Preparation and Catalytic Performance of Ni/NiO@C and SiO₂@C Composites as using Bamboo as Carbon Source for Hydrogen Evolution Reaction

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With the depletion of traditional fossil energy and the deterioration of the earth's ecological environment, the development of clean and renewable new energy is worthy of attention. Compared with traditional fossil energy, hydrogen energy has the advantages of high combustion calorific value, abundant resources, wide sources, green environmental protection, clean and renewable, easy storage and so on. In the field of hydrogen production, electrolysis of water for hydrogen production has the advantages of simple operation equipment and preparation process, relatively high purity and yield of products, and non-toxic by-products. However, the disadvantage is that in the actual electrolysis process, there is a large overpotential on the electrode, which leads to excessive power consumption, high economic cost and seriously hinders its large-scale commercialization. Therefore, the development of cheap, efficient, stable and low overpotential electrocatalyst is of great significance to improve the economic benefits of electrolytic aquaculture. In this project, Ni/NiO@C and SiO₂@C composite catalytic materials were synthesized by loading nickel oxide on bamboo carbon materials and silica on bamboo carbon materials as electrodes. The main raw material is bamboo carbon powder, which is expanded by chemical activation method. NiO and SiO₂ with the same molar concentration are loaded on the expanded bamboo carbon by hydrothermal method to form Ni/NiO@C and SiO₂@C composite catalytic materials. Scanning electron microscopy, cyclic voltammetry and linear sweep voltammetry were used for analysis. The cyclic voltammetry curves show that the Ni/NiO@C and SiO₂@C composites have symmetrical redox peaks, good cyclic stability and reversibility, and good electrochemical properties. The overpotential at 1mA was obtained from the linear sweep voltammetry curve. The mass ratio of SiO₂ in SiO₂@C composite was 5%, 15%, 30% and 50%, which were 0.563V, 0.577V, 0.584V and 0.586V respectively. The molar concentration of SiO₂ in 1.5% Ni/NiO@C composite was 0.588V. The cyclic voltammetry curves of Ni/NiO@C and SiO₂@C composites with the same molar concentration show that SiO₂@C composites have more obvious symmetrical redox peaks. The linear sweep voltammetry analysis shows that the overpotential at 1mA of SiO₂@C composites is smaller than that of Ni/NiO@C composites, and the Tafel slope is also smaller than that of Ni/NiO@C composites. The reversibility and electrochemical performance of SiO₂@C composite are better than that of Ni/NiO@C composite.

Keywords: Bamboo carbon, silica, nickel oxide, composite electrode, electrocatalytic Performance

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