A Flexible Electrochemical Sensor Based on Electric Double-Layer Capacitor

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Abstract

Flexibility is an indispensable attribute of ideal wearable devices, which can achieve a decrease in both volume and weight. Owing to its promising advantage, flexible electronics has been applied in many fields. However, constructing flexible sensors and a matching power supply is a key technology to be tackled when it comes to the measurement field.

In this study, we propose a novel electrochemical sensor (ES) based on electric double-layer capacitor that can serve as a shock sensor or tactile sensor. Our ES consists of several carbon electrodes in series, and each electrode has a porous structure to be saturated with electrolyte. Mixing Activated carbon uniformly with carbon black and rubber by ball milling at a ratio of 8:1:1, and then the mixture is rolled into sheets to make porous electrodes. As electron micrograph of a electrode film shows in Figure 1(a), numerous carbon pores are connected and supported by a rubber skeleton to form a porous structure.

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| Figure 1: (a) Electron micrograph of the piezoresistive electrode film. (b) Application of the ES as a self-powered high g impact sensor in an automobile to protect passengers during a traffic accident. (c) Machete hammer test result with a response time of about 1ms. |

These porous electrodes exhibit obvious piezoresistive effect, which means the resistance as well as the output voltage of ES will varies under external pressure during discharge. Thus, this device is able to be applied to detect high g shock from vehicle collision or other occasions by the fluctuation of the output voltage and to trigger the airbag to protect the passengers in the automobie. In addition, ES can be flexibly packaged to be wearable when carbon electrodes are made into thin layers. In this way, ES shows great advantage when it is attached to the fingers of a robot hand as a tactile sensor. As ES is a practical electrical- enegy storage device, it still works in the absence of a power supply, which is available to lighten the robot hand.

A sensor response test is completed by a Machete hammer machine to simulate the high impact of a vehicle collision,during this test, ES’s output voltage increases reversely as soon as the high impact occurs. The results prove good performance of ESs in high impact sensing.

References

1. Dai, K.R.; Wang,X.F.;Yi,F.: Discharge voltage behavior of electric double-layer capacitors during high-g impact and their application to autonomously sensing high-g accelerometers. Nano Research, , Vol.11, No. 2, pp. 1146-1156, 2018.
2. Zeng,W.; Shu,L.; Li,Q.: Fiber-Based Wearable Electronics: A Review of Materials, Fabrication, Devices, and Applications. Advanced Materials, , Vol.26, No.31, pp. 5310-5336, 2014.