Design and Evaluation of Nanotechnology Based a Stress Detection Model at Different Body Parts

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It has been claimed that a proof-of-concept prototype for the detection of physical stress at various body regions has been designed and developed at a reasonable cost, with ease of use and portability. The sensor arrangement is composed of an electrically conducting aluminium (Al) and reduced graphene oxide (RGO) layer deposited on a soft, flexible polydimethylsiloxane (PDMS) substrate. The flexible PDMS substrate's conductive layer aids in the detection of the raw surface electromyogarphic (RSEMG) potential of several human body parts, including the tongue, wrist, tip-toe, and fingertip, when they come into contact with the sensor. The sensor generates an electrical signal, which is sent to the signal processing unit. From there, it is wirelessly transmitted to an open-source mobile application, which displays the results. The prototype has the potential to be helpful in the early diagnosis of numerous cardiac, nerve, and muscle diseases that are associated with symptoms such as elevated stress levels at various body areas.

Keywords: Nano technology, sensing system, Health.

1. Introduction

One of the fundamental needs of modern life is the routine real-time monitoring of several health markers [1]. Particularly, the advent of numerous lifestyle-related disorders that were virtually unheard of a century before has been attributed to people's hectic and condensed schedules in both their personal and professional lives. All of the functioning organs have been severely impacted by the demanding daily routines of children and adults, effects that frequently go undetected due to a lack of assessment instruments. Current research suggests that the accumulation of these pressures over an extended period of time is the root cause of chronic health problems related to the heart, muscles, and brain system. These illnesses are becoming more widespread among young individuals worldwide as well as among the elderly [2].

In this case, a cost-effective and portable detection method is needed to monitor the human body's stress-related anomalies in real time [6]. Currently, the most widely used procedures for monitoring these health factors related to muscle, heart, and brain, respectively, are electromyography (EMG), electrocardiography (ECG), and electroencephalography (EEG). But in addition to being expensive and immobile, these methods are also offered by centralised health agencies [9]. The majority of these devices require professionals or medical specialists to operate and analyse the data [3]. Therefore, it may be urgently necessary to develop a portable, user-friendly gadget with an artificial intelligence-based data analysis tool for the real-time monitoring of stress accumulation characteristics [11].

The rest of the paper is organized as follows: Section 2 provides the classification scheme for the survey; Section 3 provides an overview of proposed architecture. Section 4 provides a summary and comparison of the results of the various papers discussed in this taxonomy. Finally, Section 5 concludes the paper.

2. Literature Review

Of the methods now in use, electromyography (EMG) produces an electrical signal that is comparable for diagnosing muscle strain or stiffness in various body areas, including the heart, nerves, and muscles [13]. By comparing the spontaneous "EMG-activity" in a particular muscle area to the other "EMG-quite" zones, the muscles are continuously monitored under an EMG scanner in order to determine the trigger point [4]. Treatment is given to eliminate the movement dysfunction, recurrent muscular discomfort, and problems with muscle degeneration or degradation once the trigger point causing the muscle spasm and pain has been discovered [5].

Nevertheless, prior research indicates that in order to identify the body potential, a set of muscles must be isolated using a support or restraint device configuration [12]. This restricts the patient's range of motion and makes it impractical to use in public settings. Furthermore, the instrument is not portable because it uses a numerous electrode system in conjunction with a computational equipment. Electrodes are positioned all over the spine in certain EMG devices to detect patterns in the body's electric potential, which can be used to infer a patient's health status. Before the pattern of potential in the other devices is compared and contrasted with a standard by the medical professionals, a range of motions with respect to a specific group of muscles must be generated. It is evident that the procedures associated with the EMG-based diagnosis are expensive, non-portable, complicated, and call for medical professionals [7].

3. Materials And Methods

It is commonly recognised that due to the structure of skin tissues, the surface of a muscle or piece of human skin has certain electrostatic charges. This electrostatic potential has the following cause. The extracellular matrix is joined by cells that make up human tissues, and these cells connect with one another by exchanging electrical signals through neurons and muscles. [8].

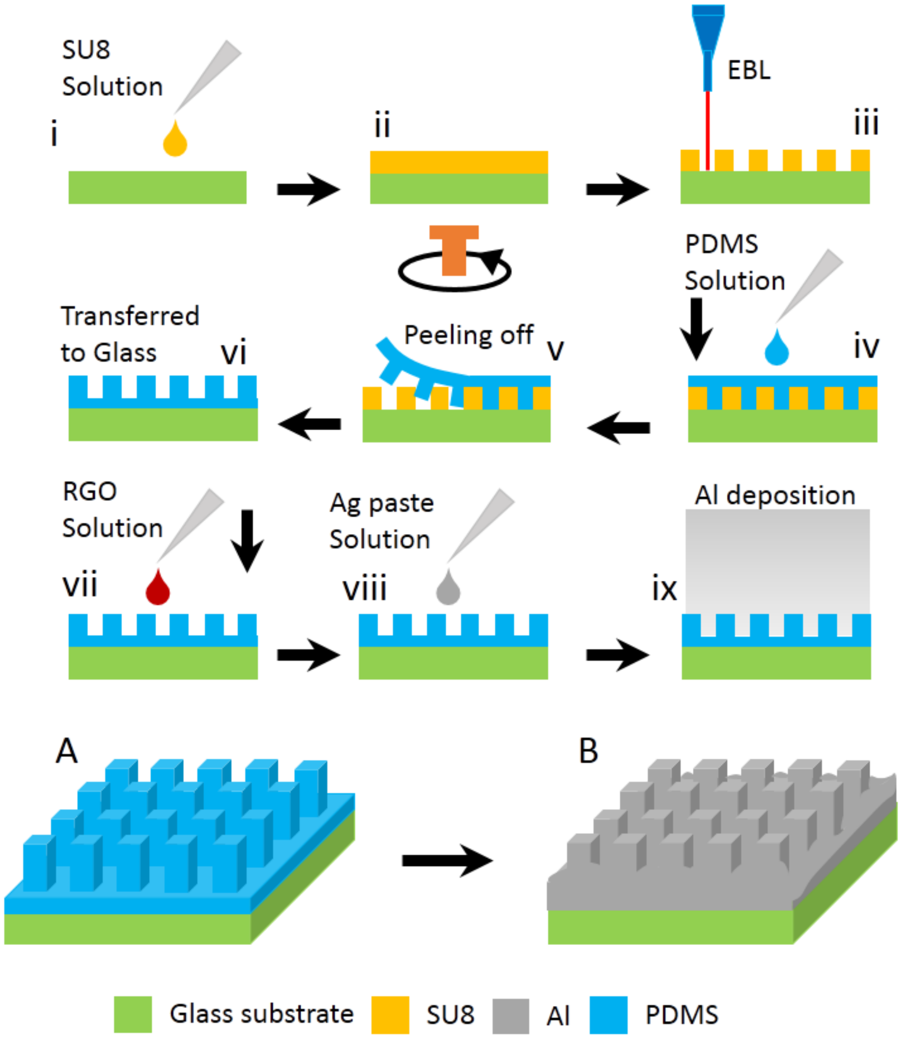

Figure 1: The figure shows fabrication steps and the schematic diagram of the patterned electrode.

Images (i) through (ix) of Figure 1 graphically depict the fabrication processes. The schematic diagram of the patterned electrode is displayed in Images (A) and (B), respectively, before and after metal deposition. To maximise the sensor electrode, several pattern sizes and spacing were created [14] [10].

4. Results and Discussions

Different spacing between the square patterns on many patterned electrodes was produced, as demonstrated in Figure 2's FESEM pictures (A) through (C). In this instance, 400 µm spacing was determined to be ideal since, as the photos illustrate, smaller patterns caused surface wrinkles to form throughout the growth stage. The Raman spectroscopy of the Al-deposited electrode and the electrode coated with Al-RGO on PDMS is displayed in Image (D). The appropriate peaks in the image verify that the materials are present.

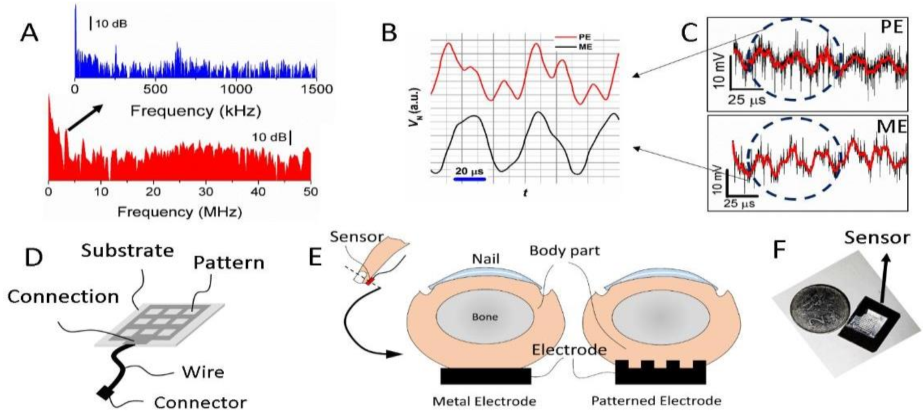

Figure 2: sensor results

The angle of view measurement using the suggested methods is displayed in Figure 2. The angle of view contraction notion is illustrated in image (a), where green denotes normal, yellow denotes a border, and red denotes the start of the disorder. The measured angle of vision of a person using and not wearing glasses is displayed in image (b). In this experiment, the person watched a video on a screen while timing the playback. Wearing power glasses usually causes a person to lose some of their eyesight because the lenses impede their field of vision. Using images (c) and (d) to demonstrate the effects of tunnel vision and normal vision, respectively, the biological significance of angle of view measurement is explained.

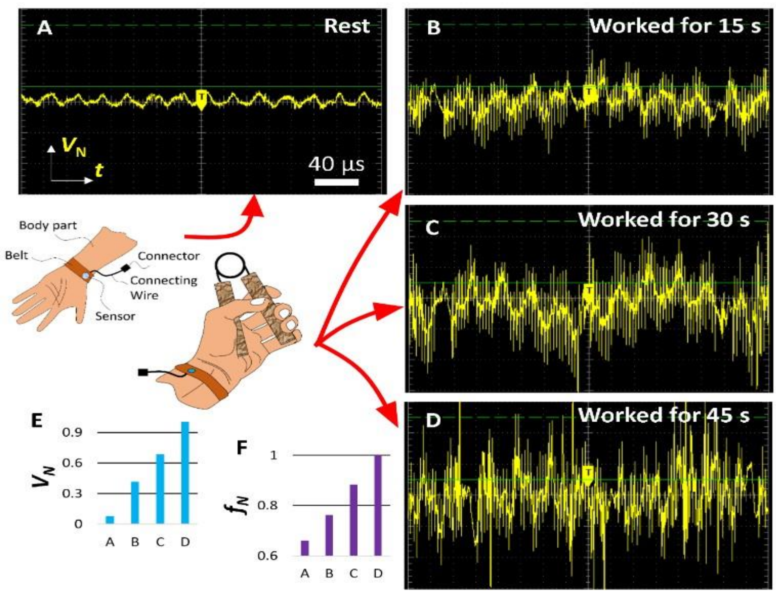

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Figure 3: the response of the PE sensor attached to the wrist at rest condition.

Figure 3 depicts a wrist response made during the exercise. In order to detect the RSEMG signal, the sensor in this instance was affixed to the left side of the left wrist.

5. Conclusion

Utilising a micro-nano pattern-based sensor, a proof-of-concept prototype that is portable and easy to use has been created for the identification of physical stress at various body locations. The polymer PDMS, which is used to make the flexible sensor, was patterned using a duplicate moulding approach and then treated with an RGO and Ag-paste solution. When a finger, toe, wrist, or tongue comes into touch with the sensor, the conductive layer coated on the flexible PDMS substrate aids in the detection of the electric field potential of that portion of the body. After being further amplified, the received signal was sent to a detecting unit for examination. It has been noted that there is a relationship between the muscle's tension and the strength and frequency of the received electric potential. Because these conditions can be linked to symptoms of increased stress at many body regions, such the tongue, wrist, fingertip, or toe, among others, the prototype is helpful in the early diagnosis of numerous diseases or disorders affecting the heart, nerves, and muscles.

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