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Research Progress of Graphene-based Flexible Sensor in Wearable Health Monitoring

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Abstract

Research of flexible sensors for human wearable health monitoring are of paramount importance. In view of the problems of traditional sensors, such as complexity, low sensitivity, insufficient strain, short service life and incompatibility with human body, the research progress of Graphene-based flexible sensors in wearable health monitoring is systematically introduced. Benefitting from the commendable flexible mechanical properties and high durability, flexible Graphene-based sensors promote its applications in motion detection, body temperature monitoring, sweat ion real-time monitoring, voice recognition, pulse-beating, and respiration detection. The challenges and prospects of the application of Graphene-based flexible sensors in wearable health monitoring are pointed out. It is expected that most current research, which is still experimental, will need several more years of study before it becomes widely used. In the future, more attention should be paid to the lack of flexibility and high sensitivity of Graphene, the preparation of high purity Graphene, the application of composite materials and the development of advanced technology.

Keywords: Graphene; Flexible Sensor; Wearable-tech; Health Monitoring

1 Introduction

With the increasing frequency of utilization in electronic devices, lightweight and wearable electronics have gradually become a mainstream direction in modern society. Wearable technology mainly relates to the application of technology which can be directly worn on the body or integrated into clothing accessories [1]. The application of wearable technology in health monitoring is a major direction of Biomedical Engineering in the future [2]. The research and development of flexible sensor is the key point of wearable technology application, which provides new opportunities for the development of wearable human-machine interface equipment. Flexible sensors are widely used in wearable health monitoring, such as motion detection, body temperature monitoring, sweat ion real-time monitoring, voice recognition, pulse beating, respiration detection, etc [3]. Traditional sensors have many problems, such as complexity, low sensitivity, insufficient strain, short service life, and difficult to be compatible with human body.

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Graphene has been highlighted as a great potential material in wearable devices, owing to its extraordinary properties such as mechanical softness, high electrical conductivity and good optical properties. Graphene is currently the thinnest material with the highest strength and the best bending properties. The electron mobility of monolayer Graphene is about 15 000 $cm^2/(V\text{-}s)$ and it has good conductivity. The absorption rate within the long wave range is about 2.3%, which is almost transparent and has a far-infrared effect [4]. In addition, Graphene has the advantages of easy chemical functionalization and potential mass production, making it a promising candidate material for flexible and wearable electronic products. Therefore, it is of great significance to study the application of graphene in wearable sensors [5].

2 Research Progress of Graphene-based Flexible Sensors

The sensor can provide the interface between the user and the electronic system by converting the physiological or environmental signal into an electrical signal, so as to achieve the effect of information transmission and data feedback. Sensors can be divided into flexible sensors and rigid sensors. At present, the sensors used in wearable devices are mainly rigid sensors. Rigid sensor has some disadvantages, such as high rigidity, not easy to bend and so on. In addition, it is not suitable for human body structure. Therefore, the research and development of flexible sensors has become a major issue. Therefore, researchers have done a lot of research on the preparation of flexible sensors with various materials. However, the development of flexible devices and multi-functional integration is greatly challenged by multi-interface coalescence and mechanical matching. Graphene and its derivatives show great potential for flexible sensing due to their unique physical and chemical properties, good conductivity, optical properties, biocompatibility, easy functionalization and flexibility [6]. In recent years, Graphene-based flexible sensors have been made great progress in the fields of pressure, strain, humidity, temperature, potentiometry and multifunctional integration. It can be used for motion detection, body temperature monitoring, real-time sweat ion monitoring, voice recognition, pulse-beating, respiration detection, etc.

2.1 Graphene-based Pressure Sensors

2.1.1 Application Progress of Graphene-based Pressure Sensors

The development of pressure sensors is of vital importance for the health monitoring of new wearable devices. For the pressure sensor, high sensitivity and large working range are the key point. Currently, scientific breakthroughs are needed to simultaneously measure high sensitivity and large working range signals. In recent years, researchers have made breakthroughs in these aspects. Table 1 has listed the research on the application of Graphene-based pressure sensor in health monitoring recent years.

Through analysis of this table, the Graphene-based pressure sensor has the following characteristics: 1) flexibility, high sensitivity and wide workable pressure range; 2) fast response and good stability; 3) good conductivity and self-powered; 4) static and dynamic monitoring simultaneously.