Mini Review
Volume 12:08, 2022

Journal of Textile Science & Engineering

ISSN: 2165-8064 **Open Access**

Pressure Sensor Arrays Based on Textiles: A Brand-New, Scalable Manufacturing Method

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Abstract

Potential applications in human computer interaction, object detection, and human motion recognition, soft pressure sensors have garnered a lot of attention over the past ten years. However, the complicated and time-consuming steps limit their mass production and availability to end users. A significant obstacle is also the scalability of the working range for various applications. As a result, this work proposes a fast, labour-free, and scalable manufacturing method for capacitive-based soft pressure sensors with a wide working range and high sensitivity. By altering production parameters in accordance with specific application requirements, the novel manufacturing technique makes it possible to alter the properties of sensors. The dielectric layers of the proposed sensor are made of thermoplastic polyurethane (TPU) sheets, and the electrode is made of conductive knit fabric. In order to capture low pressures of less than 1 kPa, the novel method makes it possible to create scalable air gaps between dielectric layers and electrodes. The working range of sensors up to 1000 kPa is also increased when multi-layer TPU sheets are used. The proposed technology is successfully used to create a variety of sensor mats for a variety of uses, including interactive gaming mats for children and improved gesture and shape recognition.

Keywords: Smart textiles • Capacitive pressure • Sensors • E- textiles

Introduction

The inherent softness, breathability, and flexibility of electronic textile structures have attracted a lot of attention over the past two decades. Textile-based sensors can be used in a wide range of applications, including electronic skin, rehabilitation/personal healthcare virtual reality (VR) and augmented reality (AR) applications, pressure mapping, and motion detection, such as breathing, speaking, and joint movements. Based on the sensing mechanism, further classifications can be made between piezoresistive capacitive triboelectric and also hybrid devices, demonstrating the relevance and diversity of sensor research. Stretch ability, sensitivity, mechanical durability, and response time are just a few of the indicators that can be used to evaluate the performance of strain and pressure sensors in real-world applications. Capacitive pressure sensors are parallel plate capacitors with a dielectric sheet placed between two flexible electrodes. These sensors are appealing due to their simplicity, low power consumption, quick response, and signal repeatability, among other benefits. Changes in capacitance are converted into electrical signals by capacitive pressure sensors when pressure is applied. The capacitance is defined by the equation that follows [1].

Discussion

Where the capacitance not entirely settled by the boundaries: $\varepsilon 0$ compares to the free space permittivity, εr is the relative permittivity, S is the region of the conductive plates and δ is the distance between the plates. To date, pressure sensors have been the subject of numerous studies. For instance, a solution based on carbon nanotubes and polyvinylidene fluoride (PVDF) powder that is utilized in the electrospinning process to produce a nanofiber dielectric layer was developed in order to circumvent the pressure sensors' limitations regarding sensing range and sensitivity. In another study, electrode patterns on polyester/spandex (PET/SP) fabrics were created by prepositioning indium tin oxide polyethylene terephthalate films to the surfaces of the nanofiber dielectric layer. On the spacer fabric's top and bottom sides, single-walled carbon nanotubes (SWCNTs) were printed using screen printing. After that, laser cutting is used to shape the sensors, and encapsulation pastes are injected into the spacer layer. Capacitive pressure sensors with Ag/SWCNT electrode layers were created at the conclusion of this step [2].

A tilted micro pillar array-structured dielectric layer is used to improve a capacitive sensor. In this work, the template was made by spin coating photoresist on a silicon wafer and exposing it to ultraviolet light. A dielectric layer structure with tilted micro pillar arrays was then bonded to Au-coated PET electrodes using poly-(dimethylsiloxane) (PDMS), which was then poured and cured. Capacitive tactile sensor with spacers that create air gaps between graphene electrodes. Monolayer graphene was made by chemical vapour deposition and transferred to PET substrates. O_2 plasma-etched and photo lithographically patterned electrodes. Photolithography was used to pattern SU-8 on the PET film in order to make spacers. PDMS was spin-coated on the other graphene and exposed to N_2 plasma during this time, forming amino groups that were able to bond with epoxy groups on the SU-8 surface and react with it [3-5].

Conclusion

The alignment and bonding of the top and bottom layers completed the process. Besides, a multi material 3D printing innovation was used to create a material detecting component that have a particular math to fit the bended surfaces. On the silicon base layer, Ag/silicone ink was used to print the bottom electrode layer. The isolating and supporting layers were printed with the silicone and pluronic inks, respectively. The sensor's top electrode was printed on the supporting layer.

Acknowledgement

None.

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Date of submission: 02 August, 2022, Manuscript No. jtese-22-81706; **Editor assigned:** 04 August, 2022, PreQC No. P-81706; **Reviewed:** 16 August, 2022, QC No. Q-81706; **Revised:** 21 August 2022, Manuscript No. R-81706; **Published:** 28 August, 2022, DOI: 10.37421/2165-8064.2022.12.497

Conflict of Interest

None.

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How to cite this article: Ozlem, Kadir. “Pressure Sensor Arrays Based on Textiles: A Brand-New, Scalable Manufacturing Method.” J Textile Sci Eng 12 (2022): 497.