(19) LE GOUVERNEMENT DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

(11) N° de publication : **LU502148**

(12) **BREVET D'INVENTION** **B1**

(21) N° de dépôt: LU502148

(22) Date de dépôt: 24/05/2022

(51) Int. Cl.:
H01M 4/88, G01N 27/48, G01N 23/2273

(30) Priorité:

(43) Date de mise à disposition du public: 24/11/2022

(47) Date de délivrance: 24/11/2022

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(54) **Co(OH)2 activated carbon composite electrode material based on electrodeposition technology and preparation method thereof.**

(57) This invention belongs to the field of electrodes composed of or including active materials, and discloses Co(OH)2 activated carbon composite electrode material based on electrodeposition technology and preparation method thereof, and an X-ray photoelectron spectroscopy analysis of the Co(OH)2 activated carbon composite electrode material is carried out by using an electrosorption performance test and analysis method; metal oxide was introduced into the electrode surface, and the electro-adsorption of Co(OH)2 activated carbon electrode material was tested by impregnation calcination method. The area enclosed by the volt-ampere curve is calculated by integration, and the electrodeposition amount of Co(OH)2 activated carbon composite electrode material is obtained. The number of activated carbon ion-exchange fibers of Co(OH)2 activated carbon composite electrode material was calculated by conductivity measurement, and the electrodeposition preparation of Co(OH)2 activated carbon composite electrode material was realized according to the combination of various elements.

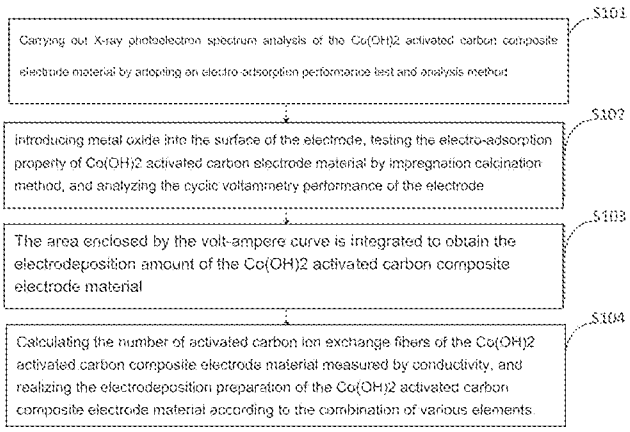


Figure 1

Description

Co(OH)2 activated carbon composite electrode material based on electrodeposition technology and preparation method thereof

Technical field

The present invention belongs to the technical field of electrodes composed of or including active materials, particularly relates to Co(OH)2 activated carbon composite electrode material based on electrodeposition technology and preparation method thereof.

Background

At present, the prior art commonly used in the industry is as follows: Co(OH)2 activated carbon composite electrode material is a typical battery electrode material. The performance of Co(OH)2 activated carbon composite electrode material is ensured to be stable by optimizing the preparation technology of Co(OH)2 activated carbon composite electrode material. Studying the optimization preparation technology of Co(OH)2 activated carbon composite electrode material will have a good application value in battery design technology optimization and electrode performance optimization control. The research on the preparation methods of Co(OH)2 activated carbon composite electrode materials mainly includes electro-adsorption desalination technology, X-ray photoelectron spectroscopy (XPS) preparation technology and new hybrid MMC preparation technology.

Li Tingting et al.provided a preparation method and electrochemical performance test method of Co(OH)2 activated carbon composite electrode material based on electro-modulation on Al2O3/ACF composite electrode when studying the effect of ionic liquid modified by group [EMIM][OAC] on acetonitrile-water-vapor-liquid equilibrium based on COSMO-RS model. The electro-adsorption deionization experiment was carried out in combination with electromagnetic coupling control method to improve the stable electromagnetic coupling output performance of Co(OH)2 activated carbon

composite electrode material. However, this method carried out electromagnetic LU502148
coupling output performance of Co(OH)2 activated carbon composite electrode material.

Liu Zhuang et al. provided a preparation and performance test method of Co(OH)2 activated carbon composite electrode material based on voltage self-balancing Boost-MMDCT coupling control in the research progress of environment-responsive intelligent hydrogel with fast response characteristics. After rectification, it was connected to the Co(OH)2 activated carbon composite electrode through MMDCT to improve the stability of the electrode material, but the process control ability of this method was not strong.

To sum up, the existing problems in the prior art are: regardless that the preparation method based on Al2O3/ACF composite electrode is poor in electro-adsorption deionization, or the preparation process control ability of the prior art based on voltage self-balancing is weak, the actual problem of the reaction is that the electrochemical stability of the prepared electrode material is poor. In the experimental process, the specific surface area of the Co(OH)2 activated carbon composite electrode material decreases and the conductivity of the electrode decreases.

The preparation method based on Al_2O_3/ACF composite electrode has poor deionization by electro-adsorption. The control ability of that prior art preparation process based on voltage self-balancing is not strong.

The difficulty of solving the above technical problems is to prepare electrode materials with good conductivity, large specific surface area and stable electrochemical performance. The main disadvantage of Co(OH)2 as an electrode material is that it has poor electrical conductivity, and its volume changes greatly during the charging/discharging process, which leads to poor rate performance and cycle stability. Therefore, activated carbon is introduced as the substrate for electrochemical deposition of Co(OH)2 to improve its electrical conductivity. And through impregnation and calcination, that activate carbon with larger specific surface area generate convenient ion transmission channels, thus reducing the ion diffusion distance and improving the dispersion degree of electrochemically deposite Co(OH)2. The conductivity and stability

are increased under the condition of having a large comparative area. The significance LU502148
of solving the above technical problems: Co(OH)2 electrode material with good performance plays an important role in the research of supercapacitors and promotes the development of supercapacitors, new energy vehicles and aerospace fields.

Summary

Aiming at the problems existing in the prior art, the invention provides Co(OH)2 activated carbon composite electrode material based on electrodeposition technology and preparation method thereof.

The invention is realized in this way, a preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology specifically includes:

Step 1, carrying out X-ray photoelectron spectrum analysis of the Co(OH)2 activated carbon composite electrode material by adopting an electro-adsorption performance test and analysis method;

Step 2, introducing metal oxide into the surface of the electrode, testing the electro-adsorption property of Co(OH)2 activated carbon electrode material by impregnation calcination method, and analyzing the cyclic voltammetry performance of the electrode;

Step 3, the area enclosed by the volt-ampere curve is integrated to obtain the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material;

Step 4, calculating the number of activated carbon ion exchange fibers of the Co(OH)2 activated carbon composite electrode material measured by conductivity, and realizing the electrodeposition preparation of the Co(OH)2 activated carbon composite electrode material according to the combination of various elements.

Further, the electric adsorption performance test and analysis method specifically comprises the following steps: the metal oxide is introduced into the electrode surface, and the disturbance error in the preparation of Co(OH)2 activated carbon composite electrode material is expressed in the form of multiple inputs and single outputs, the

electrochemical regulation error term E of Co(OH)2 activated carbon composite electrode material satisfies Gauss-Markov hypothesis by using single-point fuzzification, and the nonlinear dynamic control driving matrix for the preparation of Co(OH)2 activated carbon composite electrode material is as follows: $Y=X\beta+e$; wherein, Y is the conduction vector of n×1 activated carbon fibers adhering to graphite, X is the nonlinear function vector matrix of n×m electrolyte, β is the m×1 activated carbon fiber parameter vector, and e is n×1 random error vector.

Further, in step 2, the electrosorption test of Co(OH)2 activated carbon electrode material by impregnation calcination method specifically includes: the metal oxide is introduced into the surface of the electrode, and the cyclic voltammetry curve is analyzed by the immersion calcination method. If < m, the approximate accuracy Σ of the X-ray test of the composite electrode material is expressed as:

$$\Sigma=\begin{bmatrix}\Sigma_1 & 0\\ 0 & 0\end{bmatrix};$$

the linear error prediction of the electrode material is carried out in the NaCl solution with the electrolyte of $0.5mol\cdot L^{-1}$, the prediction error function is $\Sigma_1=diag(\delta_i)$, i=1,2,…,r, a three-electrode system is used for steady-state regulation, and the covariance matrix decomposition method is used to decompose U and V into what shown as below:

U=[U1 U2] , V=[V1 V2];

Both U1 and V1 are r columns.

Further, in step 2, in step 2, the cyclic voltammetry performance analysis methods of electrodes include: (1) The output volt-ampere characteristic curve prepared by the Co(OH)2 activated carbon composite electrode material was constructed, and the three-phase steady-state regulation model of the battery anode was established, and the electrode torque was calculated as:

$$T_{em}=\frac{\pi k_f k_c k_i k_\beta B_r l_m l_s l_w (2r_r+2l_g+l_w) J_{cm}}{\ln(\frac{r_r+l_g+l_w}{r_r-l_m})};$$

$$k_i=1-\frac{1}{0.9[r_r/(\beta p(l_g+l_w))]^2+1};$$

$$k_\beta=\frac{\alpha(\beta,k_c)}{k_c};$$

wherein, α is the instantaneous span of the state vector, and the output stability analysis of the Co(OH)2 activated carbon composite electrode material is carried out. The output of the oxide fuel cell anode satisfies $\sum_{i=1}^{m} p(a_i)=1$, and the adjustment step size of the adaptive backstepping tracking is: $\alpha=\min(\beta,kc)[ks+(1-ks)\tanh(\delta|\beta-kc|)]$; wherein, ks<1, δ is the empirical value; (2) Calculate the stretching factors of the process adaptation law of the preparation of Co(OH) 2 activated carbon composite electrode materials, L_{lp}, L_{ls} and Llm, the state variables Cp and Cs of the process control, and control the volt-ampere characteristics according to the frequency adjustment criterion, in order to obtain the operating frequency of the system:

$$\omega L_{lp}-\frac{1}{\omega C_p}=0\Rightarrow C_p=\frac{1}{\omega^2 L_{lp}};$$

$$\omega L_{ls}-\frac{1}{\omega C_s}=0\Rightarrow C_s=\frac{1}{\omega^2 L_{ls}};$$

let Y1, Y2, ..., YN be a set of samples of Y, and the output voltammetric characteristic coefficient prepared by the Co(OH)2 activated carbon composite electrode material is set to be expressed as:

$$T_{em}=\frac{\pi k_f k_c k_i k_\beta B_r l_m l_s l_w (2r_r+2l_g+l_w) J_{cm}}{\ln(\frac{r_r+l_g+l_w}{r_r-l_m})}-(\frac{P_e+P_h}{\omega_r});$$

Further, in step 3, integrate the area enclosed by the voltammetry curve to obtain the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material, which includes: integrate the area enclosed by the volt-ampere curve to obtain the control torque of electrodeposition as: $T_{out}=T_{em}-(P_w+P_b)/\omega_r$, based on the electrodeposition technology, the error compensation is carried out, and the feedback tracking adjustment method is used to obtain the fuzzy parameter distribution of the Co(OH)2 activated carbon electrode material preparation, and the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material is obtained. LU502148

Further, in step 4, in step 4, the calculated electrical conductivity measures the number of activated carbon ion-exchange fibers of the Co(OH)2 activated carbon composite electrode material, and realizes the electrodeposition preparation of the Co(OH)2 activated carbon composite electrode material according to the combination of elements, which specifically includes: 1) the load performance and output voltammetry characteristics of the prepared Co(OH)2 activated carbon composite electrode material were quantitatively analyzed, and the optimal control objective function of electrodeposition preparation was obtained as follows:

$$\begin{aligned} f_0(X) = {} & w_p P_t(X) + w_v V_t(X) + w_c C(X) \\ & + \frac{1}{\varepsilon}\{f_{u1}(1 - T_{em}/T_{em}^{*}) \\ & + f_{u2}(1 - \omega_r^{max}/\omega_r^{*}) + f_{u3}(B_{xy}/B_{xy}^{max} - 1))\}, \end{aligned}$$

ε is a small constant to control the output current and voltage of the Co(OH)2 activated carbon composite electrode material. $G_{m(s)}$ and $e^{-t_m s}$ represent the output power gain and time delay of the Co(OH)2 activated carbon composite electrode material, the measurement error $f_u(\chi)$ is defined as:

$$f_{u1}(\chi) = \frac{1}{1+e^{-\sigma\chi}};$$

σ is a large constant;

2) Through the control design of the preparation process of the composite electrode material, assuming x(t), t=0,1,...,n-1 is the sampling training sequence of the control system, the error feedback compensation control output state equation is obtained:

$$\begin{cases} C\dfrac{dV}{dt} = g_{Na}m^3h(E_{Na}-V)+g_Kn^4(E_K-V)+g_L(E_L-V)+I_{ion} \\ m = m_\infty = \alpha_m(V)/(\alpha_m(V)+\beta_m(V)) \\ \dfrac{dn}{dt} = \alpha_n(V)(1-n)-\beta_n(V)n \\ h = \max(1-1.25n,0) \end{cases};$$

in the above formula, w is the inertia weight of the output delay adjustment of the Co(OH)2 activated carbon composite electrode material, c1 and c2 are the acceleration constants, and the convergence state characteristic quantity of the preparation process control is obtained:

$$\begin{aligned} \min_{\beta}\left\|\mathbf{Y}(l)-\mathbf{X}(l)\boldsymbol{\beta}\right\| &= \min_{\beta}\left\|\begin{bmatrix} \mathbf{U}_{l1}^{T}\mathbf{Y}_{l1}-\boldsymbol{\Sigma}_{l1}\mathbf{V}_{l1}^{T}\boldsymbol{\beta} \\ \mathbf{U}_{l2}^{T}\mathbf{Y}_{l2}-\boldsymbol{\Sigma}_{l2}\mathbf{V}_{l2}^{T}\boldsymbol{\beta} \\ \vdots \\ \mathbf{U}_{\psi(l)}^{T}\mathbf{Y}_{\psi(l)}-\boldsymbol{\Sigma}_{\psi(l)}\mathbf{V}_{\psi(l)}^{T}\boldsymbol{\beta} \end{bmatrix}\right\| \\ &= \min_{\beta}\left\|\mathbf{Y}(l+1)-\mathbf{X}(l+1)\boldsymbol{\beta}\right\| \end{aligned}.$$

Another purpose of the invention is to provide battery prepared by using the Co(OH)2 activated carbon composite electrode material based on electrodeposition technology.

Another purpose of the invention is to provide green and environmentally friendly motor vehicle equipped with the battery.

To sum up, this invention provides the beneficial effects as followings:

The preparation method of the Co(OH)2 activated carbon composite electrode material based on the electrodeposition technology provided by the invention can effectively realize the preparation of the Co(OH)2 activated carbon composite electrode material, and the control performance of preparing the Co(OH)2 activated carbon composite electrode material is better, and the desalting efficiency of the electrode

material is higher. The invention realizes the optimization design of the Co(OH)2 activated carbon composite electrode material by constructing an electrochemical regulation target model of the Co(OH)2 activated carbon composite electrode material; The fuzzy parameter distribution of Co(OH)2 activated carbon electrode material preparation was obtained by feedback tracking adjustment method, and the electrodeposition amount of Co(OH)2 activated carbon composite electrode material was obtained, so as to optimize the preparation process. CN112502148

The invention can control the stability of electrochemical regulation and process in the preparation of the Co(OH)2 activated carbon composite electrode material, so as to improve the stability of the preparation process; the X-ray photoelectron spectroscopy analysis can introduce metal oxides into the electrode surface to improve the preparation efficiency.

Brief Description Of The Figures

Fig. 1 is a flow chart of the preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology provided by the embodiment of the present invention.

Fig. 2 is a SEM picture of composite electrode materials with different diffraction peak spectra provided by the embodiment of the present invention.

Fig. 3 is a schematic diagram of cyclic voltammetry performance of Co(OH)2 activated carbon composite electrode provided by the embodiment of the present invention.

Description of the present invention

In order to make the purpose, technical scheme and advantages of the present invention more clear, the present invention will be further explained in detail with examples below. It should be understood that the specific embodiments described here are only for explaining the present invention, but not for limiting the present invention.

Due to the problems that the preparation method based on Al_2O_3/ACF composite electrode has poor deionization by electro-adsorption, and that the control ability of the

prior art preparation process based on voltage self-balancing is weak, this invention CN502148 provides the technical solution that described as followings:

As Figure 1 shown, this invention provides the preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology is characterized in comprising the following steps:

S101, carrying out X-ray photoelectron spectrum analysis of the Co(OH)2 activated carbon composite electrode material by adopting an electro-adsorption performance test and analysis method;

S102, introducing metal oxide into the surface of the electrode, testing the electro-adsorption property of Co(OH)2 activated carbon electrode material by impregnation calcination method, and analyzing the cyclic voltammetry performance of the electrode;

S103, the area enclosed by the volt-ampere curve is integrated to obtain the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material;

S104, calculating the number of activated carbon ion exchange fibers of the Co(OH)2 activated carbon composite electrode material measured by conductivity, and realizing the electrodeposition preparation of the Co(OH)2 activated carbon composite electrode material according to the combination of various elements.

In S101, the electric adsorption performance test and analysis method specifically comprises the following steps: the metal oxide is introduced into the electrode surface, and the disturbance error in the preparation of Co(OH)2 activated carbon composite electrode material is expressed in the form of multiple inputs and single outputs, the electrochemical regulation error term E of Co(OH)2 activated carbon composite electrode material satisfies Gauss-Markov hypothesis by using single-point fuzzification, and the nonlinear dynamic control driving matrix for the preparation of Co(OH)2 activated carbon composite electrode material is as follows: $Y=X\beta+e$; wherein, Y is the conduction vector of n×1 activated carbon fibers adhering to graphite, X is the nonlinear function vector matrix of n×m electrolyte, β is the m×1 activated carbon fiber parameter vector, and e is n×1 random error vector.

In S102, the electrosorption test of Co(OH)2 activated carbon electrode material by impregnation calcination method specifically includes: the metal oxide is introduced into the surface of the electrode, and the cyclic voltammetry curve is analyzed by the immersion calcination method. If < m, the approximate accuracy Σ of the X-ray test of the composite electrode material is expressed as:

$$\Sigma = \begin{bmatrix} \Sigma_1 & 0 \\ 0 & 0 \end{bmatrix};$$

the linear error prediction of the electrode material is carried out in the NaCl solution with the electrolyte of 0.5mol·L^{-1}, the prediction error function is $\Sigma_1=\mathrm{diag}(\delta_i)$, i=1,2,…,r, a three-electrode system is used for steady-state regulation, and the covariance matrix decomposition method is used to decompose U and V into what shown as below: U=[U1 U2] , V=[V1 V2]; both U1 and V1 are r columns.

In S102, the cyclic voltammetry performance analysis methods of electrodes include: (1) The output volt-ampere characteristic curve prepared by the Co(OH)2 activated carbon composite electrode material was constructed, and the three-phase steady-state regulation model of the battery anode was established, and the electrode torque was calculated as:

$$T_{em} = \frac{\pi k_i k_s k_\beta B l_g U_s (2r_s + 2l_g + l_m) N_{sm}}{\ln\left(\frac{r_s + l_g + l_m}{r_s - l_m}\right)};$$

$$k_i = 1 - \frac{1}{0.9[r_s / (\beta p(l_g + l_m))]^2 + 1};$$

$$k_\beta = \frac{\alpha(\beta, k_c)}{k_c};$$

wherein, α is the instantaneous span of the state vector, and the output stability analysis of the Co(OH)2 activated carbon composite electrode material is carried out. The output of the oxide fuel cell anode satisfies $\sum_{i=1}^{m} p(a_i) = 1$, and the adjustment step size of the adaptive backstepping tracking is: $\alpha = \min(\beta, k_c)\,[k_s + (1-k_s)\tanh(\delta|\beta - k_c|)]$; wherein, ks<1, δ is the empirical value; (2) Calculate the stretching factors of the process adaptation law of the preparation of Co(OH) 2 activated carbon composite electrode materials, L_{lp} , L_{ls}

and Llm , the state variables Cp and Cs of the process control, and control the volt-ampere characteristics according to the frequency adjustment criterion, in order to obtain the operating frequency of the system:

$$\omega L_{lp} - \frac{1}{\omega C_p} = 0 \Rightarrow C_p = \frac{1}{\omega^2 L_{lp}};$$

$$\omega L_{ls} - \frac{1}{\omega C_s} = 0 \Rightarrow C_s = \frac{1}{\omega^2 L_{ls}};$$

Let Y1, Y2, ..., YN be a set of samples of Y, and the output voltammetric characteristic coefficient prepared by the Co(OH)2 activated carbon composite electrode material is set to be expressed as:

$$T_{em} = \frac{\pi k_f k_c k_i k_\beta B_r l_m l_s l_w (2r_r + 2l_g + l_w) J_{cu}}{\ln\left(\frac{r_r + l_g + l_w}{r_r - l_m}\right)} - \left(\frac{P_e + P_h}{\omega_r}\right)$$

In S103, integrate the area enclosed by the voltammetry curve to obtain the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material, which includes:integrate the area enclosed by the volt-ampere curve to obtain the control torque of electrodeposition as: $T_{out}=T_{em}-(P_w+P_b)/\omega_r$; based on the electrodeposition technology, the error compensation is carried out, and the feedback tracking adjustment method is used to obtain the fuzzy parameter distribution of the Co(OH)2 activated carbon electrode material preparation, and the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material is obtained.

In S104, the calculated electrical conductivity measures the number of activated carbon ion-exchange fibers of the Co(OH)2 activated carbon composite electrode material, and realizes the electrodeposition preparation of the Co(OH)2 activated carbon composite electrode material according to the combination of elements, which specifically includes: (1) the load performance and output voltammetry characteristics of the prepared Co(OH)2 activated carbon composite electrode material were quantitatively

analyzed, and the optimal control objective function of electrodeposition preparation was 15J502148 obtained as follows:

$$f_u(X) = w_p P_i(X) + w_v V_i(X) + w_c C(X) + \frac{1}{\varepsilon}\{f_u(1 - T_{co}/T_{co}^*) + f_u(1 - \omega_c^{max}/\omega_c^*) + f_u(B_{co}/B_{co}^{bmax} - 1)\};$$

ε is a small constant to control the output current and voltage of the Co(OH)2 activated carbon composite electrode material. $G_{m(s)}$ and $e^{-t_m s}$ represent the output power gain and time delay of the Co(OH)2 activated carbon composite electrode material, the measurement error $f_u(\chi)$ is defined as:

$$f_u(\chi) = \frac{1}{1 + e^{-\sigma\chi}}$$; wherein σ is a large constant;

(2) Through the control design of the preparation process of the composite electrode material, assuming x(t), t=0,1,...,n-1 is the sampling training sequence of the control system, the error feedback compensation control output state equation is obtained:

$$\begin{cases} C\dfrac{dV}{dt} = g_{Na} m^3 h(E_{Na} - V) + g_K n^4 (E_K - V) + g_L (E_L - V) + I_{ion} \\ m = m_\infty = \alpha_m(V)/(\alpha_m(V) + \beta_m(V)) \\ \dfrac{dn}{dt} = \alpha_n(V)(1 - n) - \beta_n(V)n \\ h = \max(1 - 1.25n, 0) \end{cases}$$;

in the above formula, w is the inertia weight of the output delay adjustment of the Co(OH)2 activated carbon composite electrode material, c1 and c2 are the acceleration constants, and the convergence state characteristic quantity of the preparation process control is obtained:

$$\min_{\beta}\left\|\mathbf{Y}(i)-\mathbf{X}(i)\boldsymbol{\beta}\right\| = \min_{\beta}\left\|\begin{bmatrix} \mathbf{U}_{i1}^{T}\mathbf{Y}_{i1}-\boldsymbol{\Sigma}_{i1}\mathbf{V}_{i1}^{T}\boldsymbol{\beta} \\ \mathbf{U}_{i2}^{T}\mathbf{Y}_{i2}-\boldsymbol{\Sigma}_{i2}\mathbf{V}_{i2}^{T}\boldsymbol{\beta} \\ \vdots \\ \mathbf{U}_{\varphi(i)}^{T}\mathbf{Y}_{\varphi(i)}-\boldsymbol{\Sigma}_{\varphi(i)}\mathbf{V}_{\varphi(i)}^{T}\boldsymbol{\beta} \end{bmatrix}\right\| = \min_{\beta}\left\|\mathbf{Y}(i+1)-\mathbf{X}(i+1)\boldsymbol{\beta}\right\|$$

The application principle of the present invention will be further described with reference to specific examples below.

Embodiment:

1. In the present invention, parameter optimization control and constraint parameter analysis for the preparation of composite electrode materials include:

(1) Parameter optimization control for the preparation of composite electrode materials

In order to realize the electrochemical regulation and process stability control in the preparation of Co(OH)2 activated carbon composite electrode material, the load balance control model of Co(OH)2 activated carbon composite electrode material was firstly constructed, and the quality of the electrode was evaluated by the control parametric analysis method. The specific capacitance test, the independent variable analysis of the dependent variable in the preparation of Co(OH)2 activated carbon composite electrode material is carried out through the orthogonal design experiment, the n groups of observations are obtained as:

$$(x_{i1},x_{i2},\cdots x_{i,m-1},y_i),i=1,2,\cdots,n \qquad (1)$$

Calculate the conductivity test vector set of activated carbon fibers to satisfy:

$$\begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix} = \begin{pmatrix} 1 & x_{11} & \cdots & x_{1,m-1} \\ 1 & x_{21} & \cdots & x_{2,m-1} \\ \vdots & \vdots & & \vdots \\ 1 & x_{n1} & \cdots & x_{n,m-1} \end{pmatrix} \begin{pmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_{m-1} \end{pmatrix} + \begin{pmatrix} e_1 \\ e_2 \\ \vdots \\ e_n \end{pmatrix} \qquad (2)$$

The metal oxide is introduced into the electrode surface, and the disturbance error in the preparation of Co(OH)2 activated carbon composite electrode material is expressed in the form of multiple inputs and single outputs, the electrochemical regulation error term E of Co(OH)2 activated carbon composite electrode material satisfies Gauss-Markov hypothesis by using single-point fuzzification, and the nonlinear dynamic control driving matrix for the preparation of Co(OH)2 activated carbon composite electrode material is as follows: $Y=X\beta+e$ (3).

Wherein, Y is the conduction vector of n×1 activated carbon fibers adhering to graphite, X is the nonlinear function vector matrix of n×m electrolyte, β is the m×1 activated carbon fiber parameter vector, and e is n×1 random error vector. The metal oxide is introduced into the surface of the electrode, and the cyclic voltammetry curve is analyzed by the immersion calcination method. If < m, the approximate accuracy Σ of the X-ray test of the composite electrode material is expressed as:

$$\Sigma=\begin{bmatrix}\Sigma_1 & 0\\ 0 & 0\end{bmatrix} \quad (4)$$

The linear error prediction of the electrode material is carried out in the NaCl solution with the electrolyte of $0.5mol\cdot L^{-1}$, the prediction error function is $\Sigma_1=diag(\delta_i)$, i=1,2,…,r, a three-electrode system is used for steady-state regulation, and the covariance matrix decomposition method is used to decompose U and V into what shown as below:

$$U=[U1\ U2]\ ,\ V=[V1\ V2] \quad (5);$$

Wherein, both U1 and V1 are r columns.

Using the transmission principle of electrochemical work, the system conduction model of the parameter optimization control of the composite electrode material preparation satisfies:

$$\begin{aligned}\min_{\beta}\|Y-X\beta\| &= \min_{\beta}\left\|U^TY-\Sigma V^T\beta\right\|\\ &= \min_{\beta}\left\|\begin{bmatrix}U_1^T\\ U_2^T\end{bmatrix}Y-\begin{bmatrix}\Sigma_1 & 0\\ 0 & 0\end{bmatrix}\begin{bmatrix}V_1^T\\ V_2^T\end{bmatrix}\beta\right\|\\ &= \min_{\beta}\left\|\begin{bmatrix}U_1^TY-\Sigma_1V_1^T\beta\\ U_2^TY\end{bmatrix}\right\|\\ &= \min_{\beta}\left\{\left\|U_1^TY-\Sigma_1V_1^T\beta\right\|+C\right\}\end{aligned} \quad (6)$$

In the above formula, C has nothing to do with β, and the change of ions is measured by the conductivity, and the steady-state control of the preparation of the composite electrode material is carried out, and the stability of the preparation process is improved.

(2) Analysis of the control constraint parameters of the preparation process

Apply a voltage of 1.6V to the device, and use a flowmeter to control the electrochemical output characteristic quantity in the preparation of the Co(OH)2 activated carbon composite electrode material. Under the action of the sensor, considering the transmission characteristic quantity of the electrosorption module, the Co(OH) 2 The control and constraint parameters for the preparation of activated carbon composite electrode materials are nonlinearly decomposed, namely:

$$\min_{\beta}\left\|\mathbf{Y}-\mathbf{X}\boldsymbol{\beta}\right\|=\min_{\beta}\left\|\mathbf{U}_1^{T}\mathbf{Y}-\boldsymbol{\Sigma}_1\mathbf{V}_1^{T}\boldsymbol{\beta}\right\| \quad (7)$$

The least squares solution for the electrochemical regulation of the Co(OH)2 activated carbon composite electrode material was obtained by the least squares fitting method as follows:

$$\hat{\beta}=V_1\Sigma_1^{-1}U_1^{T}Y \quad (8)$$

Wherein, $u_i(t)$ and $\varphi_i(t)$ are the characteristic quantities of the activated carbon fibers prepared by the Co(OH)2 activated carbon composite electrode material after loading Al_2O_3, respectively. The slow-varying function is constructed, and the output conduction model of the initial conductivity is:

$$\tilde{s}_i(t)=u_i(t)\exp[j(2\pi f_0 t+\varphi_i(t))]\ (i=1,2,\cdots,d) \quad (9)$$

Use 1 pair of activated carbon fiber electrodes for steady-state adjustment, combined with the adaptive beamforming method, the conductivity of the solution was measured, and the optimized parameter control output obtained under the limited initial state was:

$$v(t,\theta)=\sum_{m=1}^{M}\omega_i^{*}(\theta)x_i(t)=\sum_{m=1}^{M}x_i^{*}(t)\omega_i(\theta) \quad (10)$$

In the formula, "*" represents the complex conjugate operator, and the change of ions is measured by the conductivity, and the conduction equation controlled by the flowmeter is expressed as:

$$\min_{\beta}\left\|\mathbf{Y}(i)-\mathbf{X}(i)\boldsymbol{\beta}\right\|=\min_{\beta}\left\|\begin{bmatrix}\mathbf{Y}_{i1}\\ \mathbf{Y}_{i2}\\ \vdots\\ \mathbf{Y}_{ip(i)}\end{bmatrix}-\begin{bmatrix}\mathbf{X}_{i1}\\ \mathbf{X}_{i2}\\ \vdots\\ \mathbf{X}_{ip(i)}\end{bmatrix}\boldsymbol{\beta}\right\| \tag{11}$$

To establish the DC voltage and power transmission, perform singular value decomposition on the DC bipolar short-circuit characteristic distribution matrix Xij:

$$X_{ij}=U_{ij}\Sigma\ V^{T}_{ij\ ij} \tag{12}$$

Since the shunt reactors are scattered in the line, there is no obvious impact, so the tracking error integral term is added to the rear end, which are respectively recorded as Σ 'ij , U 'ij , U″ij , V 'ij and V″ij , the object parameters of the unlocked output of the converter prepared by the Co(OH)2 activated carbon composite electrode material are:

$$\mathbf{Y}(i+1)=\begin{bmatrix}\mathbf{U}_{i1}^{'T}\mathbf{Y}_{i1}\\ \mathbf{U}_{i2}^{'T}\mathbf{Y}_{i2}\\ \vdots\\ \mathbf{U}_{ip(i)}^{'T}\mathbf{Y}_{ip(i)}\end{bmatrix} \tag{13}$$

$$\mathbf{X}(i+1)=\begin{bmatrix}\boldsymbol{\Sigma}_{i1}^{'}\mathbf{V}_{i1}^{'T}\\ \boldsymbol{\Sigma}_{i2}^{'}\mathbf{V}_{i2}^{'T}\\ \vdots\\ \boldsymbol{\Sigma}_{ip(i)}^{'}\mathbf{V}_{ip(i)}^{'T}\end{bmatrix} \tag{14}$$

Through the above analysis, the small resistance characteristics of Co(OH)2 activated carbon composite electrode materials are solved, and the expression is:

$$\min_{\beta}\left\|\mathbf{Y}(i)-\mathbf{X}(i)\boldsymbol{\beta}\right\|=\min_{\beta}\left\|\mathbf{Y}(i+1)-\mathbf{X}(i+1)\boldsymbol{\beta}\right\| \tag{15}$$

$$\min_{\beta}\left\|\mathbf{Y}(i)-\mathbf{X}(i)\beta\right\|=\min_{\beta}\left\|\begin{bmatrix}\mathbf{Y}_{i1}\\ \mathbf{Y}_{i2}\\ \vdots\\ \mathbf{Y}_{ip(i)}\end{bmatrix}-\begin{bmatrix}\mathbf{U}_{i1}\boldsymbol{\Sigma}_{i1}\mathbf{V}_{i1}\\ \mathbf{U}_{i2}\boldsymbol{\Sigma}_{i2}\mathbf{V}_{i2}\\ \vdots\\ \mathbf{U}_{ip(i)}\boldsymbol{\Sigma}_{ip(i)}\mathbf{V}_{ip(i)}\end{bmatrix}\beta\right\| \quad (16)$$

Denote U(i)=diag(Uij) , j=1 ,2 ,... ,p(i) , the stability matrix U(i) of the preparation process control is still an orthogonal matrix, the X-ray photoelectron spectroscopy analysis of the Co(OH)2 activated carbon composite electrode material was carried out by using the electrosorption performance test and analysis method, and metal oxides were introduced into the electrode surface to improve the preparation efficiency.

2. The process control optimization of electrode material preparation includes:

(1) Analysis of the cyclic voltammetry performance of the electrode:

The preparation control of the Co(OH)2 activated carbon composite electrode material is based on the analysis of the control object and constraint parameters, combined with the fuzzy control strategy, the optimal design of the control law is carried out, and the output of the preparation of the Co(OH)2 activated carbon composite electrode material is constructed. volt-ampere characteristic curve, the three-phase steady-state regulation model of the battery anode is established, and the electrode torque is calculated as:

$$T_{\omega m}=\frac{\pi k_f k_c k_1 k_\beta B_r l_m l_s l_w (2r_r+2l_g+l_w)J_{\omega m}}{\ln\left(\frac{r_r+l_g+l_w}{r_r-l_w}\right)} \quad (17)$$

$$k_1=1-\frac{1}{0.9[r_r/(\beta p(l_g+l_w))]^2+1} \quad (18)$$

$$k_\beta=\frac{\alpha(\beta,k_c)}{k_c} \quad (19)$$

Wherein, α is the instantaneous span of the state vector, and the output stability analysis of the Co(OH)2 activated carbon composite electrode material is carried out.

When the output of the oxide fuel cell anode satisfies $\sum_{i=1}^{\infty} p(a_i) = 1$, the adjustment step size of the adaptive backstepping tracking is: LU502148

$$\alpha = \min(\beta, k_c)\,[k_s + (1-k_s)\tanh(\delta|\beta - k_c|)] \qquad (20)$$

Among them, ks<1, δ is the empirical value. Then, the stretching factors L_{lp}, L_{ls} and L_m of the process adaptation law for the preparation of Co(OH)2 activated carbon composite electrode materials are calculated, the state variables C_p and C_s of the process control, the volt-ampere characteristics are controlled according to the frequency regulation criterion, and the operating frequency of the system is obtained:

$$\omega L_{lp} - \frac{1}{\omega C_p} = 0 \Rightarrow C_p = \frac{1}{\omega^2 L_{lp}} \qquad (21)$$

$$\omega L_{ls} - \frac{1}{\omega C_s} = 0 \Rightarrow C_s = \frac{1}{\omega^2 L_{ls}} \qquad (22)$$

Let Y1, Y2, ..., Y_N be a set of samples of Y, and the output voltammetry characteristic coefficient prepared by the Co(OH)2 activated carbon composite electrode material is set to be expressed as:

$$T_{em} = \frac{\pi k_f k_c k_1 k_\beta B_r l_m l_s l_w (2r_r + 2l_g + l_w) J_{ca}}{\ln\left(\frac{r_r + l_g + l_w}{r_r - l_m}\right)} - \left(\frac{P_e + P_h}{\omega_r}\right) \qquad (23)$$

The electrosorption test of Co(OH)2 activated carbon electrode material was realized by the impregnation calcination method, the cyclic voltammetry performance of the electrode was analyzed, and the area enclosed by the voltammetry curve was integrated and calculated, and the control torque of electrodeposition was obtained as follows:

$$T_{out} = T_{em} - (P_e + P_h)/\omega_r \qquad (24)$$

At this time, based on the electrodeposition technology for error compensation, the feedback tracking adjustment method is used to obtain the fuzzy parameter distribution of the Co(OH)2 activated carbon electrode material preparation, and the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material is obtained, and the preparation is carried out. Optimal control of the process.

(2) Optimal control of electrodeposition preparation of Co(OH)2 activated carbon composite electrode materials:

The load performance and output voltammetry characteristics of the prepared Co(OH)2 activated carbon composite electrode material were quantitatively analyzed, and the optimal control objective function of electrodeposition preparation was defined as:

$$\begin{aligned} f_0(\mathrm{X}) &= w_p P_i(\mathrm{X}) + w_v V_i(\mathrm{X}) + w_c C(\mathrm{X}) \\ &+ \frac{1}{\varepsilon}[f_u(1 - T_{om}/T_{om}^*) \\ &+ f_u(1 - \omega_r^{max}/\omega_r^*) + f_u(B_{sy}/B_{sy}^{bmax} - 1)] \end{aligned} \tag{25}$$

Wherein, ε is a small constant, which is used to control the output current and voltage of the Co(OH)2 activated carbon composite electrode material. Gm(s) and $e^{-\tau_{ik}s}$ represent the output power gain and time of the Co(OH)2 activated carbon composite electrode material. hysteresis, the measurement error fu(χ) is defined as:

$$f_u(\chi) = \frac{1}{1 + e^{-\sigma\chi}} \tag{26}$$

wherein σ is a large constant. Through the control design of the preparation process of the composite electrode material, assuming x(t), t=0, 1, ⋯, n-1 is the sampling training sequence of the control system, the error feedback compensation control output state equation is obtained:

$$\begin{cases} C\dfrac{dV}{dt} = g_{Na} m^3 h(E_{Na} - V) + g_K n^4 (E_K - V) + g_L (E_L - V) + I_{out} \\ m = m_\infty = \alpha_m(V)/(\alpha_m(V) + \beta_m(V)) \\ \dfrac{dn}{dt} = \alpha_n(V)(1-n) - \beta_n(V)n \\ h = \max(1 - 1.25n, 0) \end{cases} \tag{27}$$

In the above formula, w is the inertia weight of the output delay adjustment of the Co(OH)2 activated carbon composite electrode material, c_1 and c_2 are the acceleration constants, and the convergence state characteristic quantity of the preparation process control is obtained:

$$\min_{\beta}\left\|\mathbf{Y}(i)-\mathbf{X}(i)\boldsymbol{\beta}\right\|=\min_{\beta}\left\|\begin{bmatrix}\mathbf{U}_{i1}^{'T}\mathbf{Y}_{i1}-\boldsymbol{\Sigma}_{i1}^{'}\mathbf{V}_{i1}^{'T}\boldsymbol{\beta}\\ \mathbf{U}_{i2}^{'T}\mathbf{Y}_{i2}-\boldsymbol{\Sigma}_{i2}^{'}\mathbf{V}_{i2}^{'T}\boldsymbol{\beta}\\ \vdots\\ \mathbf{U}_{ip(i)}^{'T}\mathbf{Y}_{ip(i)}-\boldsymbol{\Sigma}_{ip(i)}^{'}\mathbf{V}_{ip(i)}^{'T}\boldsymbol{\beta}\end{bmatrix}\right\| \tag{28}$$
$$=\min_{\beta}\left\|\mathbf{Y}(i+1)-\mathbf{X}(i+1)\boldsymbol{\beta}\right\|$$

Through the above treatment, the target model of electrochemical regulation of Co(OH)2 activated carbon composite electrode material is realized, and the preparation and optimization design of Co(OH)2 activated carbon composite electrode material are realized.

3. Performance test analysis includes:

In order to test the superior performance of the preparation method provided by the invention in the preparation of the realized Co(OH)2 activated carbon composite electrode material, the experimental performance test and analysis were carried out. 25μS·cm^{-1}, the distance between Co(OH)2 activated carbon composite electrodes is 3mm, the conductivity of the solution is measured every 5min, take 12 ml of simulated NaCl solution with a concentration of 250 mg·L^{-1} to analyze the electrochemical properties of the composite electrode material, and analyze the SEM images of the composite electrode material under different diffraction peak spectra, as shown in Fig. 2. By analyzing the spectrum of the composite electrode material shown in Fig. 2, it is shown that the preparation method provided by the present invention is used to prepare the output of the Co(OH)2 activated carbon composite electrode material, and the cyclic

voltammetry performance of the electrode is tested and the test results obtained are LU502148
shown in Fig. 3.

Analysis of Fig. 3 shows that the output frequency range of the cyclic voltammetry characteristics of the Co(OH)2 activated carbon composite electrode is 100 to 1200 Hz, and the low-pass filtering performance is good. The salt removal efficiency of the electrode materials of different preparation methods is tested, and the comparison results are obtained as table 1 shown.

Analysis of Table 1 shows that the preparation method provided by the present invention has better control performance for the preparation of Co(OH)2 activated carbon composite electrode material, and the electrode material has higher desalination efficiency.

Table 1 Comparison of salt removal efficiency of electrode materials

Iterative steps	Preparation method of this invention	Al2O3/ACF composite electrode method by Li Tingting et al.	Self-balancing method base on voltage by Liu Zhuang et al.
100	6. 455	2. 345	1. 236
300	8. 545	4. 245	3. 235
500	13. 456	6. 323	6. 543
700	20. 321	8. 323	8. 765

The invention will be further described below in combination with the effects. According to the invention, the preparation technology of the Co(OH)2 activated carbon composite electrode material is optimized, so that the output stability and electromagnetic coupling of the Co(OH)2 activated carbon composite electrode material are improved.

The invention provides a preparation method of the Co(OH) 2 activated carbon composite LU502148 electrode material based on electrodeposition technology, and adopts an electro-adsorption performance test and analysis method to perform X-ray photoelectron spectroscopy analysis of the Co(OH)2 activated carbon composite electrode material. The metal oxide was introduced into the surface of the electrode, and the electro-adsorption of Co(OH)2 activated carbon electrode material was tested by impregnation calcination method. The cyclic voltammetric performance of the electrode was analyzed, and the area enclosed by the volt-ampere curve was integrated to obtain the electro-deposition amount of Co(OH)2 activated carbon composite electrode material. The number of activated carbon ion exchange fibers in the Co(OH)2 activated carbon composite electrode material is calculated by conductivity measurement, and the electrodeposition preparation of Co(OH)2 activated carbon composite electrode material can be realized according to the combination of various elements. The load performance and output volt-ampere characteristics of the prepared Co(OH)2 activated carbon composite electrode material were quantitatively analyzed, and the electrochemical performance of the composite electrode material was analyzed. The results show that the preparation method provided by the invention can effectively realize the preparation of Co(OH)2 activated carbon composite electrode materials.

The above is only a preferred embodiment of the present invention, and it is not intended to limit the present invention. Any modifications, equivalent substitutions and improvements made within the spirit and principle of the present invention should be included in the scope of protection of the present invention.

Claims LU502148

1. The preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology is characterized in comprising the following steps:

Step 1, carrying out X-ray photoelectron spectrum analysis of the Co(OH)2 activated carbon composite electrode material by adopting an electro-adsorption performance test and analysis method;

Step 2, introducing metal oxide into the surface of the electrode, testing the electro-adsorption property of Co(OH)2 activated carbon electrode material by impregnation calcination method, and analyzing the cyclic voltammetry performance of the electrode;

Step 3, the area enclosed by the volt-ampere curve is integrated to obtain the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material;

Step 4, calculating the number of activated carbon ion exchange fibers of the Co(OH)2 activated carbon composite electrode material measured by conductivity, and realizing the electrodeposition preparation of the Co(OH)2 activated carbon composite electrode material according to the combination of various elements.

2. The preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology is characterized in that the load performance and output volt-ampere characteristics of the prepared Co(OH)2 activated carbon composite electrode material were quantitatively analyzed.

3. The preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology is characterized in that in step 1, the electric adsorption performance test and analysis method specifically comprises the following steps: the metal oxide is introduced into the electrode surface, and the disturbance error in the preparation of Co(OH)2 activated carbon composite electrode material is expressed in the form of multiple inputs and single outputs, the electrochemical regulation error term E of Co(OH)2 activated carbon composite electrode

material satisfies Gauss-Markov hypothesis by using single-point fuzzification, and the nonlinear dynamic control driving matrix for the preparation of Co(OH)2 activated carbon composite electrode material is as follows: $Y=X\beta+e$; wherein, Y is the conduction vector of n×1 activated carbon fibers adhering to graphite, X is the nonlinear function vector matrix of n×m electrolyte, β is the m×1 activated carbon fiber parameter vector, and e is n×1 random error vector.

4. The preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology is characterized in that in step 2, the electrosorption test of Co(OH)2 activated carbon electrode material by impregnation calcination method specifically includes: the metal oxide is introduced into the surface of the electrode, and the cyclic voltammetry curve is analyzed by the immersion calcination method, if < m, the approximate accuracy Σ of the X-ray test of the composite electrode material is expressed as:

$$\Sigma=\begin{bmatrix}\Sigma_1 & 0\\ 0 & 0\end{bmatrix};$$

the linear error prediction of the electrode material is carried out in the NaCl solution with the electrolyte of $0.5mol\cdot L^{-1}$, the prediction error function is $\Sigma_1=diag(\delta_i)$, i=1,2,…,r, a three-electrode system is used for steady-state regulation, and the covariance matrix decomposition method is used to decompose U and V into what shown as below:

U=[U1 U2] , V=[V1 V2]; both U1 and V1 are r columns.

5. The preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology is characterized in that in step 2, the cyclic voltammetry performance analysis methods of electrodes include: (1) the output volt-ampere characteristic curve prepared by the Co(OH)2 activated carbon composite electrode material was constructed, and the three-phase steady-state regulation model of the battery anode was established, and the electrode torque was calculated as:

$$T_{em}=\frac{\pi k_f k_c k_i k_\beta B_r l_m l_t l_w (2r_r+2l_g+l_w) J_{cu}}{\ln(\frac{r_r+l_g+l_w}{r_r-l_m})};$$

$$k_i=1-\frac{1}{0.9[r_r/(\beta p(l_g+l_w))]^2+1};$$

$$k_\beta=\frac{\alpha(\beta,k_c)}{k_c};$$

wherein, α is the instantaneous span of the state vector, and the output stability analysis of the Co(OH)2 activated carbon composite electrode material is carried out. the output of the oxide fuel cell anode satisfies $\sum_{i=1}^{m} p(a_i)=1$, and the adjustment step size of the adaptive backstepping tracking is: $\alpha=\min(\beta,kc)[ks+(1-ks)\tanh(\delta|\beta-kc|)]$; wherein, ks<1, δ is the empirical value; (2) Calculate the stretching factors of the process adaptation law of the preparation of Co(OH) 2 activated carbon composite electrode materials, L_{lp}, L_{ls} and L_{lm}, the state variables C_p and C_s of the process control, and control the volt-ampere characteristics according to the frequency adjustment criterion, in order to obtain the operating frequency of the system:

$$\omega L_{lp}-\frac{1}{\omega C_p}=0\Rightarrow C_p=\frac{1}{\omega^2 L_{lp}};$$

$$\omega L_{ls}-\frac{1}{\omega C_s}=0\Rightarrow C_s=\frac{1}{\omega^2 L_{ls}};$$

Let Y1, Y2, ..., YN be a set of samples of Y, and the output voltammetric characteristic coefficient prepared by the Co(OH)2 activated carbon composite electrode material is set to be expressed as:

$$T_{em}=\frac{\pi k_f k_c k_i k_\beta B_r l_m l_t l_w (2r_r+2l_g+l_w) J_{cu}}{\ln(\frac{r_r+l_g+l_w}{r_r-l_m})}-(\frac{P_c+P_h}{\omega_r})$$

6. The preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology is characterized in that in step 3, integrate the area enclosed by the voltammetry curve to obtain the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material, which includes: integrate the area enclosed by the volt-ampere curve to obtain the control torque of electrodeposition as: $T_{out}=T_{em}-(P_W+P_b)/\omega_r$, based on the electrodeposition technology, the error compensation is carried out, and the feedback tracking adjustment method is used to obtain the fuzzy parameter distribution of the Co(OH)2 activated carbon electrode material preparation, and the electrodeposition amount of the Co(OH)2 activated carbon composite electrode material is obtained.

7. The preparation method of Co(OH)2 activated carbon composite electrode material based on electrodeposition technology is characterized in that in step 4, the calculated electrical conductivity measures the number of activated carbon ion-exchange fibers of the Co(OH)2 activated carbon composite electrode material, and realizes the electrodeposition preparation of the Co(OH)2 activated carbon composite electrode material according to the combination of elements, which specifically includes: 1) the load performance and output voltammetry characteristics of the prepared Co(OH)2 activated carbon composite electrode material were quantitatively analyzed, and the optimal control objective function of electrodeposition preparation was obtained as follows:

$$\begin{aligned} f_g(X) = {} & w_p P_i(X) + w_v V_i(X) + w_c C(X) \\ & + \frac{1}{\varepsilon}[f_u(1 - T_{em}/T_{em}^*) \\ & + f_u(1 - \omega_r^{max}/\omega_r^*) + f_u(B_{av}/B_{av}^{max} - 1)]; \end{aligned}$$

ε is a small constant to control the output current and voltage of the Co(OH)2 activated carbon composite electrode material. $G_{m(s)}$ and $e^{-t_m s}$ represent the output power gain and time delay of the Co(OH)2 activated carbon composite electrode material, the measurement error $f_u(\chi)$ is defined as:

$$f_u(\chi) = \frac{1}{1+e^{-\alpha z}};$$

σ is a large constant; LU502148

2) through the control design of the preparation process of the composite electrode material, assuming x(t), t=0,1,...,n-1 is the sampling training sequence of the control system, the error feedback compensation control output state equation is obtained:

$$\begin{cases} C\dfrac{dV}{dt} = g_{Na}m^3h(E_{Na}-V) + g_k n^4(E_k - V) + g_L(E_L - V) + I_{inj} \\ m = m_\infty = \alpha_m(V)/(\alpha_m(V) + \beta_m(V)) \\ \dfrac{dn}{dt} = \alpha_n(V)(1-n) - \beta_n(V)n \\ h = \max(1-1.25n, 0) \end{cases};$$

in the above formula, w is the inertia weight of the output delay adjustment of the Co(OH)2 activated carbon composite electrode material, c1 and c2 are the acceleration constants, and the convergence state characteristic quantity of the preparation process control is obtained:

$$\min_{\beta}\left\|\mathbf{Y}(t) - \mathbf{X}(t)\boldsymbol{\beta}\right\| = \min_{\beta}\left\|\begin{bmatrix} \mathbf{U}_{i1}^{'T}\mathbf{Y}_{i1} - \boldsymbol{\Sigma}_{i1}^{'}\mathbf{V}_{i1}^{'T}\boldsymbol{\beta} \\ \mathbf{U}_{i2}^{'T}\mathbf{Y}_{i2} - \boldsymbol{\Sigma}_{i2}^{'}\mathbf{V}_{i2}^{'T}\boldsymbol{\beta} \\ \vdots \\ \mathbf{U}_{ip(i)}^{'T}\mathbf{Y}_{ip(i)} - \boldsymbol{\Sigma}_{ip(i)}^{'}\mathbf{V}_{ip(i)}^{'T}\boldsymbol{\beta} \end{bmatrix}\right\| = \min_{\beta}\left\|\mathbf{Y}(i+1) - \mathbf{X}(i+1)\boldsymbol{\beta}\right\|$$

8. A Co(OH)2 activated carbon composite electrode material based on electrodeposition technology prepared by the method for preparing a Co(OH)2 activated carbon composite electrode material based on electrodeposition technology according to claim 1.

9. A battery prepared by using the Co(OH)2 activated carbon composite electrode material based on electrodeposition technology according to claim 8.

10. A green and environmentally friendly motor vehicle equipped with the battery of claim 9.

Revendications LU502148

1. La méthode de préparation du matériau d'électrode composite de charbon actif Co (OH) 2 basée sur la technologie d'électrodéposition, est caractérisé en ce qu'il comprend les étapes suivantes :

Étape 1, effectuer une analyse du spectre photoélectronique aux rayons X du matériau d'électrode composite de charbon actif Co(OH)2 en adoptant un test de performance d'électro-adsorption et une méthode d'analyse ;

Étape 2, introduction d'oxyde métallique dans la surface de l'électrode, test de la propriété d'électro-adsorption du matériau d'électrode à charbon actif Co(OH)2 par la méthode de calcination par imprégnation et analyse des performances de voltamétrie cyclique de l'électrode ;

Étape 3, la zone délimitée par la courbe volt-ampère est intégrée pour obtenir la quantité d'électrodéposition du matériau d'électrode composite de charbon actif Co(OH)2 ;

Étape 4, calcul du nombre de fibres échangeuses d'ions de charbon actif du matériau d'électrode composite de charbon actif Co(OH)2 mesuré par conductivité, et réalisation de la préparation par électrodéposition du matériau d'électrode composite de charbon actif Co(OH)2 selon la combinaison de divers éléments.

2. La méthode de préparation du matériau d'électrode composite de charbon actif Co (OH) 2 basée sur la technologie d'électrodéposition, est caractérisé en ce que les performances de charge et les caractéristiques de volt-ampère de sortie du matériau d'électrode composite de charbon actif Co(OH)2 préparé ont été analysées quantitativement.

3. La méthode de préparation du matériau d'électrode composite de charbon actif Co (OH) 2 basée sur la technologie d'électrodéposition, est caractérisé en ce qu'à l'étape 1, le procédé de test et d'analyse des performances d'adsorption électrique comprend spécifiquement les étapes suivantes : l'oxyde métallique est introduit dans la surface de l'électrode, et l'erreur de perturbation dans la préparation du matériau d'électrode

composite de charbon actif Co(OH)2 est exprimée sous la forme d'entrées multiples et de LU502148
sorties uniques, le terme d'erreur de régulation électrochimique E du matériau d'électrode composite de charbon actif Co(OH)2 satisfait Gauss- l'hypothèse de Markov en utilisant la fuzzification en un seul point, et la matrice de pilotage de contrôle dynamique non linéaire pour la préparation du matériau d'électrode composite de charbon actif Co(OH)2 est la suivante : $Y=X\beta+e$; où, Y est le vecteur de conduction de n×1 fibres de charbon actif adhérant au graphite, X est la matrice de vecteurs de fonctions non linéaires de n×m électrolyte, β est le m×1 vecteur de paramètre de fibre de charbon actif, et e est n×1 aléatoire vecteur d'erreur.

4. La méthode de préparation du matériau d'électrode composite de charbon actif Co (OH) 2 basée sur la technologie d'électrodéposition, est caractérisé en ce qu'à l'étape 2, le test d'électrosorption du matériau d'électrode à charbon actif Co(OH)2 par la méthode de calcination par imprégnation comprend spécifiquement: l'oxyde métallique est introduit dans la surface de l'électrode, et la courbe de voltamétrie cyclique est analysée par la méthode de calcination par immersion, si < m, la précision approximative Σ du test aux rayons X du matériau d'électrode composite est exprimée par:

$$\Sigma \approx \begin{bmatrix} \Sigma_1 & 0 \\ 0 & 0 \end{bmatrix} ;$$

la prédiction d'erreur linéaire du matériau d'électrode est effectuée dans la solution de NaCl avec l'électrolyte de 0,5mol·L^{-1}, la fonction d'erreur de prédiction est $\Sigma_1=diag(\delta_i)$, i=1,2,…,r, a trois -le système d'électrodes est utilisé pour la régulation en régime permanent, et la méthode de décomposition de la matrice de covariance est utilisée pour décomposer U et V en ce qui est indiqué ci-dessous: U=[U1 U2] , V=[V1 V2] ; U1 et V1 sont tous deux r colonnes.

5. La méthode de préparation du matériau d'électrode composite de charbon actif Co (OH) 2 basée sur la technologie d'électrodéposition, est caractérisé en ce qu'à l'étape 2, les méthodes d'analyse des performances de voltamétrie cyclique des électrodes comprennent : (1) la courbe caractéristique de volt-ampère de sortie préparée par le matériau d'électrode composite de charbon actif Co (OH) 2 a été construite, et les trois-

modèle de régulation en régime permanent de phase de l'anode de la batterie a été établi et le couple d'électrode a été calculé comme suit :

$$T_{em}=\frac{\pi k_f k_c k_i k_\beta B_g l_{ef} l_a (2r_r+2l_g+l_m) N_{eq}}{\ln\left(\frac{r_r+l_g+l_m}{r_r-l_m}\right)};$$

$$k_i=1-\frac{1}{0.9[r_r/(\beta p(l_g+l_m))]^2+1};$$

$$k_\beta=\frac{\alpha(\beta,k_c)}{k_c};$$

dans lequel α est l'étendue instantanée du vecteur d'état, et l'analyse de stabilité de sortie du matériau d'électrode composite de charbon actif Co(OH)2 est effectuée. La sortie de l'anode de pile à combustible à oxyde satisfait $\sum_{i=1}^{m} p(a_i)=1$, et la taille de l'étape de réglage du suivi de pas en arrière adaptatif est : α = min(β,kc)[ks+(1-ks)tanh(δ|β-kc|)] ; dans laquelle, ks<1, δ est la valeur empirique ; (2) Calculer les facteurs d'étirement de la loi d'adaptation de processus de la préparation de matériaux d'électrodes composites à charbon actif Co(OH) 2, L_{lp} , L_{ls} et L_{lm} , les variables d'état C_p et C_s du contrôle de processus et contrôler le volt-ampère caractéristiques selon le critère d'ajustement de la fréquence, afin d'obtenir la fréquence de fonctionnement du système :

$$\omega L_{lp}-\frac{1}{\omega C_p}=0\Rightarrow C_p=\frac{1}{\omega^2 L_{lp}};$$

$$\omega L_{ls}-\frac{1}{\omega C_s}=0\Rightarrow C_s=\frac{1}{\omega^2 L_{ls}};$$

Soit Y1, Y2, ..., YN un ensemble d'échantillons de Y, et le coefficient caractéristique voltammétrique de sortie préparé par le matériau d'électrode composite en charbon actif Co(OH)2 est réglé pour être exprimé comme suit:

$$T_{em} = \frac{\pi k_f k_c k_t k_\beta B_g I_{sa} l_s l_w (2r_r + 2l_g + l_w) J_{ca}}{\ln(\frac{r_r + l_g + l_w}{r_r - l_w})} - (\frac{P_e + P_h}{\omega_r})$$

6. La méthode de préparation du matériau d'électrode composite de charbon actif Co (OH) 2 basée sur la technologie d'électrodéposition, est caractérisé en ce qu'à l'étape 3, intégrer la zone délimitée par la courbe de voltamétrie pour obtenir la quantité d'électrodéposition du matériau d'électrode composite de charbon actif Co(OH)2, qui comprend : intégrer la zone délimitée par la courbe voltampère pour obtenir la couple de commande d'électrodéposition comme: $T_{out}=T_{em}-(P_w+P_b)/\omega_r$; sur la base de la technologie d'électrodéposition, la compensation d'erreur est effectuée et la méthode d'ajustement de suivi de rétroaction est utilisée pour obtenir la distribution floue des paramètres de la préparation du matériau d'électrode de charbon actif Co(OH)2 et la quantité d'électrodéposition de Co(OH) 2 matériau d'électrode composite de charbon actif est obtenu.

7. La méthode de préparation du matériau d'électrode composite de charbon actif Co (OH) 2 basée sur la technologie d'électrodéposition, est caractérisé en ce qu'à l'étape 4, la conductivité électrique calculée mesure le nombre de fibres échangeuses d'ions de charbon actif du Co(OH)2 activé matériau d'électrode en composite de carbone, et réalise la préparation par électrodéposition du matériau d'électrode en composite de charbon actif Co(OH)2 selon la combinaison d'éléments, qui comprend spécifiquement : 1) les performances de charge et les caractéristiques de voltamétrie de sortie du Co(OH)2 préparé le matériau d'électrode composite au charbon actif a été analysé quantitativement et la fonction d'objectif de contrôle optimal de la préparation de l'électrodéposition a été obtenue comme suit :

$$f_0(X) = w_p P_i(X) + w_v V_r(X) + w_c C(X) + \frac{1}{\varepsilon}[f_{\tau_{em}}(1 - T_{em}/T_{em}^*) + f_{\omega_r}(1 - \omega_r^{max}/\omega_r^*) + f_{B_g}(B_{gs}/B_g^{limax} - 1)]$$

ε est une petite constante pour contrôler le courant et la tension de sortie du matériau d'électrode composite de charbon actif Co(OH)2. $G_{m(s)}$ et $e^{-t_m s}$ représentent le gain de puissance de sortie et la temporisation du matériau d'électrode en composite de charbon actif Co(OH)2, l'erreur de mesure $f_u(\chi)$ est définie comme :

$$f_u(\chi) = \frac{1}{1+e^{-\sigma\chi}}$$

σ est une grande constante ;

2) grâce à la conception de contrôle du processus de préparation du matériau d'électrode composite, en supposant que x(t), t=0,1,...,n-1 est la séquence d'apprentissage d'échantillonnage du système de contrôle, l'état de sortie de contrôle de compensation de rétroaction d'erreur l'équation est obtenue :

$$\begin{cases} C\dfrac{dV}{dt} = g_{Na}m^3h(E_{Na}-V) + g_K n^4(E_K - V) + g_L(E_L - V) + I_{ext} \\ m = m_\infty = \alpha_m(V)/(\alpha_m(V)+\beta_m(V)) \\ \dfrac{dn}{dt} = \alpha_n(V)(1-n) - \beta_n(V)n \\ h = \max(1-1.25n, 0) \end{cases}$$

dans la formule ci-dessus, w est le poids d'inertie du réglage du retard de sortie du matériau d'électrode composite de charbon actif Co(OH)2, c1 et c2 sont les constantes d'accélération, et la quantité caractéristique d'état de convergence du contrôle du processus de préparation est obtenue :

$$\min_{\beta}\|\mathbf{Y}(i)-\mathbf{X}(i)\boldsymbol{\beta}\| = \min_{\beta}\left\|\begin{bmatrix} \mathbf{U}_{n1}^{T}\mathbf{Y}_{n} - \boldsymbol{\Sigma}_{n1}\mathbf{V}_{n1}^{T}\boldsymbol{\beta} \\ \mathbf{U}_{n2}^{T}\mathbf{Y}_{n2} - \boldsymbol{\Sigma}_{n2}\mathbf{V}_{n2}^{T}\boldsymbol{\beta} \\ \vdots \\ \mathbf{U}_{\varphi(i)}^{T}\mathbf{Y}_{\varphi(i)} - \boldsymbol{\Sigma}_{\varphi(i)}\mathbf{V}_{\varphi(i)}^{T}\boldsymbol{\beta} \end{bmatrix}\right\| = \min_{\beta}\|\mathbf{Y}(i+1)-\mathbf{X}(i+1)\boldsymbol{\beta}\|$$

8. Matériau d'électrode composite de charbon actif Co(OH)2 basé sur la technologie d'électrodéposition préparé par le procédé de préparation d'un matériau d'électrode composite de charbon actif Co(OH)2 basé sur la technologie d'électrodéposition selon la

revendication 1.

9. Batterie préparée en utilisant le matériau d'électrode composite de charbon actif Co(OH)2 basé sur la technologie d'électrodéposition selon la revendication 8.

10. Véhicule à moteur écologique et respectueux de l'environnement équipé de la batterie selon la revendication 9.

Figures

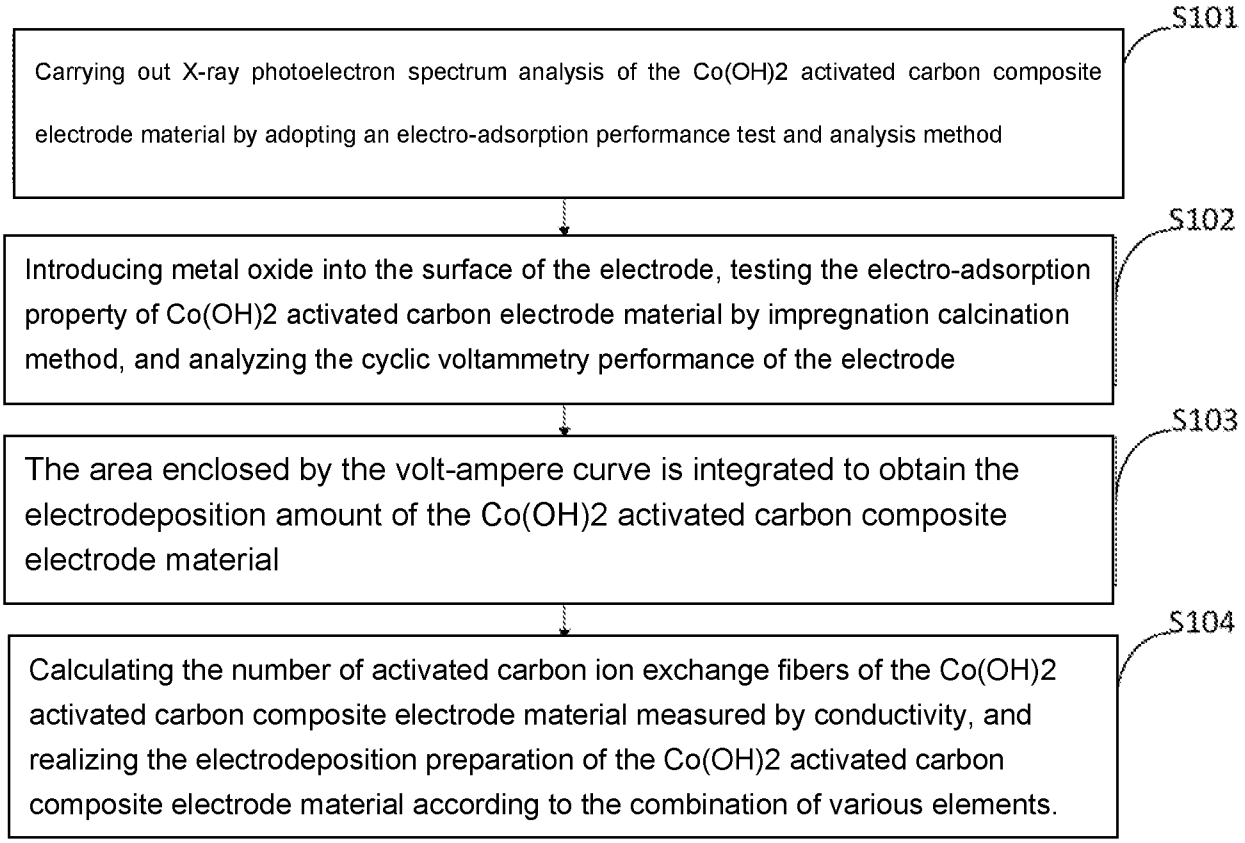
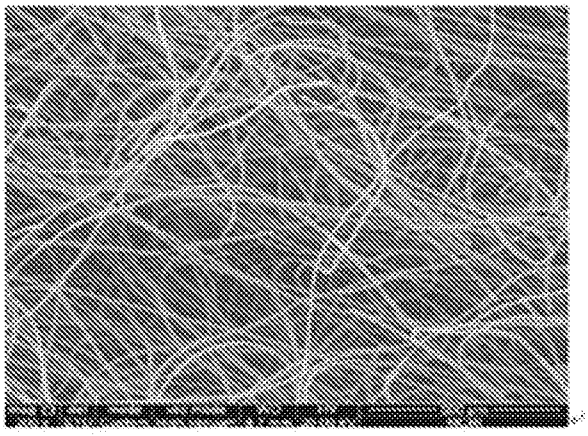
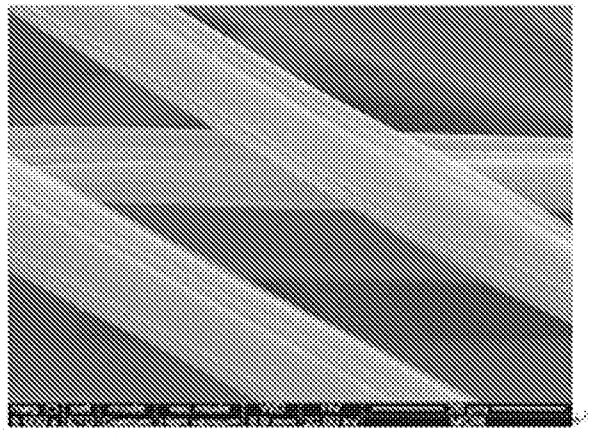


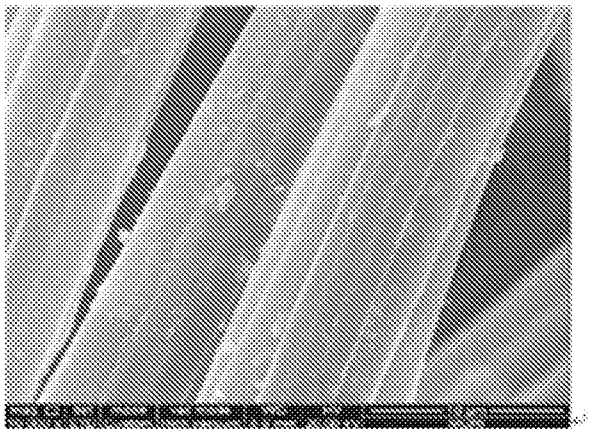
Figure 1



(a) λ =100



(b) λ =150



(c) λ =200

Figure 2

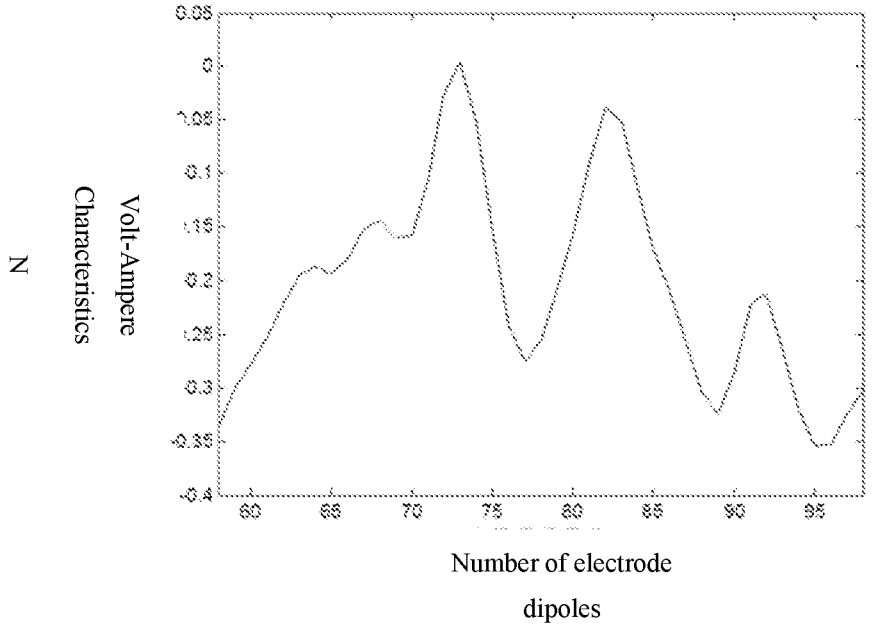

Volt-Ampere Characteristics N
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
60
65
70
75
80
85
90
95
Number of electrode dipoles

Figure 3