WHAT IS CLAIMED IS:

1. A membrane electrode with a catalyst layer for fuel cells, wherein,

the catalyst layer includes an anode catalyst and a cathode catalyst, and the anode catalyst layer includes a Pt-C catalyst, a high-dielectric small-molecule alcohol, sulfonated lignin-doped conductive polymer nanoparticles, a hydrophilic binder, an ionomer solution, and deionized water;

the cathode catalyst layer includes a catalyst, the ionomer solution, the high-dielectric small-molecule alcohol, polytetrafluoroethylene, the deionized water;

in the anode catalyst layer, within the Pt-C catalyst, a loading amount of Pt is 0.03-0.3 mg/cm², mass of an effective component in the ionomer solution is 20-80% of mass of C in the Pt-C catalyst, mass of the Pt-C catalyst is 5-20% of mass of the deionized water, a mass ratio of the deionized water to the high-dielectric small-molecule alcohol is 1:(1-4), mass of the sulfonated lignin-doped conductive polymer nanoparticles is 0.5-5% of the mass of the Pt-C catalyst, and mass of the hydrophilic binder is 2-5% of the mass of the deionized water;

in the cathode catalyst layer, the catalyst of the cathode catalyst layer is at least one of a Pt-C catalyst and a Ni-Fe catalyst; in the Pt-C catalyst, a loading amount of Pt is 0.3-0.7 mg/cm², mass of an effective component in the ionomer solution is 30-80% of mass of C in the Pt-C catalyst, mass of the Pt-C catalyst is 5-20% of mass of the deionized water, a mass ratio of the deionized water to the high-dielectric small-molecule alcohol is 1:(1-4), and mass of the polytetrafluoroethylene is 1-5% of the mass of the deionized water;

a preparation process of the membrane electrode with the catalyst layer for the fuel cells includes:

a preparation of an anode-side adhesive layer: dispensing a conductive polymer-sulfonated lignin hydrogel onto a peripheral area of a surface of the anode catalyst layer, thereby forming the anode-side adhesive layer configured for bonding the anode catalyst layer;

a preparation of the cathode-side adhesive layer: dispensing the ionomer solution onto a peripheral area of a surface of the cathode catalyst layer, thereby forming the cathode-side adhesive layer configured for bonding a cathode diffusion layer, wherein the ionomer solution is a Nafion-PEDOT conductive polymer, and the membrane electrode with the catalyst layer for the fuel cells assembly employs a frame-like

encapsulation;

wherein the high-dielectric small-molecule alcohol includes at least one of ethanol, ethylene glycol, n-propanol, and isopropanol;

the ionomer solution includes at least one of a sulfonated poly(ether ether ketone) solution, a sulfonated polystyrene solution, a sulfonated polysulfone solution, a sulfonated polyethylene solution, and a perfluorosulfonic acid resin solution; and

the hlydrophilic binder includes glycerol and polyethylene glycol (PEG).

2. A preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 1, comprising:

S1, a preparation of the anode catalyst layer: mixing raw materials contained in the anode catalyst layer and preparing the mixed raw materials contained in the anode catalyst layer on one side of a proton exchange membrane;

a preparation of the cathode catalyst layer: mixing raw materials contained in the cathode catalyst layer and preparing the mixed raw materials contained in the cathode catalyst layer on the other side of the proton exchange membrane；

S2, using a PEN frame with a hot-melt adhesive to seal the anode catalyst layer and the cathode catalyst layer, wherein edges of the anode catalyst layer and the cathode catalyst layer are 0.5-1 cm away from the PEN frame; adhering the PEN frame by performing an initial flat-plate hot pressing;

S3, a preparation of the anode-side adhesive layer: dispensing the conductive polymer-sulfonated lignin hydrogel onto the peripheral area of the surface of the anode catalyst layer, thereby forming the anode-side adhesive layer configured for bonding the anode catalyst layer;

a preparation of the cathode-side adhesive layer: dispensing the ionomer solution onto the peripheral area of the surface of the cathode catalyst layer, thereby forming the cathode-side adhesive layer configured for bonding the cathode diffusion layer;

S4, laminating an anode diffusion layer onto a surface of the anode-side adhesive layer, and laminating the cathode diffusion layer onto a surface of the cathode-side adhesive layer;

S5, processing using a second flat-plate hot pressing process to obtain the membrane electrode with the catalyst layer for the fuel cells;

wherein each of the cathode diffusion layer and the anode diffusion layer includes nano-silica and a dual-layer composite structure of carbon fiber and graphite, and the

nano-silica coats the dual-layer composite structure of carbon fiber and graphite.

3. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 2, wherein mass of the nano-silica is 10-40% of mass of the dual-layer composite structure of carbon fiber and graphite, a thickness of the carbon fiber is 150-310 μm, and a thickness of the graphite is 20-40 μm.

4. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 2, wherein a total thickness of the PEN frame is 40-80 μm.

5. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 2, wherein

the initial flat-plate hot pressing is conducted with a pressure of less than 0.3 MPa, a temperature below 120 °C, and a duration of 30s to 1 min; and

the second flat-plate hot pressing is conducted with a pressure below 0.3 MPa, a temperature ranging from 130 to 140 °C, and a duration of 30s to 2 min.

6. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 2, wherein thicknesses of the anode catalyst layer and the cathode catalyst layer are 5-10 μm, respectively.

7. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 2, wherein in the S1, a mixing process includes at least one of an ultrasonic mixing, a high-speed shear mixing, a ball milling mixing, and a high-pressure homogenization mixing.

8. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 2, wherein in the S1, the method further includes:

applying mixed anode catalyst layer ingredients to one side of the proton exchange membrane using screen printing; and

blade-coating the mixed cathode catalyst layer ingredients onto the other side of the proton exchange membrane.

9. The preparation method of the membrane electrode with the catalyst layer for the

fuel cells according to claim 2, wherein the method further includes:

immersing the dual-layer composite structure of carbon fiber and graphite in a silica suspension, removing and drying the dual-layer composite structure of carbon fiber and graphite, and repeating the immersing and drying process multiple times to form the anode diffusion layer or the cathode diffusion layer.

10. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 9, wherein an immersion time in the silica suspension is 10s, a drying temperature is 140 ℃, a drying duration is 10min, and a number of cycles is 4-5.

11. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 2, wherein a preparation process of the silica suspension includes:

obtaining a mixture by performing an initial sonication of silica, acetylacetone, and isopropanol;

adjusting pH of the mixture to less than 1 by adding concentrated sulfuric acid; and

obtaining the silica suspension by performing a second sonication of the mixture.

12. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 11, wherein

a sonication frequency of the initial sonication is 40Hz, a sonication temperature of the initial sonication is 10℃, a sonication duration of the initial sonication is 10min; and

a sonication frequency of the second sonication is 40Hz, a sonication temperature of the second sonication is 5℃, a sonication duration of the second sonication is 30min.

13. The preparation method of the membrane electrode with the catalyst layer for the fuel cells according to claim 11, wherein

mass ratios of the silica, the acetylacetone, and the isopropanol in the silica suspension are 2%, 5%, and 93%, respectively; and

a particle size of the silica in the silica suspension is 20nm.