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Flexible Composites Based on Bidimensional Nanomaterials: Eletromechanical Characterization and Applications.

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Abstract

In wearable device technology for pressure sensing and detection, direct contact between sensor and target object is necessary. Therefore flexibility of pressure sensors is an important parameter in device performance. In this work, we explore reprodutibility issues and variations in calibration curves for sensors based on Poliurethane (PU) and reduced graphene oxide (r-GO) low cost composites for tactile perpection.

Key words:

Low-cost, Device, Graphene Composite.

Introduction

Electronic sensors can provide precise and real time measurements of vital data from live organisms; as such, they become increasingly important to medical applications and healthcare. These sensors must, ideally, be soft and flexible in order to exhibit good mechanical contact with the biological tissues, which are inherently smooth and in constant movement. In this project, we intended to develop new, low cost and high performance composites for possible applications in sensor devices developed for neurological rehabilitation.

The main goal of this project is to improve a developed flexible material based on polyurethane (PU) and graphene oxide (GO) composites, in order to come up with wearable devices that can be used in tactile detection.

Results and Discussion

The fabrication of the PU-GO composite was obtained from the deposition of GO in PU commercial foams. At first, foams with different specifications were used, so the resistance response could be related to the properties of each type.

The PU foams were cut with squared area (10mm in side) and different values of height, and subsequently used in two different protocols for modification with Graphene Oxide (GO). The first consisted of immersion in a dispersion of GO (2 mg/ml) for 30 minutes, then dried in a stove for 10 minutes at 80ºC. This procedure was repeated several times; the second protocol involved a single cycle centrifugation process into a dispersion of GO (4 mg/ml).

Reduced graphene oxide (r-GO) was obtained by reducing GO with ascorbic acid; the electrical resistances of the samples dropped by 1-2 (2-3) orders of magnitude for both presented protocols.

Compression tests of the samples were carried out, observing compression length and force responses as a function of the electrical resistance and thus current as a response to applied voltage. Calibration curves were plotted for several samples with different values of height; the electrical resistance decreased with compression due to enhanced current (percolation) as compression takes places. Also, real time measurements have taken place to validate the response time of the devices; the value obtained for a sensor of 6 mm in height was 250 ms for the pressuring response and 700 ms for the relaxation response.

One of the main goals is to get the thinnest sensor possible, which would be more suitable for tactile detection application. Currently, the sensor used so far had 4 mm in height, although variations on the concentration of the GO and other variables of the procedures of fabrication are being tested so the best case scenario is yet to be achieved. The calibration curves were obtained with the use of different types of contact profile beyond normal contact in order to validate the use for non-uniform touch characteristic of the soft skin, although a difference between the calibration curves was observed, an adequate circuit or software processing is enough to provide an useful final response.

The structural characterization of the samples was carried out by scanning electron microscopy (SEM). The obtained images showed that both GO and r-GO remain adhered to the foam even after 6000 compressions (acquired with up to 80% of the sample height), indicating good resilience of the sensors.

Three similar samples of each specification were fabricated under the exact same process, validating good reproducibility of the processes of fabrication.

Finally, the production of user-friendly functioning devices can be initiated using these composites and different types of feedback can be explored, e.g. visual, sound and tactile feedback.

Conclusions

With the results in response time, resilience and reproducibility, we can conclude that the fabricated composites are suitable for tactile detection, due to the force range observed in the calibration curves. The range of electrical resistances observed from the sensors also allows simple circuits to monitor their response. Furthermore, the production of functioning devices could be initiated and tested.

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