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Retraction

Retracted: Monitoring of Sports Health Indicators Based on Wearable Nanobiosensors

Advances in Materials Science and Engineering

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Advances in Materials Science and Engineering has retracted the article titled "Monitoring of Sports Health Indicators Based on Wearable Nanobiosensors" [1]. Since publication, readers have raised concerns that the error bars in Figure 9 appear to be the letter "T." Moreover, it has been noted that the authors state that "no datasets were generated or analyzed during the current study" which is contradictory to the study described. This therefore raises questions about the reliability of the underlying data and the article's conclusions.

The article includes several instances where different sections are clearly unrelated. For instance, as the survey collecting information on the fitness activity of elderly people in Jilin province is not well described, it is unclear how it relates to the research on nanomaterials and wearable biosensors. Furthermore, several references cited do not support the article and have been found to be irrelevant. Of note, in addition to not being relevant to the corresponding text, reference [16] was retracted prior to the submission of the current article due to containing nonsensical content [2].

Finally, we would like also to acknowledge that a reader raised concerns that an incorrect notation was used in Equations (13) and (14); however, upon review, this appears to be an error made during the production process. The Publisher apologizes for this error.

The authors did not respond to our summary of the concerns nor our request to provide the original data and ethics approval documentation. After careful assessment of the concerns raised, we have concerns about the article's scientific reliability and are therefore retracting.

The authors agree to the retraction and the notice.

References

[1] R. Gong and B. Liu, "Monitoring of Sports Health Indicators Based on Wearable Nanobiosensors," *Advances in Materials Science and Engineering*, vol. 2022, Article ID 3802603, 11 pages, 2022.

[2] J. Pang, X. Li, and X. Zhang, "Retraction Note to: Coastline land use Planning and Big Data Health Sports Management Based on Virtual Reality Technology," *Arabian Journal of Geosciences*, vol. 14, no. 22, p. 2376, 2021.

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Research Article

Monitoring of Sports Health Indicators Based on Wearable Nanobiosensors

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Biosensors are instruments that are sensitive to biological substances and convert their concentration into electrical signals for detection. Generally speaking, there are two main means to promote health: one is medical intervention, and the other is exercise intervention. Medicine is mainly the second half of the health decay of the whole person, that is, disease treatment and control, while exercise intervention is mainly to prevent and promote the first half of the health decay. The purpose of this paper is to study the biochemical properties of nanomaterials and the exercise health of the elderly. In this paper, an electrochemical research method for detecting the kinase activity of polynucleotides by streptavidin-gold nanoparticles and enzyme amplification is proposed based on the thermophysical properties of materials and the properties of nanoparticles. The experimental results show that, compared with the traditional electrochemical method, the method has the advantages of simple operation, high sensitivity, and high selectivity, its linear range is from 0 U/mL to 5 U/mL, and the detection limit is 0.01 U/mL. In contrast, AgNWs cotton fiber films exhibited lower volume resistivity. The experimental design of this paper provides a theoretical and practical basis for researchers and has great research significance for the innovative research and development of nanomaterials.

1. Introduction

After the specific reaction or combination of the analyte in the biosensor sample and the antibody, enzyme, cell, or microorganisms in the molecular recognition element, the conversion element converts this specific reaction or combination into a signal (light, electricity, heat, etc.) that can be directly output. After passing through the signal amplification and processing device, it is recorded by the signal recording device to realize the quantitative detection of the analyte. Biosensors can be divided into immune biosensors, enzyme biosensors, DNA biosensors, microbial sensors, tissue sensors, and so on. According to the different conversion elements, biosensors can be divided into optical biosensors, electrochemical biosensors, piezoelectric biosensors, and so on. The research and development of biosensors has become a new hot spot in the world's scientific and technological development and has important strategic significance. The impact of exercise on a healthy lifestyle is of irreplaceable significance; "lack of exercise is the fourth leading cause of death in the world." Every year, more than 3 million people worldwide die due to lack of exercise, and the trend has been increasing rapidly in the past 10 years.

The innovations of the paper are as follows: (1) An electrochemical research method for detecting the kinase activity of polynucleotides by streptavidin-gold nanoparticles and enzymatic amplification is proposed based on the thermophysical properties of materials and the properties of nanoparticles. (2) Through the experiment of the "dynamic bridging effect" of silver nanowires on graphene, a dynamic adjustment method of resistance rGO cotton fiber film is proposed. (3) To understand the sports health indicators in a certain area, survey and analysis of the sports health of the elderly in Jilin Province were carried out.

2. Related Work

In recent years, ZnO nanoparticles have attracted the attention of the scientific community due to their biological properties. Kumar et al. reviewed recent advances in the fabrication of ZnO nanomaterials with altered morphology, growth factors, surface morphology, and defects as well as different laboratory methods for evaluating antibacterial activity against Gram-negative and Gram-negative strains [1]. Mitchell et al. reported a fluorescent sensor suite of six sensors showing progress in detecting platinum levels in chemotherapy patients. Biologically relevant and heavy metals enable the separation and identification of platinum complexes in heterogeneous coordinate environments with 100% accuracy [2]. Keeler et al. proposed that resonance mass measurement has become an effective tool for cell characterization in medical and biological research. Microfluidics for diagnostics and clinical development to find large sample data has become an important carrier for continuous measurements [3]. Ha et al. investigated different synthesis methods and growth mechanisms of metal halide perovskites as well as their new properties and applications. They proposed that different nanoparticles have different optical and electrical characteristics due to their different quantum confinement [4]. Pidpomoga has found that students are attracted to a specific type of motor function. Among the types of sports competitions offered outdoors, athletic gymnastics is the first choice. The least appealing genres are cycling, nontraditional genres, gymnastics, chess, and so on [5]. To reach and include socially disadvantaged groups through sport, Hermens et al. proposed that it is important to develop partnerships (such as the Sports Health Partnership) between sports organizations and public health organizations [6]. Kong et al. proposed that a controlled-release system with the ability to directly and real-time monitor drug release and dynamics of living systems is of great value for anticancer chemotherapy [7]. Schürmann and Bald proposed that the decomposition of 8BrA is due to the transfer of electrons due to heating [8]. Although predecessors have done a lot of work in sports, health, nanomaterials, and so on, they have not carried out joint research in many aspects.

3. Material Thermophysical Performance Index and Mathematical Model

Biosensor is a high-tech developed by interpenetration of biology, chemistry, physics, electronic technology, and other disciplines. Biosensor is a device that specifically recognizes biological substances and their changes and then converts this recognition into measurable physical signals such as light, electricity, heat, and other signals through signal conversion. It is mainly composed of identification elements, transducers, and signal detection devices. The structure is shown in Figure 1.

3.1. Material Thermophysical Performance Index. Common material thermophysical performance parameters include thermal conductivity, thermal expansion coefficient, and elastic modulus, and the basic theory will be introduced in the following [9].

Thermal conductivity is a physical quantity that describes the thermal conductivity of a material, which is related to the type and temperature of the material. According to Fourier's law of heat conduction, for a uniform metal rod with temperatures $t1$ and $t2$ at both ends, the temperature at each point does not change with time (steady state). The heat flux q through the vertical section per unit time is proportional to the temperature gradient of the rod.

Its mathematical expression is

$$q = k\frac{dt}{dx} = -\text{kgrandt}. \quad (1)$$

In the above formula, the negative sign means that the heat spreads to a low temperature, the proportionality coefficient k is called thermal conductivity (also called thermal conductivity), and the unit is $W/(m \cdot k)$.

The thermal expansion coefficient is an important parameter of the material. The theoretical formula for the calculation of the expansion coefficient is as follows: set $\overline{\alpha}$ as the average linear expansion coefficient, and the change value of the sample length in the temperature range is as follows:

$$\Delta l = l_2 - l_1. \quad (2)$$

Then,

$$\Delta T = T_2 - T_1. \quad (3)$$

Next,

$$l_2 = l_1\left[1 + \overline{\alpha}_1\left(T_2 - T_1\right)\right],$$
$$\overline{\alpha}_l = \frac{\Delta l}{l_1 \Delta T}. \quad (4)$$

In the same way, the average volume expansion coefficient is as follows:

$$\overline{\beta} = \frac{\Delta V}{V_1 \Delta T}. \quad (5)$$

In general, the average linear expansion coefficient is used to characterize the thermal expansion of materials.

3.2. Basics of Data Sheets. In this section, what we refer to is the data table of sample point × variable type [10]. If there are n variables $y_1, y_2, \ldots, y_n$, each of them is sampled m times (or observations), and m sample points are obtained:

$$\left(y_{i1}, y_{i1}, \ldots, y_{in}\right), i = 1, 2, \ldots, m. \quad (6)$$

Then, the formed data table X can be written as an $m \times n$-dimensional matrix:

$$Y = \left(y_{ij}\right)_{m\times n} = \begin{bmatrix} e_1^T \\ \vdots \\ e_m^T \end{bmatrix}. \quad (7)$$

In the formula $e_i = \left(y_{i1}, y_{i2}, \ldots, y_{in}\right)^T \in R^n, i = 1, 2, \ldots m$, e_i is referred to as the i-th sample point. The mean of the sample is as follows:

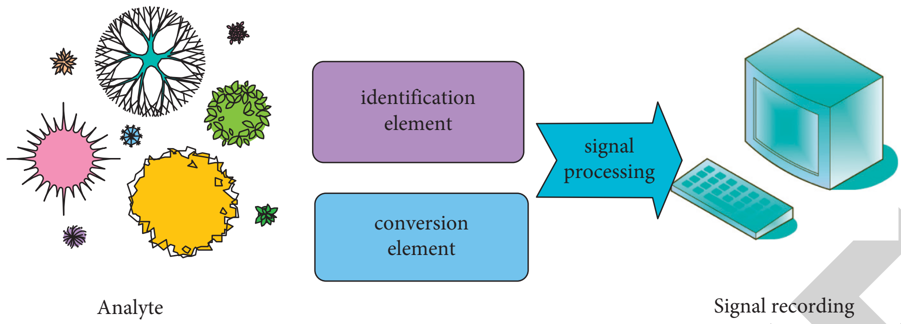

FIGURE 1: Schematic diagram of the basic principle of biosensors.

$$\bar{y} = (\bar{y}_1, \bar{y}_2, \ldots, \bar{y}_n),$$
$$\bar{y}_j = \frac{1}{m}\sum_{i=1}^{m} y_{ij} j = 1, 2, \ldots, n. \tag{8}$$

The sample correlation coefficient matrices are as follows:

$$S = (s_{ij})_{n\times n} = \frac{1}{m-1}\sum_{k=1}^{m} (e_k - \bar{y})(e_k - \bar{y})^T R = (r_{ij})_{n\times n} = \left(\frac{s_{ij}}{\sqrt{s_{ii}s_{jj}}}\right). \tag{9}$$

Here,

$$s_{ij} = \frac{1}{m-1}\sum_{k=1}^{m} (y_{ki} - \bar{y}_i)(y_{kj} - \bar{y}_j). \tag{10}$$

3.3. Univariate Linear Regression Model. The model of univariate linear regression is

$$y = \beta_0 + \beta_1 x + \varepsilon. \tag{11}$$

In the formula, β_0, β_1 are the regression coefficients, ε is the random error term, always assume $\varepsilon \sim N(0, \sigma^2)$, and then the random variable is $y \sim N(\beta_0 + \beta_1 x, \sigma^2)$.

If n independent observations are made on y and x, respectively, n pairs of observations are obtained:

$$(y_i, x_i), i = 1, 2, \ldots, n,$$
$$y_i = \beta_0 + \beta_1 x + \varepsilon_i, i = 1, 2, \ldots, n. \tag{12}$$

Here, x_i is the value of the independent variable at the ith observation. Corresponding to x_i, y_i is a random variable whose randomness is caused by ε_i. $\varepsilon_1 \sim N(0, \sigma^2)$; for different observations, when $i \neq j$, ε_i and ε_j are independent of each other.

Use the least squares method to estimate the value of β_0, β_1; that is, take a set of estimated values $\hat{\beta}_0, \hat{\beta}_1$ of β_0, β_1 to minimize the sum of squared errors of y_i and $\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x$. If

$$Q(\beta_0, \beta_1) = \sum_{i=1}^{n} (y_i - \beta_0 - \beta_1 x_i)^2. \tag{13}$$

then

$$Q(\hat{\beta}_0, \hat{\beta}_1) = \min_{\beta_0, \beta_1} Q(\beta_0, \beta_1) = \sum_{i=1}^{n} \left(y_i - \hat{\beta}_0 - \hat{\beta}_1 x_i\right)^2. \tag{14}$$

Obviously, $Q(\beta_0, \beta_1) \geq 0$, and differentiable with respect to β_0, β_1, then from the necessary conditions for the existence of extreme values of multivariate functions, we can get

$$\frac{\partial Q}{\partial \beta_0} = -2\sum_{i=1}^{n} (y_i - \beta_0 - \beta_1 x_i) = 0,$$
$$\frac{\partial Q}{\partial \beta_1} = -2\sum_{i=1}^{n} x_i (y_i - \beta_0 - \beta_1 x_i) = 0. \tag{15}$$

After finishing, we get the following system of equations:

$$\begin{cases} n\beta_0 + \beta_1 \sum_{i=1}^{n} x_i = \sum_{i=1}^{n} y_i, \\ \beta_0 \sum_{i=1}^{n} x_i + \beta_i \sum_{i=1}^{n} x_i^2 = \sum_{i=1}^{n} x_i y_i. \end{cases} \tag{16}$$

This system of equations is called a normal system of equations and can be solved by solving

$$\begin{cases} \hat{\beta}_1 = \dfrac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n} (x_i - \bar{x})^2}, \\ \hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}. \end{cases} \tag{17}$$

Call $\hat{\beta}_0, \hat{\beta}_1$ the least squares estimate of β_0, β_1, where $\bar{x}, \bar{y}$ is the sample mean of x_i, y_i; that is, $\bar{x} = 1/n \sum_{i=1}^{n} x_i, \bar{y} = 1/n \sum_{i=1}^{n} y_i$.

4. Biochemical Experiments of Nanomaterials and Related Investigations on Exercise Health of the Elderly

4.1. Streptavidin-Gold Nanoparticles and Enzymatically Amplified Electrochemical Methods for the Detection of Polynucleotide Kinase Activity

4.1.1. Polynucleotide Kinase. Polynucleotide kinase (PNK) is an essential enzyme, which plays an essential role in DNA recombination, replication, and repair [11]. Its main function is that it can catalyze the phosphorylation of the 5′ end and the dephosphorylation of the 3′ end of DNA/RNA. At the same time, PNK is also one of the widely used tool enzymes in the field of molecular biology. Therefore, designing and developing new methods to detect PNK activity is essential in studying biological processes related to DNA phosphorylation.

The traditional methods to measure PNK activity include radioisotope labeling and polyacrylamide gel electrophoresis. However, the disadvantages of these traditional methods are obvious, such as time-consuming, complicated operating procedures, and radioactive isotopes that threaten the safety of the experimenters. In recent years, to solve these problems, researchers have designed and developed many new methods; the most common is the method based on fluorescence. Compared with traditional methods, although these analytical methods have obvious advantages, the disadvantages of these methods are still inevitable. This method is mainly based on the degradation of phosphorylated DNA by λ exonuclease and the amplification of the electrochemical signals by streptavidin-gold nanoparticle complexes (SA-AuNPs) and alkaline phosphatase (ALP) [12]. λ exonuclease is an exonuclease that can degrade and digest $5'$ phosphorylated double-stranded DNA but has very low activity on unphosphorylated DNA. Due to their large specific surface area and good biocompatibility, gold nanoparticles are very suitable for use as biomolecular carriers for related analytical research. In this paper, gold nanoparticles were mainly used as carriers of streptavidin (SA) to construct streptavidin-gold nanoparticle complexes (SA-AuNPs) [13]. Through the combination of SA on its surface and biotin, it can capture more biotinylated alkaline phosphatase (biotin-ALP) molecules, thereby amplifying the electrochemical signal. When PNK exists in the system, the substrate probe immobilized on the surface of the gold electrode will be phosphorylated [14]. When the phosphorylated substrate probe hybridizes with the detection probe, the substrate probe will be recognized and degraded by λ exonuclease so that the biotinylated detection probe will dissociate from the electrode surface. SA-AuNPs and biotin-ALP could not be captured on the electrode surface, resulting in a decrease in the electrochemical signal. The degree of electrochemical signal reduction correlated with the active concentration of PNK [15]. According to this principle, we established a new method to detect the active concentration of PNK.

4.1.2. The Basic Principle of Signal Amplification Electrochemical Method to Measure PNK Activity. The basic principle of measuring PNK activity based on the signal amplification electrochemical method is shown in Figure 2. The method is mainly based on the degradation of phosphorylated DNA by λ exonuclease and the two-step amplification of the electrochemical signal based on SA-AuNPs and biotin-ALP [16].

4.1.3. Electrochemical Determination of PNK Activity. In this paper, gold nanoparticles were used as carriers for SA due to their large specific surface area [17]. Several SA molecules may be adsorbed on each gold nanoparticle so that it can bind more biotin-ALP and obtain a larger electrochemical signal [18]. As shown in Figure 3, when there is no PNK in the system, under the same experimental conditions, we compared the effect of SA and SA-AuNPs on electrochemical signal amplification. The results show that the electrochemical signal received when using SA-AuNPs (curve A) is much stronger than that of SA alone (curve B). From this, we can conclude that SA-AuNPs indeed play a good role in amplifying the electrochemical signal [19].

4.1.4. Electrochemical Characterization of Electrodes. A chemically modified electrode is an electrode made of a conductor or semiconductor. The surface of the electrode is modified by chemical or physical methods and designed according to people's intentions to form a thin film with expected functions, such as accelerated electron transfer reaction, selective membrane permeation, preferential enrichment, higher selectivity, sensitivity, and stability. Electrochemical impedance is a very effective method for characterizing electrode modification processes. As shown in Figure 4, each step of the self-assembly of the gold electrode corresponds to an electrochemical impedance spectrum; for example, curve A is the electrochemical impedance spectrum of the bare gold electrode. When the substrate is bound to the electrode surface via Au-S bonds, the electrochemical impedance increases significantly (curve B); when the electrode is blocked with MCH, the electrochemical impedance increases further (curve C). At this time, if we drop 10 U/mL PNK on the electrode surface, after a period of time, add λ exonuclease and detection probe. When the detection probe hybridizes with the substrate probe, the phosphorylated end of the substrate probe is recognized by λ exonuclease, the substrate probe is degraded, and the detection probe will detach from the electrode surface. This reduces the electron transfer resistance on the electrode surface, resulting in a greatly reduced electrochemical impedance (curve D). Then the electrochemical impedance increases due to the blocking effect of BSA on the nonspecific adsorption sites (curve E). It can be seen that the sensing interface has been successfully constructed and can be used for PNK activity detection [20].

4.1.5. Optimization of Experimental Conditions. The test results are shown in Figure 5. The I/I0 gradually decreased with the increase of SA-AuNPs collection. When the combination ratio of SA-AuNPs was 1 : 50, the I/I0 value reached the minimum value. It continues to grow, instead of increasing the value of I/I0 [21]. Therefore, in this experiment, the dilution ratio of SA-AuNPs was selected as 1 : 50. We have also optimized the optimal amount of λ exonucleases. The experimental results show that when the amount of λ exonuclease is 10 U, it is enough to degrade all phosphorylated DNA so that I/I0 reaches the minimum value, as shown in Figure 6. Therefore, the dosage of λ exonuclease was set as 10 U for the best effect.

In this experiment, ATP provides phosphate groups for the phosphorylation of DNA, so its concentration is also very critical. We studied the effect of different concentrations of ATP on the process of DNA phosphorylation, and the experimental results are shown in Figure 7. When the

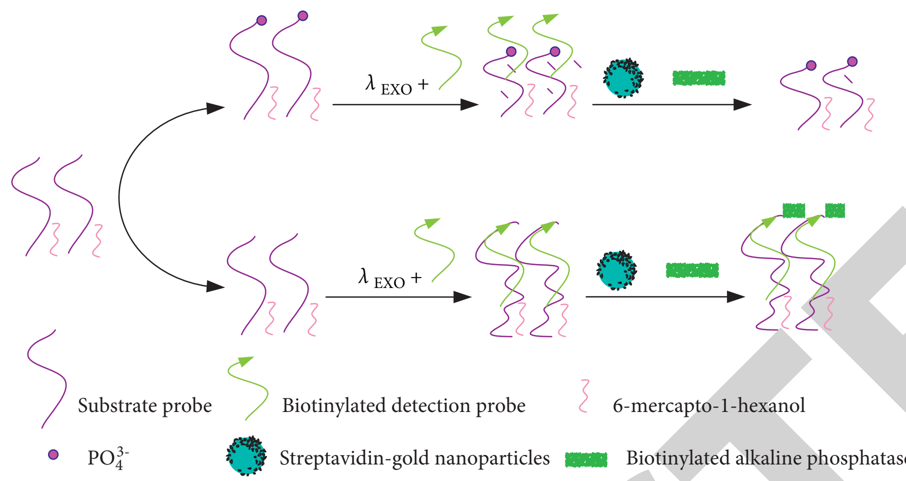

Figure 2: Schematic diagram of the basic principle of detection of PNK activity based on electrochemical signal amplification.

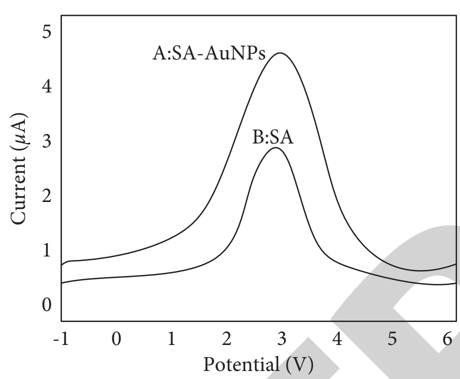

Figure 3: Amplification effect of SA-AuNPs on electrochemical signal.

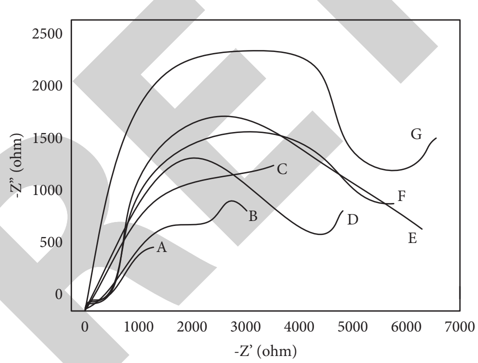

Figure 4: Electrochemical impedance spectroscopy during the electrode surface modification process.

ATP concentration was less than 1 mM, the peak current decreased with increasing ATP concentration. However, when the concentration of ATP continued to increase, the peak current did not continue to decrease, which indicated that the degree of phosphorylation did not increase when the concentration of ATP continued to increase [22]. Therefore, in the subsequent determination of PNK activity, the ATP concentration was selected as 1 mM.

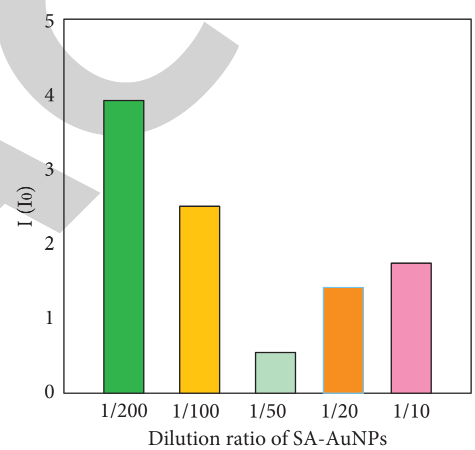

Figure 5: Effect of SA-AuNPs concentration on the analytical performance of the sensor.

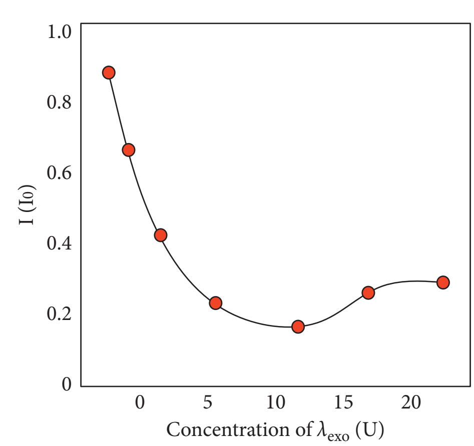

Figure 6: The effect of the amount of λ exonuclease on the analytical performance of the sensor.

4.1.6. Quantitative Determination of PNK Activity. Figure 8(a) is a DPV response profile of different active concentrations of PNK. The active concentrations of PNK from top to bottom are 0, 0.01, 0.05, and 0.1 U/mL.

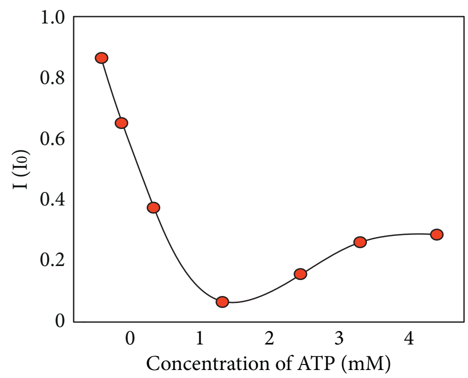

Figure 7: Effect of ATP concentration on the analytical performance of the sensor.

Figure 8(b) is the kinetic response range of the sensor to PNK concentration. The inset in Figure 8(b) is the calibration curve for the sensor to detect PNK [23].

Under the optimal experimental conditions, we scanned the DPV spectra at different PNK active concentrations, as shown in Figure 8(a). The experimental results showed that, with the increase of the active concentration of PNK, the peak current decreased gradually. Figure 8(b) shows the peak current values corresponding to different active concentrations of PNK. It can be seen from the inset in Figure 8(b) that when the active concentration of PNK is in the range of 0 U/mL to 5 U/mL, the peak current value of the system has a linear relationship with the logarithm of the active concentration of PNK, and the detection limit is 0.01 U/mL.

We also examined the selectivity of this sensor, and we selected several proteases. Thrombin, Endo IV, and hOGG1 were interferers. In the experiment, the concentration of various interfering enzymes was 10 U/mL, and the effects of these enzymes on the peak current were determined. Other test conditions and operating steps are the same as those for PNK determination. The experimental results are shown in Figure 9, and the concentration of each substance is 10 U/mL. It can be seen from Figure 9 that the presence of these enzymes has no significant effect on the peak current of the sensor. This shows that the sensor has high selectivity for PNK [24].

4.1.7. Determination of Inhibitors. In this experiment, we also examined the effect of inhibitors on PNK activity. We chose ammonium sulfate as the inhibitor and added different concentrations of ammonium sulfate and 10 U/mL of PNK into the reaction system. It was found that, with the increase of ammonium sulfate concentration, the peak current gradually increased, as shown in Figure 10; the reason was that the activity of PNK was inhibited by ammonium sulfate.

4.2. "Dynamic Bridging Effect" of Silver Nanowires on Graphene and Structural Design and Performance Regulation of Flexible Piezoresistive Materials

4.2.1. Structural Design and Performance Regulation of Flexible Piezoresistive Materials. A large number of works have shown that the introduction of rough microstructures into FPM can significantly weaken the hysteresis viscoelasticity of the polymer matrix, improve its sensitivity, and reduce the response time, which is one of the important means to prepare high-performance FPM. Not only can the use of the intrinsic rough structure (Ra = 39.4) on the surface of the cotton fiber film save the tedious preparation process of constructing the microstructure in the early stage, but also the cotton fiber film is completely biodegradable. It has a wide range of sources and low prices. It can be used to prepare FPM by loading conductive fillers on the surface of cotton fibers, which opens up new ideas for the preparation of new electronic functional materials.

The internal structure of the microstructure-based FPM is simple, and the sensing mechanism is easy to understand. It is generally believed that the contact area (Ac) of the upper and lower microstructures is squeezed and deformed under the action of external loads (such as pressure, bending, and twisting). Therefore, the increase of the contact area (Ac) leads to the decrease of the contact resistance (Rc) of the entire FPM, and the external mechanical signal is converted into an electrical signal to realize sensing. This sensing mechanism based on contact resistance can better explain the resistance change law of FPM based on microstructure. However, the contact resistance is still a relatively apparent physical parameter, and explaining the sensing mechanism of the FPM by the contact resistance mechanism cannot penetrate into the core of the FPM.

As we all know, FPM is the first and foremost conductive material, and its electrical signals (current, resistance, or voltage) are realized by the transmission of electrons. Therefore, the sensing essence of FPM is the change of the conduction path or conduction state of the material before and after the application of the external load. A deeper level is the difference in the electron transport or transfer state before and after the external load is applied. Therefore, designing the difference in the electron transport mechanism before and after the external load is applied is the key to designing the FPM and the core means to realize the performance regulation of the FPM. The transfer and transport of electrons require conductive fillers as the medium, and the transport of electrons in different media is quite different. For example, the transport of electrons in metals such as gold, silver, and copper is very easy, but the transport in defective carbon materials (such as graphene and carbon nanotubes) is relatively difficult. Because electrons need to traverse a high energy barrier, choosing the right filler to achieve this is particularly critical.

4.2.2. Construction of the Conductive Network of Silver Nanowires and Graphene on the Surface of Cotton Fibers. AgNWs accumulate on the surface of cotton fibers and are heated to form a highly conductive AgNWs cotton sheath. The GO was assembled on the surface of cotton fibers by a "dip coating-drying" process as follows. The commercial cotton fiber film was washed with deionized water and absolute ethanol 3 times in turn, and then the cotton fiber film ($5\,cm \times 6\,cm \times 200\,\mu m$) was completely immersed in

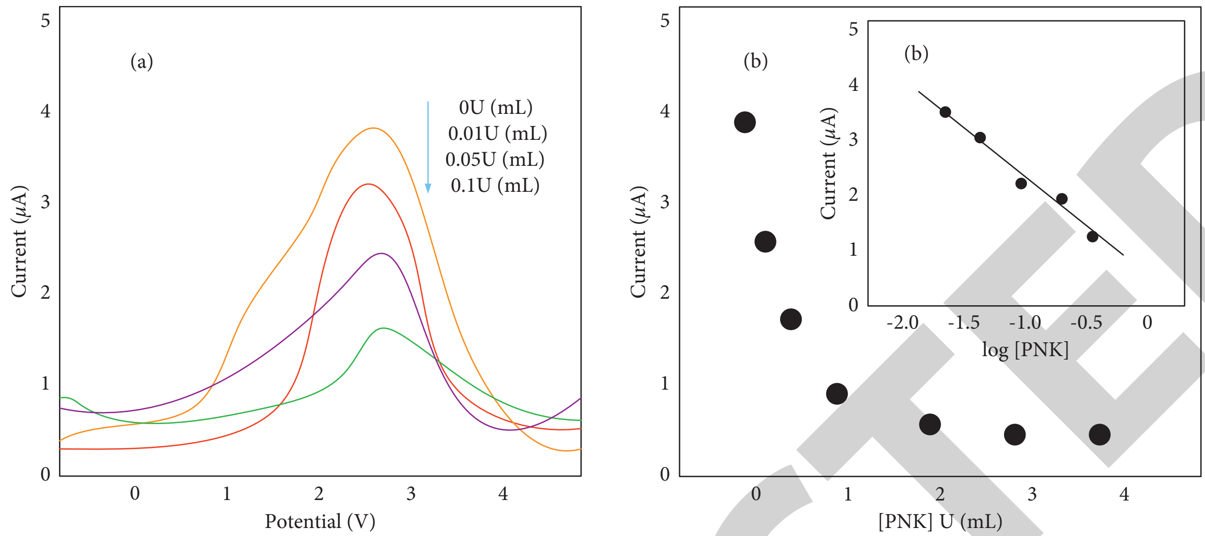

FIGURE 8: Quantitative determination of PNK activity.

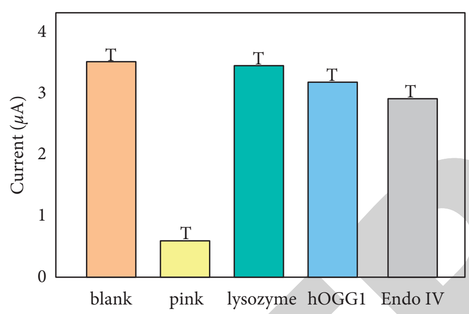

FIGURE 9: Selectivity of the analytical method.

2.0 mg·mL^{-1} of GO aqueous dispersion. Take it out after 1 min and air dry naturally. The above GO-loaded cotton fiber film was reduced in hydrazine hydrate vapor (100°C) for 2.0 h to obtain rGO conductive cotton fiber film.

Copper electrodes were welded to both ends of a certain size rGO conductive cotton fiber film, and the highly conductive AgNWs cotton fiber film was assembled "face to face" on the rGO conductive cotton fiber film (note: AgNWs conductive cotton fiber film cannot be in contact with copper electrodes). The AgNWs-rGO FPM was obtained after encapsulation on 3M Scotch tape.

The electrical resistance ρ (unit: Ω) of the material was tested with a TEGAM 1740 microohmmeter (TEGAM, USA), and the volume resistivity R (unit: Ω·cm) of the material was calculated using the following formula:

$$R = \frac{\rho S_c}{L}. \tag{18}$$

In formula (18), L (cm) and Sc (cm^2) are the length and transverse cross-sectional area of the sample, respectively. The sensitivity of AgNWs-rGO FPM was calculated using (S, unit: kPa^{-1})

$$S = \frac{\Delta R}{\Delta P \cdot R_0}. \tag{19}$$

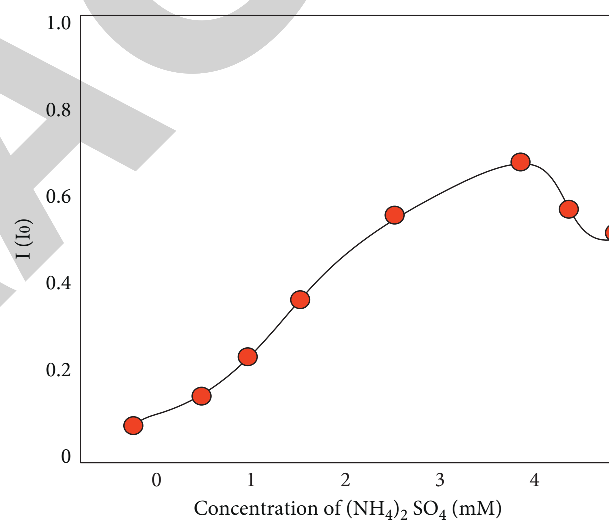

FIGURE 10: The effect of ammonium sulfate on PNK activity.

An instantaneous pressure (100 Pa) was applied to the AgNWs-rGO FPM, and the resistance change of the AgNWs-rGO FPM under compression was recorded in real time. And it takes 90% of the time required before and after the resistance change becomes stable as the response time of the AgNWs-rGO FPM. The coating stability of rGO on the surface of cotton fibers was reflected by ultrasonic treatment (ultrasonic power: 280 W) in the aqueous phase, and the relationship between the sheet resistance of rGO on cotton fibers and the ultrasonic time was recorded.

4.2.3. Results and Discussion. Due to the large number of oxygen-containing functional groups (such as hydroxyl, carbonyl, and epoxy) on the surface of GO, we can have strong hydrogen bond interactions with the hydroxyl groups on the cellulose molecular chain of cotton fibers. Therefore, in this paper, a simple "dip coating-drying" process was used

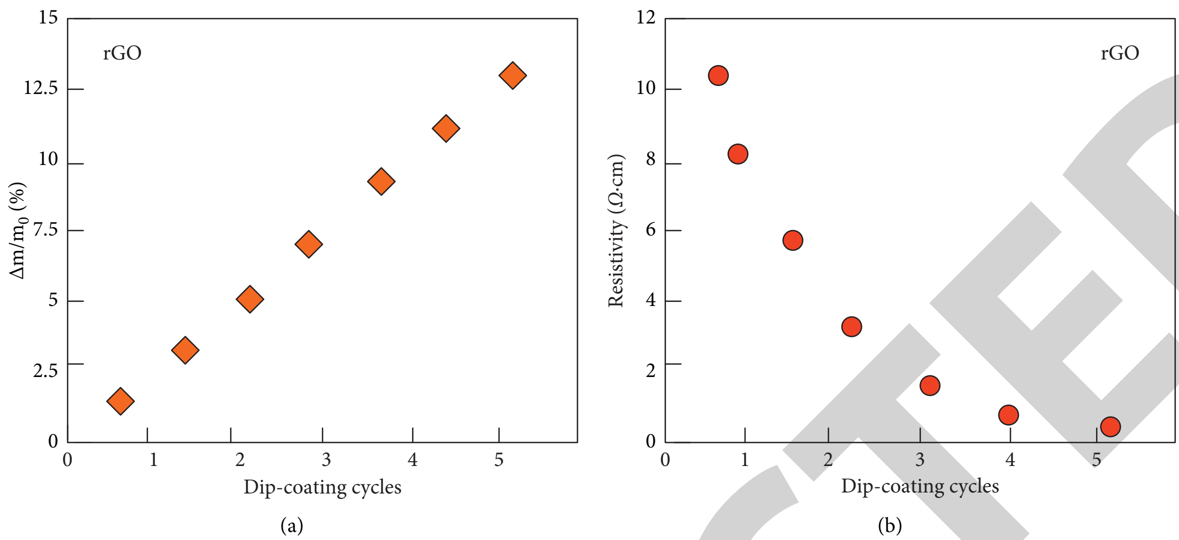

FIGURE 11: Mass and resistance of rGO cotton fiber films as a function of "dip-dry" time.

to assemble GO networks on the surface of cotton fibers, and the cleaned cotton fiber films ($5\,cm \times 6\,cm \times 200\,\mu m$) were immersed in $2\,mg{\cdot}mL^{-1}$ GO aqueous dispersion. The color of the cotton fiber film changed from white to light yellow after drying, indicating that GO had been assembled on the surface of the cotton fiber. After the GO cotton fiber film was sealed in a polytetrafluoroethylene liner and reduced by hydrazine hydrate steam, the color of the cotton fiber film became dark black, indicating that GO was reduced to rGO, and a conductive rGO cotton fiber film was obtained.

Figure 11 shows the change in the mass and resistance of the rGO cotton fiber film with the number of "dipping-drying" times. It can be seen that the quality of the rGO cotton fiber film increases linearly with the increase of the "dip coating-drying" time, and the resistance of the rGO cotton fiber film decreases regularly and gradually with the increase of the "dipping-coating-drying" time. It is shown that the resistance of the rGO cotton fiber film can be regulated simply by adjusting the number of "dipping-drying" times. When the number of "dipping-drying" times is 1 time, the volume resistivity of the rGO cotton fiber film is about $5.1\,\Omega\,cm$; when the number of "dipping-coating-drying" times is 8 times, the volume resistivity of the rGO cotton fiber film is about $0.26\,\Omega\,cm$. The resistance of rGO cotton fiber film is closely related to the intrinsic conjugated structure of rGO. In contrast, AgNWs cotton fiber films exhibited lower volume resistivity.

4.3. Physical Fitness Survey of the Elderly

4.3.1. Attitudes and Cognitions on Exercise Health among the Elderly in Urban Communities in Jilin Province. From the results in Table 1, it can be seen that most of the elderly in urban communities in Jilin Province have a clearer understanding of exercise on health. More than half of the people believe that exercise has a great impact on health and believe that participating in sports can experience a lot of fun and feel good after exercise and it is a part of life. 35% of people think that exercise is more helpful to health; 88% of the respondents think that exercise is of great help to health. On the whole, most people have accepted that exercise is good for health, but 12% think that exercise is less helpful for health, and it is not clear why. The impact of exercise on health has been scientifically proven, and it has a good effect on the health of the human body. Therefore, we need to make more efforts in the promotion and explanation of sports health knowledge and the training of sports health skills. Secondly, when providing sports health services, whether it is repaid or free, it is necessary to cultivate the correct concept of healthy consumption of the elderly.

TABLE 1: The proportion of elderly self-assessed that exercise helps their health ($n = 210$).

Level	Smaller	Generally	Larger	Very big
Number of people selected	4	20	70	107
Percentage	2%	10%	35%	53%
Satisfaction	10%	37%	64%	77%

4.3.2. The Participation of the Elderly in Sports. There are four main motivations for the participation of the elderly in urban communities through data review. In the survey of a total of 210 people, 163 people chose to improve their physical fitness, 115 people chose hobbies, and the third place was to make friends and have fun. From Table 2, it can be seen that the main motivation for the elderly to participate in sports in urban communities in Jilin Province is to improve their physical fitness, which is quite different from the number of people selected for the option of curing diseases and maintaining health. The elderly have a profound understanding of the promotion of health through exercise and can recognize that exercise is a defense against disease, not a cure. The second is hobbies. From the perspective of the elderly, we believe that the elderly have a high enthusiasm for sports, and making friends and entertainment also account for a large reason. The elderly regard

Table 2: Motivation for participation in sports for the elderly in urban communities ($n = 210$).

Type	Enhance physical fitness	Make friends	Entertainment	Display ability
Number of people selected	163	81	86	26
Percentage	77.6%	38.3%	40.9%	12.2%
Satisfaction	11%	24%	56%	83%

Table 3: Proportion of selected sports and fitness items for the elderly in urban communities ($n = 210$).

Type	Martial arts healthcare	Running class	Dance gymnastics	Chess and cards
Number of people selected	56	159	38	62
Percentage	14%	41%	10%	16%
Satisfaction	15%	33%	76%	92%

Table 4: Exercise and fitness methods for the elderly in urban communities ($n = 210$).

Type	Tutoring club	Free exercise	Neighborhood committee activities	Unit activity
Number of people selected	22	190	26	20
Percentage	22%	62%	15%	24%
Satisfaction	32%	63%	36%	53%

sports and fitness as the pleasure of life, which are basically some low-intensity and highly interesting sports activities.

Due to their own physical characteristics, the elderly should try to choose nonconfrontational sports with low exercise intensity, long exercise time, and simple and easy operation. As shown in Table 3, after a survey in Jilin urban communities, it was found that many people chose running sports, and 41% of the elderly would prefer running in the choice of fitness sports. Running is simple and easy to implement and has the advantages of easy regulation of exercise volume, no need for special venues, and single or multiperson exercise. The second is chess and cards, which is interesting and competitive and is one of the favorite events of the elderly, and there are relatively few martial arts and dance exercises. The main reason is that there are certain gender restrictions; most of the martial arts sports are male, and women like less. While women in dance gymnastics are more common, such as square dance, men participate less. In sports, there is basically a situation in which one dominates, and many go hand in hand.

As shown in Table 4, the elderly tend to have a variety of exercise and fitness methods. In terms of fitness methods, the elderly basically choose to exercise freely by themselves and occasionally participate in sports activities organized by the neighborhood committee. They participate in tutoring centers, clubs, or units. From the data, only 15% of the elderly have participated in sports activities specially organized by the neighborhood committee or an organization for the elderly. This also reflects that most of the former elderly exercised on their own initiative and hardly participated in sports activities organized by teams and associations, which reflects the current shortage of sports health services for the elderly, and many needs are not met.

As shown in Table 5, according to the survey statistics, most people exercise in the morning and evening, and nearly half of the people in the survey sample will choose to exercise in the morning or evening. The number of people who exercise in the morning and evening is basically the same, the second is that the number of people who choose to exercise in the evening is relatively small, and a small number of people choose to exercise at other time periods. It can be seen that the time of the elderly is relatively loose and discretionary.

Table 5: Exercise and fitness time for the elderly in urban communities ($n = 210$).

Time	Morning	Evening	Night	Others
Number of people selected	90	65	90	25
Percentage	33%	24%	33%	9%
Satisfaction	45%	31%	53%	17%

Table 6: Proportion of various venues suitable for the elderly to exercise ($n = 40$).

Type	Number	Percentage (%)
Martial arts healthcare	31	16.85
Running class	31	16.85
Dance gymnastics	26	14.13
Chess and cards	42	22.83
Ball	20	10.87
Water	2	1.09
Other venues	32	17.39

After investigation and research, the total number of venues of various types in the surveyed sample communities is shown in the numerical column of Table 6, and the chess and card venues ranked first, accounting for 22.83%, followed by martial arts, healthcare, and running; of course, these two sports do not have very high requirements on the venue, and they are basically universal. The values are relatively close, and other types of venues also account for a relatively high proportion, mainly because of a wide variety. From the data, it can be seen that there are relatively few sports venues for elderly water, and it is more suitable for the physical condition of the elderly because of safety concerns. In the survey of 40 communities, according to the data, the basic facilities of the elderly sports services have a certain foundation, but they are not surplus and slightly lacking.

5. Conclusions

There are many types of biosensors, and different types of biosensors have specific uses in specific environments. And biosensors are closely related to nanomaterials, so the research and development of nanomaterials is of great significance in the development of biosensors. In the future, we will continue to develop nanomaterials to make them more suitable for current needs. With the rapid development of nanomaterials, the application of new nanomaterials has also been continuously expanded, and the problem of sports health of the elderly has always puzzled many scientists. The biochemical properties of nanomaterials and the health of the elderly have become the mainstream research directions. In this paper, an electrochemical research method for detecting the kinase activity of polynucleotides by streptavidin-gold nanoparticles and enzyme amplification is proposed based on the thermophysical properties of materials and the properties of nanoparticles. The experimental results show that, compared with the traditional electrochemical method, the method has the advantages of simple operation, high sensitivity, and high selectivity, its linear range is from 0 U/mL to 5 U/mL, and the detection limit is 0.01 U/mL. In contrast, AgNWs cotton fiber films exhibited lower volume resistivity. Future work is needed to develop a more sensitive nanoparticle biosensor to address current market needs. In any case, the experimental design of this paper provides a direction for future research and is of great significance to related researchers.

Data Availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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