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Flexible Composites Based on Polyurethane and Graphene Oxide: Eletromechanical Characterization for Applications in Tactile Transduction

Flavio A. Borges*, João H. Clerici, Daniel M. Ugarte, Cecília C. C. Silva, Mônica A. Cotta.

Abstract

Wearable devicetechnology advances at a fast pace, creating opportunities for new medical applications. In particular, for pressure sensing and detection, direct contact between sensor and target object is necessary. When this object is soft, the flexibility of pressure sensors is an important parameter for suitable device performance.In this work, we report on the synthesis of low cost composites based on poliurethane (PU) and reduced graphene oxide (r-GO) for possible applications in tactile detection for neurologically impaired patients.

Key words:

Tactile Sensor, Low-cost, 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 the development and characterization of a low cost, flexible material based on polyurethane (PU) and graphene oxide (GO) composites, in order to obtain suitable conversion, resistance and resilience coefficients for pressure and vibration devices working in the range of 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 related to the properties of each type, mostly density and size of the pores, could be observed and analyzed.

Table 1. Properties of the different foams used.

PROPERTIES	D18	D28	D35	D45
Density (kg/m3), min	16,2	25,2	31,5	40,5
Resilience (%)	400	450	450	450

The PU foams were cut in cubic form (10mm in side) 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 acid ascorbic; the electrical resistances of the samples dropped by 1-2 (2-3) orders of magnitude for the immersion and centrifugation protocols, respectively.

Compression tests of the samples were carried out, observing compression length and force responses as a function of the electrical resistance. Calibration curves were plotted for several samples with 6 mm in height; the electrical resistance decreased with compression due to enhanced current (percolation) as compression takes places. The calibration curves were obtained with the use of different types of contact profile beyond normal contact, simulating inclined, pointy and irregular touching surfaces.

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 (80%of the sample height). This result may explain the similarity between the calibration curves from before and after 6000 compressions, indicating that the sensor has good resilience.

Finally, 3 similar samples of each specification were fabricated under the exact same process, for both protocols, so sample reproducibility could be tested; from this, we got similar force versus resistance curves (10% variation, on average, for the entire range of tactile force), showing good reproducibility of the sensor.

Conclusions

The SEM images show that the r-GO has good adherence to the PU samples, and the composites present high durability. With this result and the calibration curves, we can conclude that the fabricated composites are suitable to the purpose of the project – sensors 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 samples presented good resilience and reproducibility results, indicating that sensor devices can be fabricated from our composites.

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