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Study on Electrochemical Sensing Properties of Novel Carbon Nanocomposites

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Abstract: *In order to master the comprehensive properties of new carbon nanocomposites and provide technical support for their promotion and use, the electrochemical sensing performance of materials was tested and analyzed. To ensure the objectivity and authenticity of the test results, raw materials and test instruments shall be prepared according to the test requirements; Preparation of new carbon nanocomposites prepared according to the standard, grinding low concentration MoS2 and 1-butyl-3-methylimidazole hexafluorophosphate bulk materials to prepare reference materials; Through the characterization of the material and the testing of the electrochemical sensing performance of the material at different concentrations, it is proved that the content of carbon nanofibers in the new carbon nanocomposites is high and the electrochemical sensing ability is strong; The concentration of raw materials will have a certain impact on the electrochemical sensing performance of the prepared materials, and the two show a positive relationship, that is, within a certain range, the higher the concentration, the stronger the electrochemical sensing performance of the prepared materials.*

Keywords: *Carbon nanocomposites; Characterization; Raw material; Sensing performance; Electrochemistry; New type*

1. Introduction

Nano-composite materials mainly refer to the use of rubber, metal, resin and other materials as the basis, auxiliary nano-level modifiers, and appropriate preparation methods to make the ions and inorganic particles in the materials evenly dispersed in the matrix. Generated material [1]. In recent years, with the continuous deepening of scientific and technological research, there have been more and more scientific research achievements related to nanomaterials, the production and manufacturing technology level of nanocomposite materials has been continuously improved, and a variety of new carbon nanomaterials have been promoted and used in the market. The structural diagram of carbon nanocomposites is shown in Figure 1.

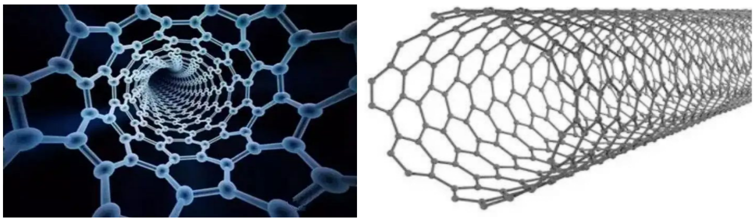

Figure 1: The structural diagram of carbon nanocomposites

The practice and research show that the application of micro-nano conductive polymer materials to the production and design of electrochemical sensors can effectively improve the comprehensive performance of electrochemical sensors [2]. In order to further realize the promotion of this material in the relevant fields of the market, the following will carry out in-depth research on the electrochemical sensing performance of the material.

2. Raw materials and test equipment

In order to ensure the objectivity and authenticity of the test results, raw materials, reagents and instruments required for the test shall be prepared according to the requirements of electrochemical

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sensing performance test before relevant research [3]. Relevant contents are shown in Table 1 and Table 2 below.

Table 1: Raw materials for electrochemical sensing performance test

Serial number	Raw material reagent	Production unit/supply unit
(1)	1-Butyl-3-methylimidazolium hexafluorophosphate	Maclean ltd.
(2)	MoS2	Maclean ltd.
(3)	Potassium chloride, dipotassium hydrogen phosphate, CS, potassium ferricyanide, absolute ethanol	Sinopharm Group Chemical Reagent Co., Ltd.
(4)	Acetic acid, acetone, ethylene glycol	Qiangsheng Functional Chemicals Co., Ltd.

Table 2: Instruments and equipment in the test

Serial number	Equipment model/parameters	Equipment
(1)	AC105-N	Electronic Analytical Balance
(2)	CPA-225D	Digital electronic balance
(3)	CHI-660	Electrochemical Workstation
(4)	82-5	Constant temperature magnetic heating stirring device
(5)	20μL/100μL/1mL	Micro injection device
(6)	40B-TDL	Desktop centrifuge
(7)	HC-3018	High-speed stirring centrifuge
(8)	93-SZ	Automatic double pure water distiller
(9)	BCD-213	Refrigeration unit
(10)	HW-SY11-K	Electric thermostatic water bath
(11)	JJ-1	Blast dryer
(12)	9070MBE-GZX	Ultrasonic intelligent cleaning machine

According to the above method, the relevant preparations before the performance test of the new carbon nanocomposite were completed.

3. Preparation of new carbon nanocomposites

After completing the above preparations, a new type of carbon nanocomposite material is prepared. Before preparation, the raw materials are processed according to the specific requirements of the relevant work. During the treatment, the liquid phase exfoliation method was used to grind the bulk materials of MoS2 and 1-butyl-3-methylimidazolium hexafluorophosphate, and the bulk components in the raw materials were stripped [4]. On this basis, weigh 0.1 g of MoS2 material, prepare 0.05 g of CS material, use a pipette to weigh 600 μL of ionic liquid as backup, put the prepared raw materials into an agate mortar container, and use a stirring bar to fully Submerge the material for more than 1 hour.

Place the milled material in a high-speed stirring centrifuge, mix acetone into it, and set the operating speed of the centrifuge to 1.0 × 104 r / min, clean the raw materials at least three times, and control the time of each cleaning within the range of 10min ~ 15min.

On this basis, use 0.6% ethylene glycol solution and continue to clean the raw materials at least 3 times according to the above steps. The bench type centrifuge is used to filter the precipitate and ionic water, and then the bench type centrifuge is used. The design speed is 1.0 × 104 r / min. after centrifugation once, the massive MoS2 material in the reagent was removed. Peel off the upper layer liquid, and collect the dark green solution in the upper layer solution using a micro injection device. At this time, the lower layer material in the device is the carbon nanocomposite after peeling off treatment.

On this basis, the prepared carbon nanocomposites were placed in a container and dispersed with 30ml-40ml of ethanol solution. The magnetic stirring method was used, and the stirring was continued for 30 min. The black liquid in the container at this time was moved into an electric heating constant temperature water bath, and the constant temperature was set to 200 °C, and the reaction was continued for 12 h [5]. After the reaction is completed, the material is placed in an ultrasonic intelligent cleaning machine for cleaning treatment, and the cleaned material is placed in a refrigeration device to cool it to

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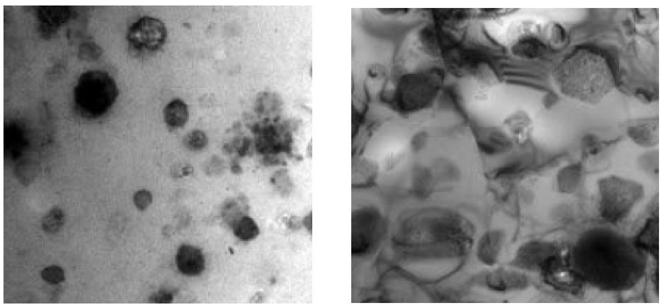
room temperature. On this basis, remove the upper layer of liquid in the container, transfer the sediment in the bottom layer to a centrifugal device, and then use ethanol solution and deionized solution to wash it at least 3 times. The cleaned materials were placed in a blast dryer, and the materials were dried for more than 24 hours at a constant temperature of 60°C. According to the above method, a novel carbon nanocomposite material can be obtained.

According to the above steps, the bulk material of low concentration MoS2 and 1-butyl-3-methylimidazolium hexafluorophosphate was ground to prepare the reference material.

4. Electrochemical sensing performance test

4.1. Characterization Analysis

After completing the above research, the prepared new carbon nanocomposites and reference materials were placed under a microscope to observe the characterization of the materials. The observation results are shown in Figure 2 below.



（1） （2）

Figure 2: Characterization of new carbon nanocomposites and reference materials

In the above Figure 2, (1) represents the characterization phenomenon of the low concentration reference material under the microscope; (2) It represents the characterization phenomenon of the new carbon nanocomposites under the microscope.

From the characterization results shown in Figure 2 above, it can be seen that the content of carbon nanofibers in the new carbon nanocomposites is high, and the overall distribution presents a connected network structure. The content of carbon nanofibers in the low concentration reference material is relatively low, and the overall distribution is random and loose. Carbon nanofibers are the key structure to realize the electrochemical sensing effect of materials. Therefore, after completing the above research, it is proved that the content of carbon nanofibers in the new carbon nanocomposites is high and the electrochemical sensing ability is strong.

4.2. Analysis of electrochemical sensing performance of materials at different concentrations

The low-concentration reference material and the new carbon nanocomposite were tested by cyclic voltammetry to analyze the electrochemical sensing ability of the material in use. The results are shown in Figure 3 below.

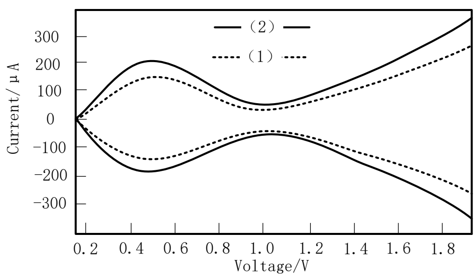


Figure 3: Electrochemical sensing performance of new carbon nanocomposites and reference materials

In Figure 3, (1) shows the electrochemical sensing performance of the low concentration reference

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material; (2) Represents the electrochemical sensing performance of the new carbon nanocomposite.

From the experimental results shown in Figure 3 above, it can be seen that the new carbon nanocomposites have strong electrical sensing ability, which proves that the concentration of MoS2 and 1-butyl-3-methylimidazole hexafluorophosphate in the raw materials will have a certain impact on the electrochemical sensing performance of the prepared materials, and the two show a positive relationship, that is, within a certain range, the higher the concentration, the stronger the electrochemical sensing performance of the prepared materials.

5. Conclusion

Compared with other materials, the new carbon nanocomposites have the advantages of high sensitivity, low detection limit and low manufacturing cost. At present, this new material has a wide application prospect in chemical analysis, industrial production and other fields. In order to deepen the use of materials, this paper carried out experimental analysis of the electrochemical sensing performance of materials. Through this study, the influence of the doping concentration of raw materials on their performance in the process of material preparation was clarified. In this way, objective data were provided to support the work in chemical scientific research and other related fields.

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