What is claimed is:

1. An electrode assembly for a fuel cell without a proton exchange membrane, comprising:

   a polymer electrolyte layer;

   a negative pole catalyst layer and a positive pole catalyst layer located on two surfaces of the polymer electrolyte layer; and

   a negative pole diffusion layer located on the negative pole catalyst layer away from the polymer electrolyte layer, and a positive pole diffusion layer located on the positive pole catalyst layer away from the polymer electrolyte layer,

   wherein a material of the polymer electrolyte layer only contains polymer electrolyte,

   wherein the negative pole catalyst layer or/and the positive pole catalyst layer comprise a polymer electrolyte material and a catalyst active material, and a particle size range of the catalyst active material is 0.1-1 nm.

2. The electrode assembly for a fuel cell without a proton exchange membrane according to claim 1, wherein the polymer electrolyte layer comprises at least one of a perfluorosulfonic acid resin, a perfluorocarboxylic acid resin, a sulfonated polyether ether ketone resin, a sulfonated polysulfone resin, and a polybenzimidazole soaked in an acid liquid or an alkali liquid.

3. The electrode assembly for a fuel cell without a proton exchange membrane according to claim 1, wherein a thickness of the polymer electrolyte layer is 1-10 μm; and a thickness of the electrode assembly for a fuel cell is less than 200 μm.

4. The electrode assembly for a fuel cell without a proton exchange membrane according to any one of claims 1-3, wherein the polymer electrolyte material is consistent with the polymer electrolyte material in the polymer electrolyte layer.

5. The electrode assembly for a fuel cell without a proton exchange membrane according to claim 4, wherein a mass ratio of the catalyst active material to the polymer electrolyte material is 1: 0.1-1: 0.5;

   optionally, a particle size range of the polymer electrolyte material is 0.2-5 μm; and

   optionally, porosity of the catalyst layer is 10%-90%.

6. The electrode assembly for a fuel cell without a proton exchange membrane according to claim 4, wherein the catalyst active material comprises a noble metal catalyst or/and a metal oxide catalyst, wherein

optionally, the noble metal catalyst comprises at least one of a Pt catalyst, a Pt-based composite catalyst, and a Pt/C catalyst; and

optionally, the metal oxide catalyst comprises at least one of an iridium oxide, a rubidium oxide, and a ruthenium oxide.

7. The electrode assembly for a fuel cell without a proton exchange membrane according to any one of claims 1-3, wherein a material of the negative pole diffusion layer or/and the positive pole diffusion layer is one selected from the group consisting of carbon fiber paper, carbon fiber woven fabric, carbon black paper, foam metal, and nonwoven fabric, wherein

optionally, the foam metal is one selected from the group consisting of foam nickel, foam copper, foam aluminum, foam zinc, and foam titanium; and

optionally, the negative pole diffusion layer and the positive pole diffusion layer are both carbon fiber paper.

8. A fuel cell, comprising a negative pole gas guide groove, a positive pole gas guide groove, and the electrode assembly for a fuel cell without a proton exchange membrane according to any one of claims 1-7 provided between the negative pole gas guide groove and the positive pole gas guide groove.

9. A preparation method of the electrode assembly for a fuel cell without a proton exchange membrane according to any one of claims 1-7, comprising:

forming the positive pole catalyst layer on the positive pole diffusion layer to obtain a positive electrode; forming the negative pole catalyst layer on the negative pole diffusion layer to obtain a negative electrode; and growing the polymer electrolyte layer on the positive pole catalyst layer or/and the negative pole catalyst layer; and

compounding the positive electrode and the negative electrode so that the polymer electrolyte layer is located between the positive pole catalyst layer and the negative pole catalyst layer.

10. The preparation method according to claim 9, wherein a polymer electrolyte resin layer is formed while forming the positive pole catalyst layer on the positive pole diffusion layer to obtain the positive electrode; or/and

a polymer electrolyte resin layer is formed while forming the negative pole catalyst layer on the negative pole diffusion layer to obtain the negative electrode; and

the positive electrode and the negative electrode are compounded so that the polymer electrolyte resin layer is located between the positive pole catalyst layer and the negative pole catalyst layer.

11. The preparation method according to claim 10, wherein a preparation method for the positive electrode or/and the negative electrode comprises:

mixing a catalyst active material, a catalyst solvent, and a polymer electrolyte resin to obtain a catalyst slurry; and

coating the catalyst slurry on a surface of the diffusion layer and curing, so that a catalyst layer close to the diffusion layer and the polymer electrolyte resin layer away from the diffusion layer are formed on the diffusion layer;

optionally, the polymer electrolyte resin comprises at least one of a perfluorosulfonic acid resin, a perfluorocarboxylic acid resin, a sulfonated polyether ether ketone resin, and a sulfonated polysulfone resin; and

optionally, a mass concentration of the polymer electrolyte resin in the catalyst slurry is 2%-20%, a mass concentration of the catalyst active material in the catalyst slurry is 5%-45%, and a mass ratio of the catalyst active material to the polymer electrolyte resin is 1: 0.2-1: 0.5.

12. The preparation method according to claim 11, wherein the catalyst slurry further comprises a high boiling point solvent, and a boiling point of the high boiling point solvent is greater than a boiling point of the catalyst solvent;

optionally, the catalyst solvent comprises at least one of isopropyl alcohol, ethanol, methanol, and propanol, and the high boiling point solvent comprises ethylene glycol or glycerol;

optionally, the catalyst slurry further comprises a pore forming agent;

optionally, the pore forming agent comprises at least one of ammonium acetate, ammonium sulfate, and ammonium bicarbonate; and

optionally, a mass ratio of the catalyst active material to the high boiling point solvent and the pore forming agent is 1: (0.1-3): (0.1-0.33).

13. The preparation method according to claim 9, wherein a porous polymer layer is formed while forming the positive pole catalyst layer on the positive pole diffusion layer to obtain the positive electrode; or/and

a porous polymer layer is formed while forming the negative pole catalyst layer on the negative pole diffusion layer to obtain the negative electrode;

the porous polymer layer is soaked in an acid liquid or an alkali liquid, and then dried to form the polymer electrolyte layer; and

the positive electrode and the negative electrode are compounded so that the polymer electrolyte layer is located between the positive pole catalyst layer and the negative pole catalyst layer, wherein

optionally, the acid liquid is a phosphoric acid solution, a sulfuric acid solution, a hydrochloric acid solution, or a nitric acid solution;

optionally, a mass concentration of the acid liquid is 5%-15%;

optionally, the alkali liquid is a sodium hydroxide solution or/and a potassium hydroxide solution; and

optionally, a mass concentration of the alkali liquid is 5%-15%.

14. The preparation method according to claim 13, wherein a preparation method for the positive electrode or/and the negative electrode comprises:

mixing a catalyst active material, a catalyst solvent, and a porous polymer to obtain a catalyst slurry; and

coating the catalyst slurry on a surface of the diffusion layer, and drying the catalyst slurry to form on the diffusion layer the catalyst layer close to the diffusion layer and the porous polymer layer away from the diffusion layer, wherein

optionally, the porous polymer comprises polybenzimidazole; and

optionally, a mass concentration of the porous polymer in the catalyst slurry is 2%-20%, a mass concentration of the catalyst active material in the catalyst slurry is 5%-45%, and a mass ratio of the catalyst active material to the porous polymer is 1: 0.2-1: 0.5.

15. The preparation method according to claim 14, wherein the catalyst slurry further comprises a high boiling point solvent, and a boiling point of the high boiling point solvent is greater than a boiling point of the catalyst solvent;

optionally, the catalyst solvent comprises at least one of isopropyl alcohol, ethanol, methanol, and propanol, and the high boiling point solvent comprises ethylene glycol or glycerol;

optionally, the catalyst slurry further comprises a pore forming agent;

optionally, the pore forming agent comprises at least one of ammonium acetate, ammonium sulfate, and ammonium bicarbonate; and

optionally, a mass ratio of the catalyst active material to the high boiling point solvent and the pore forming agent is 1: (0.1-3): (0.1-0.33).

16. The preparation method according to claim 9, wherein the positive pole catalyst layer is formed on the positive pole diffusion layer to obtain the positive electrode, and the negative pole catalyst layer is formed on the negative pole diffusion layer to obtain the negative electrode;

the catalyst layer of the positive electrode or/and the negative electrode is soaked in a polymer electrolyte resin solution, and dried to form a polymer electrolyte resin layer on the catalyst layer; and

the positive electrode and the negative electrode are compounded so that the polymer electrolyte resin layer is located between the positive pole catalyst layer and the negative pole catalyst layer, wherein

optionally, a mass concentration of the polymer electrolyte resin solution is 3%-10%; and

optionally, the polymer electrolyte resin comprises at least one of a perfluorosulfonic acid resin, a perfluorocarboxylic acid resin, a sulfonated polyether ether ketone resin, and a sulfonated polysulfone resin.

17. The preparation method according to claim 9, wherein the positive pole catalyst layer is formed on the positive pole diffusion layer to obtain the positive electrode, and the negative pole catalyst layer is formed on the negative pole diffusion layer to obtain the negative electrode;

the catalyst layer of the positive electrode or/and the negative electrode is soaked in a porous polymer solution, and dried to form a porous polymer layer on the catalyst layer;

the porous polymer layer is soaked in an acid liquid or an alkali liquid, and dried to form the polymer electrolyte layer; and

the positive electrode and the negative electrode are compounded so that the polymer electrolyte layer is located between the positive pole catalyst layer and the negative pole catalyst layer, wherein

optionally, a mass concentration of the porous polymer solution is 3%-10%;

optionally, the porous polymer is polybenzimidazole;

optionally, the acid liquid is a phosphoric acid solution, a sulfuric acid solution, a hydrochloric acid solution, or a nitric acid solution;

optionally, a mass concentration of the acid liquid is 5%-15%;

optionally, the alkali liquid is a sodium hydroxide solution or/and a potassium hydroxide solution; and

optionally, a mass concentration of the alkali liquid is 5%-15%.

18. The preparation method according to claim 16 or 17, wherein a preparation method for the positive electrode or/and the negative electrode comprises:

mixing a catalyst active material, a catalyst solvent, and a hydrophobic polymer to obtain a catalyst slurry; and

coating the catalyst slurry on a surface of the diffusion layer, and drying the catalyst slurry to form on the diffusion layer the catalyst layer and the polymer electrolyte layer, wherein

optionally, the hydrophobic polymer is PTFE emulsion or dimethyl silicone oil; and

optionally, a mass concentration of the hydrophobic polymer in the catalyst slurry is 2%-20%, a mass concentration of the catalyst active

material in the catalyst slurry is 5%-45%, and a mass ratio of the catalyst active material to the hydrophobic polymer is 1: 0.2-1: 0.5.

19. The preparation method according to claim 18, wherein the catalyst slurry further comprises a pore forming agent, wherein

optionally, the pore forming agent comprises at least one of ammonium acetate, ammonium sulfate, and ammonium bicarbonate; and

a mass ratio of the catalyst active material to the pore forming agent is 1: 0.1-1: 0.33.