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***Journal of Power Sources***

**LEAD-ACID****6313611****LOW POWER INDICATION CIRCUIT FOR LEAD ACID BATTERY PACK**

Michael R. Mowry; Thomas P. Becker; USA assigned to Snap-on Technologies Inc.

A lead-acid battery pack has an electronically-controlled power switch connected in series with the battery. A voltage monitor/controller is connected in series with a normally-open ON/OFF switch across the battery, the controller controlling a ramped pulse width modulator which provides a switch control signal to the power switch. The controller is program controlled so that, a fraction of a second after the ON/OFF switch is closed, the modulator will provide a constant dc level control signal to the power switch to hold it closed. If the battery voltage drops below a first level for several seconds, the modulator will produce a PWM switch control signal of gradually decreasing pulse width and duty cycle until the power switch is permanently open. This gradual decrease of power delivered from the battery will occur immediately upon the battery voltage dropping below a second level lower than the first level.

**6316148****FOIL-ENCAPSULATED, LIGHTWEIGHT, HIGH ENERGY ELECTRODES FOR LEAD-ACID BATTERIES**

John B. Timmons; Ramesh Bhardwaj; Joseph A. Orsino; USA assigned to Condord Battery Corporation

A lightweight, high-energy electrode plate for a lead acid battery, and method for making an electrode plate, comprising a highly conductive non-lead substrate having a specific gravity no greater than 70% that of lead, a pair of outer layers of thin sheets of imperforate conductive foil that is corrosive resistant to the electrolyte acids of the battery and that are welded together to encapsulate the non-lead substrate.

**6322921****SECONDARY BATTERY AND SEALING PLATE ASSEMBLY THEREFOR**

Yoshinori Iwaizono; Kenjin Masumoto; Shinji Tsurutani; Japan assigned to Matsushita Electric Industrial Company Ltd.

A secondary battery which may be handled in a same way as conventional single cell, if the gas pressure within battery went unusually high the gas is immediately discharged outside, and bursting of the battery is prevented. Sealing portion of the secondary battery is composed by a flexible circuit board having an aperture and a safety circuit mounted thereon, a plus terminal for input/output of control provided with a gas discharge aperture and minus terminal for safety circuit provided with a gas discharge aperture which keep a

surface contact with the flexible circuit board at the upper surface and are connected respectively to the safety circuit by wirings, a PTC element keeping a surface contact with the flexible circuit board at the reverse surface, a vent having a slit and is attached to the reverse surface of PTC element, the above members being united into a one-piece unit by an inner gasket, and a subfilter having an aperture and is welded to said vent at the center, which is clamped, together with the inner gasket, by the circumferential edge of an aperture-bearing filter.

**6322922****SEALED BATTERY AND METHOD FOR MANUFACTURING SAME**

Hideaki Yoshio; Seiichi Mizutani; Shinji Tsurutani; Saburo Nakatsuka; Mamoru Iida; Japan assigned to Matsushita Electric Industrial Company Ltd.

A metal reinforcing plate is welded in place close to the opening on the inside of the battery case, and a plastic insulation gasket and a sealing member provided with an anti-explosion mechanism or the like are sequentially mounted on the metal reinforcing plate. By this arrangement, higher battery capacity can be realized by eliminating the waste of space because it is unnecessary to form a conventional indentation around the upper wall of a battery case. A sealed battery construction having an anti-explosion mechanism and being highly reliable in terms of leakage prevention can be thereby obtained.

**BATTERY MATERIALS****6316142****ELECTRODE CONTAINING A POLYMERIC BINDER MATERIAL, METHOD OF FORMATION THEREOF AND ELECTROCHEMICAL CELL**

Frank M. Delnick; Alan Iwamoto; Zhendong Hu; Liya Wang; USA assigned to Imra America Inc.

Provided are methods of forming an electrode suitable for use in an electrochemical cell, and novel electrodes which can be formed therefrom. The methods involve the steps of: (a) forming an electrode slurry from components comprising a solvent, a polymeric binder material and a solid electrode material, wherein the polymeric binder material is formed by modifying a polyolefin with at least one unsaturated polycarboxylic acid or an anhydride of the acid, chlorinating the modified polyolefin and partially crosslinking carboxyl groups or acid anhydride groups on the chlorinated, modified polyolefin with an epoxy group of a compound which has at least two epoxy groups per molecule; (b) coating the electrode slurry on a substrate; and (c) evaporating the solvent. Also provided are electrochemical cells which include the inventive electrodes. The invention has particular applicability to the manufacture of nonaqueous electrochemical power supplies.

**6316144****PRE-GRAPHITIC CARBONACEOUS INSERTION COMPOUNDS AND USE AS ANODES IN RECHARGEABLE BATTERIES**

Jiayu Simon Xue; Alfred MacDonald Wilson; Jeffrey Raymond Dahn; Yinghu Liu; Ulrich von Sacken; Qiming Zhong; Tao Zheng; Canada assigned to Moli Energy Limited, 1990

Carbonaceous insertion compounds and methods for preparation are described wherein the compounds comprise a highly disordered, impurity free, hard pre-graphitic carbonaceous host. Carbonaceous insertion compounds can be prepared which have large reversible capacity for lithium yet low irreversible capacity and voltage hysteresis. Such insertion compounds can be prepared by simple pyrolysis of suitable epoxy, phenolic resin, or carbohydrate precursors at an appropriate temperature. These insertion compounds may be suitable for use as high capacity anodes in lithium ion batteries.

**6316146****CARBON MATERIALS FOR NEGATIVE ELECTRODE OF SECONDARY BATTERY AND MANUFACTURING PROCESS**

Kazuhiro Watanabe; Norishige Nanai; Katsuhiko Nichogi; Akihito Miyamoto; Soji Tsuchiya; Japans signed to Matsushita Electric Industrial Company Ltd.

A carbon material for negative electrode of a secondary battery, in particular lithium-ion secondary battery, is prepared by pyrolysis in an inert gas atmosphere or in a vacuum of a composite resin obtained by dissolving pitch in a pitch-soluble resin such as a nobolac phenol resin as it is, or a resin solidified by curing treatment in a state in which the above composite resin is dispersed in a resin solidified by curing treatment or in an uncured resin having a phenol hydroxyl radical, such as resol type phenol resin, followed by pulverization in an inert gas, and further heat treatment in an inert gas atmosphere or in a vacuum. Also, a negative electrode material with which irreversible capacity is small, initial discharge capacity is large, and capacity decrease due to cycles is small can be provided by pyrolyzing in an inert gas atmosphere or in a vacuum powder of a resin such as a resol type phenol resin the primary chain of which containing an aromatic compound, or pyrolyzing in an inert gas atmosphere or in a vacuum in a first step, followed by heat treatment in a vacuum in a second step. By employing these negative electrode materials, it is possible to achieve a higher capacity in lithium-ion secondary batteries.

**6316149****SOLID POLYMER ELECTROLYTE COMPOSITIONS**

James E. Garbe; Radoslav Atanasoski; Steven J. Hamrock; Dinh Ba Le; USA assigned to Minnesota Mining and Manufacturing, Hydro-Quebec Corporation

An electrolyte composition is featured that includes a solid, ionically conductive polymer, organically modified oxide particles that include organic groups covalently bonded to the oxide particles, and an alkali metal salt. The electrolyte composition is free of lithiated zeolite. The invention also features cells that incorporate the electrolyte composition.

**6322923****SEPARATOR FOR GEL ELECTROLYTE BATTERY**

Robert Mark Spotnitz; Charles Glen Wensley; USA assigned to Celgard Inc.

A battery separator for a gel electrolyte battery includes a microporous membrane; and an adherent coating thereon, or a gel-forming coating thereon, the gel-forming coating including a gel-forming polymer and a plasticizer. The gel-forming polymer is preferably a poly(vinylidene fluoride:hexafluoropropylene) copolymer, and the plasticizer is preferably an ester.

**6322924****PREPARATION OF CROSSLINKED SOLID POLYMER ELECTROLYTE**

Kazuhiro Hirahara; Toru Nakanishi; Japan assigned to Shin-Etsu Chemical Company Ltd.

A crosslinked solid polymer electrolyte is prepared by adding a reactive polyalkylene oxide and an inorganic lithium salt to a block-graft copolymer comprising first and second block chains, and subjecting the reactive polyalkylene oxide to crosslinking reaction. The crosslinked solid polymer electrolyte has a high ionic conductivity and can be readily formed into a tough film and is thus suited for use in large-size secondary batteries.

**6322928****MODIFIED LITHIUM VANADIUM OXIDE ELECTRODE MATERIALS AND PRODUCTS**

Michael M. Thackeray; Arthur J. Kahaian; Keith D. Kepler; Donald R. Vissers; USA assigned to 3M Innovative Properties Company

Improved lithium vanadium oxide formulations are presented having a nominal formula of  $\text{Li}_x\text{V}_{3-\delta}\text{M}_\delta\text{O}_y$ . Herein preferred cation doped vanadium oxide materials, electrodes using such materials, and electrochemical cells including at least one electrode therein comprising such materials are provided.

**FUEL CELL****6312843****FUEL CELL APPARATUS**

Masahiko Kimbara; Takashi Ban; Hidehito Kubo; Hirohisa Katoh; Japan assigned to Kabushiki Kaisha Toyoda Jidoshokki Seisakusho

This invention relates to a fuel cell apparatus in which a discharge gas having a pressure energy even after an oxygen has been consumed at the fuel cell is expanded at an expander to collect the pressure energy in the discharge gas as a mechanical energy for assisting driving of a compressor. A clutch is disposed between the electric motor and the expander for connecting/interrupting the expander with/from the electric motor, and a control means for controlling the clutch is provided. The control means detects a pressure in the gas discharge tube between the fuel cell and the expander, to interrupt the clutch as long as a detected pressure is lower than a predetermined value, and to connect the clutch when the detected pressure becomes higher than the predetermined value.

#### 6312846

##### FUEL CELL AND POWER CHIP TECHNOLOGY

Stephen A. Marsh; USA assigned to Integrated Fuel Cell Technologies Inc.

A fuel cell is disclosed which is formed on a semiconductor wafer by etching channel in the wafer and forming a proton exchange membrane PEM barrier in the etched channel. The barrier divides the channel into two. A hydrogen fuel is admitted into one of the divided channels and an oxidant into the other. The hydrogen reacts with a catalyst formed on an anode electrode at the hydrogen side of the channel to release hydrogen ions (protons) which are absorbed into the PEM. The protons migrate through the PEM and recombine with return hydrogen electrons on a cathode electrode on the oxygen side of the PEM and the oxygen to form water.

#### 6312847

##### BASE TUBE FOR FUEL CELL

Hiroshi Tsukuda; Akihiro Yamashita; Kenichiro Kosaka; Nagao Hisatome; Toru Houjyou; Japan assigned to Mitsubishi Heavy Industries Ltd.

The present invention discloses a base tube for a fuel cell produced by forming a film of a fuel electrode and a film of an air electrode on a surface of the base tube, the base tube comprising a mixture of a raw material for the base tube, and coarse particles of metal oxide, whereby the mixture shrinks nonuniformly when sintered to increase the porosity of the base tube. Thus, the gas permeability and the cell electrical efficiency can be increased.

#### 6313750

##### MEASURING CELL VOLTAGES OF A FUEL CELL STACK

Robert A. Lacy; USA assigned to Plug Power Inc.

A system includes a divider network, a memory and a circuit. The divider network is adapted to be coupled to fuel cells of a fuel cell stack and provide pairs of signals.

Each pair of signals is associated with a different fuel cell and indicates a terminal voltage of the associated cell and another voltage common to the pair of signals. The memory stores indications of different common mode gains, and each common mode gain indication is associated with a different one of the pairs of signals. The circuit is coupled to the memory and adapted to generate an indication of the terminal voltage from each pair based on the associated common mode gain indication.

#### 6316133

##### DEVICE FOR CONVERTING ENERGY USING FUEL CELLS WITH INTEGRATED HYDROGEN GAS PRODUCTION

Ulf G. Bossel; Switzerland assigned to DCH Technology Inc.

A device for converting energy by a proton-conducting electrolyte, includes an integrated arrangement for producing hydrogen gas. The arrangement has a reaction chamber for producing H<sub>2</sub> gas by reaction of water with a hydride; and a fuel cell stack having an H<sub>2</sub> gas is transferred. Each fuel cell has an opening which together form the distribution channel and by means of which an H<sub>2</sub> gas distribution in individual fuel cells is provided. The reaction chamber is situated underneath, and a water coupling is situated above the cell stack. Further a tension rod having a longitudinal internal passage connecting the water coupling with the reaction chamber is disposed in the openings for holding together the fuel cells. A valve is connected to the tension rod for controlling the passage.

#### 6316134

##### FUEL CELL ELECTRIC POWER GENERATION SYSTEM

Ryan Cownden; Michael Eiche; Craig Louie; David S. Watkins; Canada assigned to Ballard Generation Systems Inc.

A fuel cell electric power generation system comprises an electric power generation subsystem, a fuel processing subsystem, an oxidant subsystem, a water circulation subsystem, and a temperature control subsystem. The improved system employs a novel arrangement of components which provides improved interaction between the subsystems while also simplifying the apparatus by integrating components to provide improved thermal and electrical efficiency. The fuel processing subsystem preferably comprises a furnace for providing heat to a plurality of components disposed within the furnace. In one embodiment, a reformer, a fuel stream humidifier, and a heat exchanger are all disposed within the furnace vessel, with the outlet of the humidifier fluidly connected to the inlet of the reformer and the outlet of the heat exchanger fluidly connected to a desulfurizer located external to the furnace. The fuel processing subsystem may further comprise a shift reactor that exchanges

heat with a cathode exhaust stream directed to the shift reactor from the power generation subsystem. After passing through the shift reactor, the cathode exhaust stream is preferably directed to the furnace burner.

#### 6316135

##### **DIRECT ANTIFREEZE COOLED FUEL CELL**

Richard D. Breault; David A. Condit; Albert P. Grasso; Michael E. Gorman; USA assigned to International Fuel Cells LLC

A direct antifreeze cooled fuel cell is disclosed for producing electrical energy from reducing and process oxidant fluid streams that includes an electrolyte secured between an anode catalyst and a cathode catalyst; a porous anode substrate secured in direct fluid communication with and supporting the anode catalyst; a porous wet proofed cathode substrate secured in direct fluid communication with and supporting the cathode catalyst; a porous water transport plate secured in direct fluid communication with the porous cathode substrate; and, a direct antifreeze solution passing through the porous water transport plate. In operation of the fuel cell, because product water generated electrochemically at the cathode catalyst flows away from the cathode catalyst into the cathode substrate and into the water transport plate and because the cathode substrate is wetproofed, the antifreeze solution passing through the water transport plate remains essentially within this plate. In a preferred embodiment, the antifreeze solution passing through the water transport plate may be directed to flow at a pressure less than that of the oxidant stream passing adjacent the cathode substrate.

#### 6316136

##### **INTERCONNECTOR FOR HIGH TEMPERATURE FUEL CELLS**

Emad Batawi; Switzerland assigned to Sulzer Hexis AG

The interconnector for high temperature fuel cells is arranged between a first and a second planar electrochemically active element. In this it separates a chamber containing a combustion gas from a chamber containing oxygen. A porous sinter body of the interconnector has pores which are at least partly sealed by a medium. Through the sealing, a passage of gases between the named chambers is prevented.

#### 6316137

##### **COOLING A FUEL CELL STACK**

James H. Kralick; USA assigned to Plug Power Inc.

A fuel cell system includes a fuel cell stack and a pump system. The pump system circulates a coolant through the fuel cell stack. The coolant is substantially electrically non-conductive and has a freezing point substantially below the freezing point of water.

#### 6316138

##### **SOLID OXIDE ELECTROLYTE FUEL CELL**

Tokuki Satake; Kiyoshi Watanabe; Fusayuki Nanjo; Koichi Takenobu; Hitoshi Miyamoto; Japan assigned to Mitsubishi; Jukogyo Kabushiki Kaisha

An improved structure of a solid oxide electrolyte fuel cell (SOFC) is disclosed. A generating layer in the SOFC consists of three layers of a fuel electrode, an oxide layer and an oxygen electrode, and is shaped into a dimpled structure having recessed portions on its both surfaces. Protruded portions on the side of the fuel electrode are electrically bonded with an interconnector layer via a first conductive adhesive, while protruded portions on the side of the oxygen electrode of another generating layer are electrically bonded with the same interconnector layer via a second conductive adhesive. A plurality of generating layers and a plurality of interconnector layers are alternately stacked and they are electrically bonded in the above-described manner. Preferably, the first conductive adhesive is made of material common to the fuel electrode and the second conductive adhesive is made of material common to the oxygen electrode. Owing to the improved structure, occurrence of lateral flows of electrons in the interconnector layers having a large resistance can be suppressed, hence an electrical resistance can be reduced, and also amounts of materials of the oxygen electrode and the fuel electrode can be made small.

#### 6316139

##### **FUEL CELL HAVING A GASKET WITH AN ADHESIVE LAYER**

Makoto Uchida; Yuk Fukuoka; Yasushi Sugawara; Hideo Ohara; Nobuo Eda; Japan assigned to Matsushita Electric Industrial Company Ltd.

A polymer electrolyte fuel cell having a large economical advantage uses a gasket which includes an elastomer layer that is inexpensive, highly resistant to chemicals, particularly to acids, and exhibits a high sealability. The elastomer layer is provided with an adhesive layer, and the gasket is both easy to position and easy to assemble. The fuel cell includes unit cells each including a positive electrode, an electrolyte plate, and a negative electrode, and gaskets each arranged at the circumferential part of the unit cell alternately stacked via a separator placed there between. The gasket includes an elastomer layer and an adhesive layer, with the elastomer layer being adhered to at least one side of the separator via the adhesive layer.

#### 6319626

##### **CATHODE COMPOSITION FOR SOLID OXIDE FUEL CELL**

Sten A. Wallin; Sunil D. Wijeyesekera; USA assigned to The Dow Chemical Company

A high performance electrocatalyst is based on transition metal perovskites of praseodymium, samarium, terbium or

neodymium which react with YSZ to form a product which is itself active as the cathode in a fuel cell. While  $\text{PrCoO}_3$  reacts with YSZ, the reaction product(s) do not result in severe degradation of cell performance. A fuel cell made with a cathode composed of only the reaction product of YSZ and  $\text{PrCoO}_3$  has good performance, indicating that this phase is itself not only a good conductor, but also a good catalyst for oxygen activation.

### 6321145

#### METHOD AND APPARATUS FOR A FUEL CELL PROPULSION SYSTEM

Kaushik Rajashekara; USA assigned to Delphi Technologies Inc.

Propulsion control system and method are provided for use in vehicles including a propulsion motor that is powered by a fuel cell. The fuel cell unit produces a compatible voltage for the propulsion motor, thereby, removing the need for a dc/dc boost converter. A buck/boost converter and a standard 12 V battery are used to start the fuel cell. An inverter receives dc electric voltage from the fuel cell and outputs ac electric voltage to the propulsion motor. A vehicle controller receives a voltage input from the fuel cell unit and outputs a current reference to a comparing device. The comparing device compares the current reference from the vehicle controller to an actual current of the fuel cell unit and then outputs a signal to a PI control which outputs a control signal to a fuel cell controller, whereby the power output of the fuel cell is controlled based on the actual current of the fuel cell.

### 6322914

#### METHOD AND APPARATUS FOR DISTRIBUTING WATER IN AN ARRAY OF FUEL CELL STACKS

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

A method and apparatus are provided for distributing water produced by the electrochemical reaction to ion-exchange membranes in an array comprising a plurality of electrochemical fuel cell stacks. Water distribution within individual fuel cell stacks within the array 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 oxidant stream flow direction within at least one of the plurality of fuel cell stacks. The apparatus comprises an oxidant stream flow switching device for periodically switching the flow direction of an oxidant stream through an individual fuel cell stack.

### 6322915

#### HUMIDIFICATION SYSTEM FOR A FUEL CELL POWER PLANT

William P. Collins; Leslie L. Van Dine; USA assigned to International Fuel Cells LLC

The invention is a humidification system for a fuel cell power plant. The system includes at least one fuel cell comprising a coolant flow field adjacent the cathode flow field. The coolant flow field includes a coolant inlet, a coolant outlet, and a split-path coolant distribution channel between the coolant inlet and outlet. The split-path distribution channel directs some of the coolest portion of the coolant stream to flow adjacent the cathode inlet and some of the coolest portion to flow adjacent the cathode outlet. The humidification system lowers a temperature of the process oxidant stream adjacent the cathode inlet, thereby, increasing relative humidity of the stream in the cathode flow field adjacent the cathode inlet.

### 6322916

#### METHOD OF OPERATING A MOLTEN CARBONATE FUEL CELL, A FUEL CELL, A FUEL CELL STACK AND AN APPARATUS PROVIDED THEREWITH

Klaas Hemmes; Gerhard Pieter Jan Dijkema; The Netherlands assigned to Technische Universiteit Delft

A method of operating a molten carbonate fuel cell having an anode and a cathode and in between a matrix comprising molten carbonate. Carbon dioxide is introduced into the matrix at a distance from the cathode. This greatly reduces the cathode's deterioration and in the system design increases the control potential of the fuel cell. A fuel cell or a fuel cell stack using said method. Method of generating electricity in a fuel cell, wherein water and carbonaceous material are heated at high temperature, yielding hydrogenous gas for the anode. The hydrogenous depleted gas from the anode is supplied with oxygenous gas and at least partially oxidized, producing heat for heat exchange with the water and carbonaceous material. Installation comprising a reform unit and a fuel cell using said method.

### 6322918

#### WATER MANAGEMENT SYSTEM FOR FUEL CELLS

Ronald J. Kelley; Steven D. Pratt; Sivakumar Muthuswamy; Robert W. Pennisi; USA assigned to Motorola Inc.

A water management system reduces the problems with flooding and also enhances the flow of fuel gas to the anodes. Individual unit cells in an array are separated by cell walls, the array is covered by a fuel manifold, and the manifold is arranged so that the individual unit cells have their own respective chambers. Each chamber is arranged so that the fuel gas flows from one chamber into another through an opening or vent in the chamber wall. The opening contains a hydrophobic portion that serves to urge liquid water that accumulates in the opening to migrate away.

**6322919****FUEL CELL AND BIPOLAR PLATE FOR USE WITH SAME**

Jefferson Y.S. Yang; Timothy J. Rehg; USA assigned to Allied Signal Inc.

A fuel cell bipolar plate including a fuel side having a series of fuel channels defining respective fuel paths and an oxidant side having a series of oxidant channels defining respective oxidant paths. At least some of the fuel channels are offset from adjacent oxidant channels in a direction transverse to the fuel and oxidant paths. A fuel manifold is connected to the fuel channels, while an oxidant manifold is connected to the oxidant channels. One of the two manifolds is located between the bipolar plate and the other manifold, where a connector extends from whichever manifold is outermost to the associated fuel or oxidant channels.

**6322920****FUEL CELL ISOLATION SYSTEM**

Louis R. Tomson; USA assigned to Plug Power Inc.

A fuel cell stack may be enclosed within a plastic membrane. In one embodiment of the invention, a stack may be enclosed within a heat shrinkable membrane and the membrane caused to shrink about the stack. In this way, any leakage of fluids from the stack may be prevented or retarded by the membrane. A variety of different membranes may be utilized including composite membranes made up of barrier film and heat shrinkable puncture resistant film or bubble wrap covered by shrink wrap film. Any openings formed in the enclosure may be closed using plastic tape or heat sealing techniques. A leak detector may be provided within the enclosure for detecting leaks including gas leaks from within the stack.

**LITHIUM BATTERIES****6315823****LITHIUM AND VANADIUM CONTAINING SEALING COMPOSITION AND PROCESS THEREWITH**

Shawn E. Dolan; USA assigned to Henkel Corporation

The corrosion resistance of an article having a surface with a primary inorganic coating, such as a conversion coating, over a metal substrate can be improved by treatment of the primary coating with an aqueous liquid sealing composition comprising lithium cations and vanadate anions. This treatment is particularly advantageous for primary coatings formed on aluminum alloys by treating them with a conversion coating forming aqueous composition made by reacting cobalt(II) cations, acetate ions, hydroxyalkyl amines, and peroxides in aqueous solution.

**6316143****ELECTRODE FOR RECHARGEABLE LITHIUM-ION BATTERY AND METHOD OF FABRICATION**

Donald L. Foster; Jeffrey Wolfenstine; Jeffrey Read; Wishvender K. Behl; USA assigned to The United States of America as represented by the Secretary of the Army

An electrode for a rechargeable lithium-ion battery is formed by mixing stannous oxide (SnO) and lithium nitride (Li<sub>3</sub>N) in a stoichiometric ratio of 2 moles of Li<sub>3</sub>N to 3 moles of SnO to form a mixture, milling the mixture to obtain a milled powder, and processing the milled powder in accordance with an electrode-forming technique. The electrode forming technique can be any one of die pressing, spraying, doctor-blading and rolling. Conductive additives, such as carbon and binders (PVDF, cellulose and Teflon), can be introduced during the processing step. Preferably, the method is carried out in a dry, inert atmosphere of argon or helium. As a result of the invention, a smaller, lighter and more efficient lithium-ion battery is produced.

**6319632****ACTIVE MATERIAL FOR LITHIUM BATTERIES**

Khalil Amine; USA assigned to Japan Storage Battery Company Ltd.

An active material of formula LiCu<sub>1-x</sub>PO<sub>4</sub> (0 less than or equal to  $x$  less than or equal to 1) which could be used as cathode material in lithium primary and secondary batteries.

**6319633****RECHARGEABLE LITHIUM BATTERY**

Hiroaki Ikeda; Masahisa Fujimoto; Shin Fujitani; Japan assigned to Sanyo Electric Company Ltd.

A rechargeable lithium battery has a positive electrode, a negative electrode and a non-aqueous electrolyte. The active material of the positive or negative electrode is tungsten complex sulfide, either with or without addition of lithium thereto. The tungsten complex sulfide contains tungsten, sulfur and at least one transition metal selected from Cu, V, Cr, Mn, Fe, Co and Ni, and has substantially the same crystal structure as WS<sub>2</sub>.

**6322599****METHOD OF FABRICATING A LITHIUM ION SECONDARY BATTERY**

Kouji Hamano; Yasuhiro Yoshida; Hisashi Shiota; Shou Shiraga; Shigeru Aihara; Michio Murai; Takayuki Inuzuka; Japan assigned to Mitsubishi Denki Kabushiki Kaisha

A method of fabricating a lithium ion secondary battery, wherein a positive electrode is prepared by bonding a positive electrode active material layer to a positive electrode collector, a negative electrode is prepared by bonding a negative electrode active material layer to a negative electrode collector and a separator which is arranged between these two electrodes and closely adhered thereto by bonding, using a fluoride containing adhesive resin mixed with

*N*-methylpyrrolidone solvent and in which the *N*-methylpyrrolidone solvent is evaporated to produce through holes, which communicate the positive electrode active material layer and the negative electrode active material layer with the separator 4.

**6322744**

**LITHIUM MANGANESE OXIDE-BASED ACTIVE MATERIAL**

Tracy E. Kelley; Porter H. Mitchell; Chariclea A. Scordilis-Kelley; USA assigned to Valence Technology Inc.

The invention provides an electrochemically active material comprising particles of spinel lithium manganese oxide having on the surface of each particle cationic metal species bound to the spinel at anionic sites of the particle surface; where the cationic metal species includes a metal selected from the group consisting of transition metals, non-transition metals having a +3 valence state, and mixtures thereof. The active material is characterized by a reduced surface area and increased capacity expressed in milliamp hour per gram as compared to the spinel alone.

**6322929**

**LITHIUM SECONDARY BATTERY WITH A HIGH CHARGE-DISCHARGE EFFICIENCY AND A LOW SELF-DISCHARGING TENDENCY**

Kazunori Takada; Makoto Fujino; Kazuya Iwamoto; Shigeo Kondo; Japan assigned to Matsushita Electric Industrial Company Ltd.

A lithium secondary battery free from problems encountered with a positive electrode active material exhibiting an electrode potential of not lower than 4.5 V versus Li—a deterioration in performances because of self-discharge with decomposition of the electrolyte. The lithium secondary battery uses a sulfide based lithium ion conductive solid electrolyte as the electrolyte. Thus, a lithium secondary battery with a very low self-discharge tendency, that is, with the decomposition of electrolyte highly controlled, can be obtained even using the positive electrode active material generating a high voltage.

**NICKEL METAL HYDRIDE BATTERIES**

**6322926**

**HYDROGEN ABSORBING ALLOY POWDER, PROCESS FOR PRODUCING SAME, AND ALKALINE SECONDARY BATTERY**

Masaki Kasashima; Hiroto Sugahara; Japan assigned to Shin-Etsu Chemical Company Ltd.

Provided is an AB<sub>5</sub> type hydrogen absorbing alloy powder obtained by quenching a melt of a hydrogen absorbing alloy rapidly and subjecting the resulting hydrogen absorbing alloy to fracturing by absorbing hydrogen, wherein the

particle size distribution of the hydrogen absorbing alloy powder is such that, when the frequencies of detection of various particle diameters are cumulatively added from smaller-diameter to larger-diameter particles, and the particle diameters corresponding to 10, 50 and 90% of all particles are represented by D<sub>10</sub>, D<sub>50</sub> and D<sub>90</sub>, respectively, the values of D<sub>10</sub>, D<sub>50</sub> and D<sub>90</sub> fall within the respective ranges defined by 4 μm less than or equal to D<sub>10</sub> less than or equal to 14 μm, 17 μm less than or equal to D<sub>50</sub> less than or equal to 37 μm, and 40 μm less than or equal to D<sub>90</sub> less than or equal to 70 μm.

**COMPONENTS AND/OR CHARGERS**

**6316909**

**ELECTRONIC DEVICE, CONTROL METHOD FOR ELECTRONIC DEVICE, RECHARGE-RATE ESTIMATING METHOD FOR SECONDARY BATTERY, AND CHARGING CONTROL METHOD FOR SECONDARY BATTERY**

Katsuyuki Honda; Motomu Hayakawa; Ichiro Aoshima; Tsukasa Kosuda; Japan assigned to Seiko Epson Corporation

A first circuit having a first coil electrically charges a second circuit having a second coil through electromagnetic coupling of the two coils. When data signals are to be transferred between the first and second circuits, signal transfer is started only after the second circuit has been charged for a predetermined period of time. The position relationship between the coils is also detected, and a charging/transfer selector changes a duty ratio between charge transfer and data transfer in accordance with the detected result. The charge is transferred in an intermittent manner, and the charging rate is adjusted according to the difference between the voltage of a secondary battery observed during a charging phase and the voltage of the secondary battery observed a certain time after interruption of the charging phase, or vice versa.

**6316913**

**LOW DISSIPATION SYSTEM AND METHOD FOR DETERMINING BATTERY CAPACITY AND BATTERY PLANT INCORPORATING THE SAME**

Subhas C. Chalasani; Vijayan J. Thottuvelil; USA

A system and method for determining a capacity of a battery in a battery string that provides power to a load. In one embodiment, the system includes: (1) a power converter, having an input couplable across the battery and an output couplable across the battery string, that is adapted to transfer power from the battery to the load over a period of time and (2) a voltage sensor, associated with the power converter, that measures voltages of the battery during the period of time, wherein the voltages indicate the capacity of the battery.



**6317697****BATTERY LIFE DETERMINATION APPARATUS AND BATTERY LIFE DETERMINATION METHOD**

Tetsuo Yoshikawa; Hiroshi Fujii; Shigemitsu Kiso; Japan assigned to Omron Corporation

An apparatus for determining life of a battery which supplies charged electricity to an electrical appliance is equipped with a storage part for storing relationship between standard total values of discharge voltage drop amounts since a start of discharge of the battery and standard life values, a discharge voltage drop amount totalizer part for totalizing the discharge voltage drop amounts since the start of discharge with the battery being discharged, and a life determination part for determining the life of the battery from a measured total value of totalized discharge voltage drop amounts and the standard total values of the storage means.

**OTHER BATTERIES****6312844****METAL-AIR FUEL CELL BATTERY SYSTEM HAVING MEANS FOR DISCHARGING AND RECHARGING METAL-FUEL CARDS SUPPLIED FROM A CASSETTE-TYPE STORAGE DEVICE**

Sadeg M. Faris; USA assigned to Reveo Inc.

Disclosed are metal-air fuel-cell battery (FCB) systems adapted to discharge a supply of (re)charged metal-fuel cards supplied from a cassette-type storage device, wherein each (re)charged metal-fuel card is physically disconnected from each other (re)charged metal-fuel card. Each (re)charged metal-fuel card is automatically loaded from the cassette-type cartridge into the discharging bay of the system, and after discharged, transported back into the cassette-type storage device. In the illustrative embodiments, a metal-air FCB system is disclosed, wherein the system is adapted to one or more discharged metal-fuel cards supplied from the cassette-type storage device. In such a system, each discharged metal-fuel card is automatically loaded from the cassette-type cartridge into the (re)charging bay of the system, and after (re)charging, transported back into the cassette-type storage device. In another illustrative embodiment of the present invention, simultaneous discharging and recharging of metal-fuel cards is enabled in a simple and convenient manner.

**6314638****APPARATUS FOR MANUFACTURING ELECTRODE PLATE FOR NONAQUEOUS ELECTROLYTE BATTERY**

Hideki Kaido; Kouichi Matsumoto; Minoru Hashimoto; Mitsuru Furuichi; Japan assigned to Toshiba Battery Company Ltd.

An apparatus for manufacturing an electrode plate of a nonaqueous secondary battery comprises means for moving

a sheet conductive base material in a first direction, a die nozzle for injecting an electrode material composition onto the sheet conductive base material, a pump disposed in supplying pipes, a valve disposed at the pipes between the pump and the die nozzle, a suction system disposed at the pipes between the valve and the die nozzle, and means for drying the electrode material composition. To form uncoated areas, either the die nozzle or sheet conductive base material may be configured to move in a direction substantially perpendicular to one another, or the die nozzle may be configured to move along the first direction. Additionally a coated amount of the electrode material composition per unit area along the first direction may be continuously increased or decreased.

**6316140****NONAQUEOUS-ELECTROLYTE SECONDARY BATTERY WITH A CASE HAVING HEAT-WELDED PORTIONS**

Tsuyonobu Hatazawa; Kazuhito Hatsuta; Tomitara Hara; Japan assigned to Sony Corporation

A nonaqueous-electrolyte secondary battery is disclosed which is capable of maintaining satisfactory adhesiveness of leads of terminals of electrodes in heat-welded portions of a case of the nonaqueous-electrolyte secondary battery without deterioration of the moisture proofing characteristics. A battery element is accommodated in a case constituted by laminated film such that the battery element is encapsulated by heat welding. Leads of terminals of electrodes electrically connected with the electrodes which constitute the battery element are exposed to the outside portion of the nonaqueous-electrolyte secondary battery through heat-welded portions. Portions of the leads of the terminals of the electrodes corresponding to the heat-welded portions are coated with an olefine adhesive layer containing a titanate coupling material and a coating layer made of resin which is the same as resin which forms the innermost layer of each of the laminated films.

**6316141****HIGH-ENERGY, RECHARGEABLE, ELECTROCHEMICAL CELLS WITH NON-AQUEOUS ELECTROLYTES**

Doron Aurbach; Yosef Gofer; Alexander Schechter; Lu Zhonghua; Chaim Gizbar; Israel assigned to Bar Ilan University

A non-aqueous electrolyte for use in an electrochemical cell comprising: (a) at least one organic solvent; (b) at least one electrolytically active salt represented by the formula: in which: M' is selected from a group consisting of magnesium, calcium, aluminum, lithium and sodium; Z is selected from a group consisting of aluminium, boron, phosphorus, antimony and arsenic; R represents radical selected from the following groups: alkyl, alkenyl, aryl, phenyl, benzyl, and

amido; X is a halogen (I, Br, Cl, F);  $m = 1-3$ ; and  $n = 0-5$  and  $q = 6$  in the case of Z: phosphorus, antimony and arsenic, and  $n = 0-3$  and  $q = 4$  in the case of Z: aluminum and boron. Rechargeable, high energy density electrochemical cells containing an intercalation cathode, a metal anode, and an electrolyte of the above-described type are also disclosed.

#### 6316145

##### NON-AQUEOUS ELECTROLYTE BATTERY AND CHARGING METHOD THEREFOR

Yoshinori Kida; Ryuji Ohshita; Maruo Kamino; Seiji Yoshimura; Toshiyuki Nohma; Koji Nishio; Japan assigned to Sanyo Electric Company Ltd.

In a non-aqueous electrolyte battery using titanium oxide or lithium titanate as a negative electrode material for negative electrode, polymeric electrolyte is interposed between the negative electrode and a positive electrode. If titanium oxide or lithium titanate is used as the negative electrode material for negative electrode and the polymeric electrolyte is interposed between the negative electrode and the positive electrode, the polymeric electrolyte is less liable to be decomposed by catalytic reduction induced by titanium oxide or lithium titanate. This prevents decline in the charge/discharge efficiency which occurs when a non-aqueous electrolyte solution is used. Thus, the non-aqueous electrolyte battery excellent in charge/discharge efficiency is provided.

#### 6319630

##### LAMINATE FILM CASE COMPRISING NONAQUEOUS ELECTROLYTE BATTERY AND CONTROL CIRCUIT

Daisuke Hasegawa; Masataka Arakawa; Japan assigned to Sony Corporation

A nonaqueous electrolyte battery is disclosed which is capable of realizing a sufficiently large space for accommodating a control circuit and preventing enlargement of the size thereof. The nonaqueous electrolyte battery incorporating a case constituted by a laminate film and arranged to accommodate a battery element which is enclosed by heat welding; and electrode terminal leads which are electrically connected to electrodes constituting the battery element and which are extended to the outside of the case such that the electrode terminal leads are sandwiched by a heat welded portion, wherein the nonaqueous electrolyte battery has a rectangular outer shape, two corners of one side of four sides of the nonaqueous electrolyte battery from which the electrode terminal leads extend to the outside of the nonaqueous electrolyte battery are cut, bent such that the width of each of heat welded portions corresponding to the other sides is smaller than the thickness of the nonaqueous electrolyte battery and inwards folded back along the side surface of the battery element so that a space is created and a control circuit for the nonaqueous electrolyte battery is accommodated in the space.

#### 6322930

##### NON-AQUEOUS ELECTROLYTE BATTERY

Seiji Yoshimura; Toshiyuki Nohma; Koji Nishio; Japan assigned to Sanyo Electric Company Ltd.

A non-aqueous electrolyte battery includes a positive electrode, a negative electrode and a non-aqueous electrolyte, wherein the non-aqueous electrolyte contains boric acid ester as a solvent.