is below a predetermined voltage value, which is between the nominal voltage value of the storage battery and the charging voltage value of the storage battery-generator system, indicating that the battery is not receiving charge. A second plurality of light sources that light only when the voltage of a storage battery in a storage battery-generator system is above a predetermined voltage value, which is between the nominal voltage value of the storage battery and the charging voltage value of the storage battery-generator system, indicating that the battery is receiving charge.

**5945804**

**METHOD AND DEVICE FOR CONTROLLING  
THE VOLTAGE ACROSS INDIVIDUAL CELLS  
IN A BATTERY**

Hansson, Magnus, Frannhagen, Bjorn; Malmo, Lund, Sweden assigned to Telefonaktiebolaget LM Ericsson

Terminal voltage differences are controlled between individual battery cells in a battery during charging. The terminal voltage for each cell is measured, differences between the terminal voltages are determined, and a portion of the charging current is shunted in parallel to any of the cells in response thereto. A shunt device is connected in parallel to the respective battery cell and is arranged to shunt an electric current of a certain magnitude in response to the input signal value on a control input. A controller, with inputs connected to each battery cell and with outputs connected to the control input on the respective shunt device, measures voltage differences between individual cells and controls, in response thereto, the shunt devices for reducing or eliminating the voltage differences. The controller has a charging information history unit and storage means for storing, during an on-going charging cycle, terminal voltage data continuously read for each cell. The history unit is arranged to retrieve and analyze the stored terminal voltage data during a subsequent charg-

ing cycle, so as to determine the magnitude and duration of the shunted current.

**5945812**

**BATTERY CHARGING CIRCUIT FOR CHARGING  
A BATTERY IN ACCORDANCE WITH  
TEMPERATURE**

Choi, Ki-Ryong; Suwon, South Korea assigned to Samsung Electronics Company Ltd.

Herein is provided a battery charging circuit including a power supply circuit for providing a rechargeable battery with a charge voltage. The circuit generates a reference voltage adaptive to a surrounding temperature, which is set corresponding to the full charge voltage of the rechargeable battery. The charge voltage of the rechargeable battery is compared with the reference voltage to generate a control signal. A switching device connects and disconnects the power supply circuit from the rechargeable battery in response to the control signal to adaptively control the full charge voltage according to variations of the surrounding temperature.

**5949217**

**METHOD FOR DETERMINING THE REMAINING  
CAPACITY OF A RECHARGEABLE BATTERY**

Okada, Tetsuya; Yamashita, Takahiro; Sumoto, Japan assigned to Sanyo Electric Company Ltd.

This method for determining the remaining capacity of a rechargeable battery calculates the remaining battery capacity by subtracting the discharge capacity, computed by integrating the battery discharge current, from the charge capacity. Voltage of the discharging rechargeable battery is measured, and when the battery voltage reaches a first voltage and a lower second voltage, the computed remaining battery capacity is corrected according to a previously established first remaining battery capacity and second remaining battery capacity corresponding to those voltages. The difference between the calculated remaining battery capacity or discharge capacity at the first and second voltages is compared to the difference between the previously established first and second remaining battery capacity values, and the first voltage is modified to make those two differences equal.

**5949219**

**OPTICAL STATE-OF-CHARGE MONITOR FOR  
BATTERIES**

Weiss, Jonathan D.; Albuquerque, NM, USA assigned to The United States of America as represented by the United States Department of Energy

Herein are disclosed a method and apparatus for determining the instantaneous state-of-charge of a battery in which change in composition with discharge manifests itself as a

change in optical absorption. In a lead-acid battery, the sensor comprises a fiber optic system with an absorption cell, or alternatively, an optical fiber woven into an absorbed-glass-mat battery. In a lithium-ion battery, the sensor comprises fiber optics for introducing light into the anode to monitor absorption when lithium ions are introduced.

**5932367**

**LOW MERCURY, HIGH DISCHARGE RATE  
ELECTROCHEMICAL CELL**

Collien, Randall L.; Spellman, Patrick J.; Dopp, Robert B.; Oltman, John Edward; Burns, John David; Passaniti, Joseph Lynn; Root, Michael J.; Madison, Middleton, Marietta, Mount Horeb, Newton Hall Estate, Fitchburg, Verona, Great Britain assigned to Rayovac Corporation

This invention pertains to novel electrochemical metal air cells having improved closed circuit voltage characteristics. The improved voltage characteristics are illustrated at a constant load of 51  $\Omega$ . The closed circuit voltage during an initial placement into use of the cell of the invention has a decreased voltage drop relative to prior art cells, and recovers to a higher voltage. For example, the closed circuit voltage of the metal air cell drops to a minimum voltage during the first 20 s of initial placement into use. The minimum voltage is no more than 22% less than the initial open circuit voltage. This voltage drop is less than the voltage drop of other known metal air cells at 51  $\Omega$ . Metal air cells of the invention recover, during the first minute of use, to a closed circuit voltage of at least 79% of the initial open circuit voltage. The value of the open circuit voltage of the metal air cell of the invention is preferably about 1.43 V.

**5932375**

**FORM CHARGING ALUMINUM-LITHIUM  
BATTERY CELLS**

Tarcy, Gary P.; Slausenhaupt, Michael L.; Murrysville, Apollo, PA, USA assigned to Aluminum Company of America

Herein is provided a novel aluminum-lithium negative electrode and a method for making such a novel aluminum-lithium negative electrode, including providing an admixture of aluminum powder and lithium halide electrolyte salts to form an aluminum lithium halide mixture, pressing the aluminum lithium halide mixture to form an aluminum lithium halide mixture negative electrode, placing the aluminum lithium halide mixture negative electrode next to a separate electrode composed of MgO and lithium halide electrolyte salts, providing a positive electrode of iron sulfide, lithium carbonate, and carbon, assembling the electrodes into a battery, and reacting lithium carbonate, carbon, and aluminum in situ in the battery to form an aluminum-lithium alloy negative electrode.

**5939224****NONAQUEOUS ELECTROLYTE SECONDARY BATTERY**

Bito, Yasuhiko; Murata, Toshihide; Ito, Shuji; Toyoguchi, Yoshinori; Minamikawachi-gun, Izumiotsu, Akashi, Yao, Japan assigned to Matsushita Electric Industrial Company Ltd.

The invention provides a nonaqueous electrolyte secondary battery which employs, as a negative electrode active material, a carbide containing an alkali metal in a charged stage. The carbide used is an ionic bond type carbide, a covalent bond type carbide, or an intermetallic compound type carbide. The ionic bond type carbide is exemplified as  $\text{Na}_2\text{C}_2$ ,  $\text{K}_2\text{C}_2$ ,  $\text{Cu}_2\text{C}_2$ ,  $\text{VC}_2$ , and the like. The covalent bond type carbide is exemplified as  $\text{Cr}_4\text{C}$ , and the like. The intermetallic compound type carbide is exemplified as  $\text{Mn}_3\text{C}$ ,  $\text{Mn}_{23}\text{C}_6$ ,  $\text{Mn}_7\text{C}_3$ ,  $\text{Fe}_2\text{C}$ ,  $\text{FeC}$ ,  $\text{Ni}_3\text{C}$ , and the like. A highly reliable nonaqueous electrolyte secondary battery with a high energy density and excellent cycle life characteristics can be obtained.

**5942878****METHOD AND DEVICE FOR REDUCING MEMORY EFFECT OF BATTERY**

Ito, Masaki; Iwata, Japan assigned to Yamaha Hatsudoki Kabushiki Kaisha

According to the invention, the discharge depth representing the ratio of discharged capacity relative to the rated discharge capacity of a battery is divided into a plurality of ranges, with each range allocated with the number of charges at which a refresh discharge should be carried out. The discharge depth is obtained as a sum of discharged capacity between one charge and the next. At the time of charging, summing up the count of the number of charges in the corresponding range according to the discharge depth is repeated until the number of charges in any of the ranges reaches the number at which the refresh discharge should be carried out. Then, the refresh discharge is carried out either automatically or manually. Since the discharge depth is divided into a plurality of ranges, with each range allocated with the number of charges at which the refresh discharge should be carried out and the refresh discharge is carried out when the number of charges in any of the ranges reaches the allocated number, the refresh discharge is carried out at an appropriate timing at which the effect of the refresh discharge is most efficiently used either automatically or manually so that the influence of the memory effect is effectively and efficiently reduced.

**5945234****METAL-AIR CATHODE CAN HAVING REDUCED CORNER RADIUS AND ELECTROCHEMICAL CELLS MADE THEREWITH**

Burns, John David; Durham, Great Britain assigned to Rayovac Corporation

This invention pertains to electrode cans and metal-air electrochemical cells made with the electrode cans. The invention provides improved structure, and methods for making the outer edge of the closed end of the can at the joint between the closed end of the can and a side wall extending from the closed end. A substantially flat portion of the outer surface of the closed end of the can extends outwards with reference to the inner surface of the side wall. The electrochemical cells are assembled using improved assembly methods. Button-type electrochemical cells made using the invention are free of the inward dishing common to especially cathode cans in such button cells.

**5945808****HYBRID ELECTRIC VEHICLE WITH BATTERY MANAGEMENT**

Kikuchi, Toshio; Kitada, Shinichiro; Hirano, Hiroyuki; Inada, Eiji; Aso, Takeshi; Idoguchi, Ryuichi; Kaneko, Yutaro, Kanagawa, Tokyo, Kanagawa, Yokohama, Kanagawa, Japan assigned to Nissan Motor Company Ltd.

A hybrid electric vehicle comprises an electric motor, a battery pack for the electric motor, a generator driven by an engine to provide electric power used for charging the battery pack, and a battery management for the battery pack. The battery management determines a current value of battery temperature (BT) of the battery pack and a current value of state of charge (SOC) within the battery pack. What are stored are a first set of varying SOC values and a second set of varying SOC values against varying BT values. The first set of varying SOC values are minimum SOC values required for the battery pack to produce a constant electric power output at varying BT values. The second set of varying SOC values are each indicative of an allowable upper limit to the quantity of electric charge that will accumulate in the battery pack due to operation of charging the battery pack with a constant electric power input at a corresponding BT value. The battery management provides an actuator command for control of electric power input upon charging the battery pack in response to the current value of BT, the current value of SOC, the first set of varying SOC values and the second set of varying SOC values.

**5952117****METHOD AND APPARATUS FOR REFUELING AN ELECTROCHEMICAL POWER SOURCE**

Colborn, Jeffrey A.; Wright, Kenneth A.; Gulino, Ronald; Cardiff, La Mesa, Solano Beach, CA, USA assigned to Metallic Power Inc.

A transportable container for refueling a refuelable battery includes a case, an electrolyte reservoir within the case, a first valve connected to the electrolyte reservoir, a fuel

compartment within the case, a second valve connected to the fuel compartment, and a conduit connected to the electrolyte reservoir and the fuel compartment. When the transportable container is attached to a refuelable battery, a closed flow circuit for the circulation of electrolyte is defined. Fuel particles and electrolyte are fed from the transportable container into the refuelable battery. When the refuelable battery is discharged, the transportable container, containing spent electrolyte and reaction products, is detached from the refuelable battery.

#### 5955216

##### SEALED ALKALINE STORAGE BATTERY

Hoshina, Yasuko; Hattori, Yohei; Ito, Noboru; Morishita, Nobuyasu; Ikoma, Munehisa; Hirakata, Fujisawa, Toyohashi, Japan assigned to Matsushita Electric Industrial Company Ltd.

A sealed alkaline storage battery of the present invention employs a non-woven fabric having a double-layer structure of a dense and sparse layers as a separator to separate a positive electrode from a negative electrode, the sparse layer facing the negative electrode and being lower than the dense layer in fiber density.

#### 5958623

##### ELECTROCHEMICAL CELL EMPLOYING A FINE CARBON ADDITIVE

Kozawa, Akiya; Mase, Shunzo; Sato, Atsushi; Ukino, Chiakicho, Ichinomiya-shi, Aichi-ken, 491, Tobishimamura, Ama-gun, Aichi-ken, 490-14, Meitoku, Nagoya-shi, Aichi-ken, 465, JAPAN

In an electrochemical cell such as a lead-acid cell, fine carbon particles with or without an organic material is disposed in the electrolyte of the cell, deposited on the surface and/or dispersed within the electrically active material of the cell.

#### 5958625

##### POSITIVE LEAD-ACID BATTERY GRIDS AND CELLS AND BATTERIES USING SUCH GRIDS

Rao, Purushothama; Aurora, IL, USA assigned to GNB Technologies, Inc.

Positive grids for lead-acid batteries for SLI, industrial battery, and electric vehicle batteries are disclosed. The positive active material paste pellet openings have a reduced area and the number per square inch of the grid area is increased. The individual area and the number of paste pellets vary with the intended application. The preferred embodiments include reduced distances from the center of the paste pellet to the adjacent grid wires, as well as an optimized amount of positive active material per area of the grid wire surface area so as to allow enhanced electrical performance, if desired, or substantial savings in grid

weight while achieving electrical performance commensurate with conventional lead-acid cells and batteries.

#### 5962161

##### RECOMBINANT BATTERY SEPARATOR

Zucker, Jerry; Charleston, SC, USA assigned to Daramic Inc.

A recombinant battery separator pad is made from a mat of meltblown ultrafine polymer fibers, with the fibers being treated with an agent to render them permanently wettable. The fibers include at least 10% of less than 1  $\mu\text{m}$ , with the majority less than 5  $\mu\text{m}$ . The mat has a liquid porosity of at least 90% and a surface area of at least 1.0  $\text{m}^2/\text{g}$ .

#### 5962164

##### NATURAL OIL BATTERY ELECTROLYTE ADDITIVE

Lajeunesse, Yves; Palm Beach Gardens, FL, USA assigned to Valany Import Export Inc.

The instant invention is an electrolyte additive for use with lead-acid batteries containing antimony. The electrolyte additive consists of a mixture of natural oil such as white mineral oil or a hydro-cracked and treated oil with naphthenic oil, a zinc-free rust and oxidation inhibitor and an ethylene-propylene copolymer. The electrolyte additive is placed above the plate cells in lead-acid batteries having antimony to inhibit gassing and misting with an ancillary benefit of increasing performance and durability of the battery.

#### 5958304

##### DOPED LANTHANUM CHROMITE MATERIAL FOR BIPOLAR INTERCONNECTS FOR SOLID OXIDE FUEL CELLS

Khandkar, Ashok C.; Milliken, Christopher E.; Elangovan, Singaravelu; Hartvigsen, Joseph J.; Sandy, Kaysville, Salt Lake City, UT, USA assigned to Gas Research Institute

An improved ceramic interconnect component for a solid oxide fuel cell having good electrical conductivity and thermodynamic stability in the presence of fuel and a coefficient of thermal expansion matching closely that of zirconia electrolytes is disclosed. The interconnect is a lanthanum chromite material including strontium and magnesium as dopants.

#### 5958613

##### POLYMER ELECTROLYTE FUEL CELL AND A POLYMER ELECTROLYTE FUEL CELL SYSTEM WHICH SUPPLY ANODE-SIDE CHANNELS WITH A GAS-LIQUID MIXTURE

Hamada, Akira; Matsubayashi, Takaaki; Nakaoka, Toru; Miyake, Yasuo; Nakajima, Toshikazu; Osaka, Bukui, JAPAN assigned to Sanyo Electric Company Ltd.