Flexible PET-based resistive tactile sensors via a hybrid fabrication approach using reduced graphene oxide/silver nanoparticle nanocomposite electrodes and graphene piezoresistive layer

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Azhar, Muhammad Izzuddin Mohamad [a]; Ralib, Aliza Aini Md [a]; Nordin, Nor Hidayati Diyana [b]; Jaafar, Syed Muhammad Hafiz Syed Mohd [c]; Kamal, Shafarina Azlinda Ahmad [d]; +2 authors

[a] VLSI-MEMS Research Unit, Department of Electrical and Computer Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, 53100, Malaysia

Abstract

Precise measurement of force and pressure plays a vital role in human motion monitoring where it widely used in rehabilitation to track grip strength by measuring force distribution generated during movement. Flexible commercial resistive force sensor or so called force sensitive resistors (FSRs) are widely used in wearable electronics for detecting force changes associated with human motion. While commercial FSRs are commonly employed, it lacks adaptability, flexibility and ergonomic fit required in rehabilitation settings. Personalized and custom-made resistive sensors provide tailored sensing range, sensitivity and flexibility to facilitate personalized therapy. Hence, this work explores the new technique for developing a flexible PET-based resistive tactile sensor using a hybrid fabrication approach. The developed sensor consists of the interdigitated electrode, piezoresistive layer, and the gap spacer. The reduced graphene oxide/silver nanoparticle nanocomposite electrodes layer was fabricated using inkjet printing, while the graphene piezoresistive layer was fabricated using stencil printing. The measurement setup consists of dynamic mechanical analysis (DMA) system to analyze the sensing range, sensitivity, response and recovery time, and stability. Measurement result shows a nonlinear response similar to the commercial FSR. The fabricated PET-based resistive tactile sensor achieved fractional change of resistance of 0.35 and reaching saturated resistance at 35 kPa. Low response time and recovery time was also recorded at 164.04 ms and 161.54 ms, respectively. The custom PET-based resistive tactile sensor demonstrated stable performance with minimal variation of output signal when subjected to a constant displacement and load over 400 load cycles at a frequency of 1 Hz. The sensor was tested in a system to detect gripping action by sensing muscle contraction forces from 3 upper forearm muscle groups. Hence, the proposed flexible PET-based resistive tactile sensor using inkjet printable rGO/AgNP nanocomposites conductive ink and graphene ink has high potential to be used for wearable pressure sensing applications.

Indexed keywords

Engineering controlled terms

Dynamic mechanical analysis; Electrodes; Fabrication; Flexible electronics; Ink; Ink jet printing; Nanoparticles; Reduced Graphene Oxide; Sensitivity analysis; Tactile sensors; Wearable sensors

Engineering uncontrolled terms

Force sensitive resistors; Graphenes; Human motions; Hybrid fabrication; Nanocomposite electrodes; Piezo-resistive; Precise measurements; Reduced graphene oxides; Sensing ranges; Tactile sensors

Engineering main heading

Muscle

Corresponding authors

Corresponding author A.A.M. Ralib