Effects of mechanical stress on electrical parameters and noise of supercapacitors

Arkadiusz Szewczyk, Łukasz Lentka, Janusz Smulko
Faculty of Electronics, Telecommunication and Informatics
Gdańsk University of Technology
Gdańsk, Poland
szewczyk@eti.pg.edu.pl

Abstract — Results of noise and electrical parameters measurements of prototype electrochemical double layer capacitors (EDLC) are reported at presence of selected mechanical stress. This issue is of great importance due to eventual applications in wearable technology. The measurement results are compared and we may conclude than flicker noise is more sensitive to any stress than other considered electrical parameters.

Keywords— EDLC, supercapacitor, noise, mechanical stress

I. INTRODUCTION

Electrochemical double layer capacitor (EDLC) is a device that is capable to store relatively high amount of electrical energy in comparison to its mass. Additionally, it may work effectively for a long time. The charge is stored in a double electrical layer that is formed between the porous electrode and electrolyte solution interface. The interface is very fragile to any changes in the EDLCs due to low size of the pores, even below 1 nm, where the ions preserve electrical charge.

The device may be applied as an energy supplier in wearable electronic systems of low power consumption. It means that it should be cheap and resistive to mechanical stress during exploitation. We present measurement results of selected electrical parameters of exemplary EDLCs when mechanically bended. These parameters were compared with low frequency noise measurements (in flicker noise and white noise regions).

II. SAMPLES

In our experimental studies the prototype EDLC cells were used. The cell comprises of two electrodes with porous carbon layer with ion permissible separator between them that is typical for such elements. The electrolyte solution fulfill the space between electrodes. The structure is enclosed in hermetically welded pouch cell. Electrodes are led out on both sides of the pouch to assure electric contacts. The pouch cell is flat and flexible, and may be attached to cloths. It’s size is approximately about 8 cm x 9 cm. The applied electrolyte is organic and the nominal voltage is 2.7 V. The cell capacitance C ~ 7 F, which is sufficient to supply an energy for tiny electronic systems.

III. EXPERIMENT

The measurement set-up comprises of programmable potentiostat-galvanostat to assure charging-discharging process of the tested EDLC, and noise measurement channel utilizing low-noise amplifier and 24-bit analog-to-digital converter [1, 2].

The tested EDLC was placed on a flat surface and pressed by 1 kg mass to stabilize its geometry. The sample was charged to different voltages from 0.5 V to 2.5 V and back. Capacitance C, equivalent serial resistance ESR and flicker noise were measured. Noise was recorded during discharging through the loading resistance 100 Ω. The same experiment was repeated by bending the samples using the selected rigid forms (Fig. 1), fabricated by 3D printing technology.

IV. RESULTS

We have observed some changes of C and ESR values at different polarizing voltages and bending. Noise intensity depended on polarizing voltage as well and changed when bended or when the experiment was run again. We may conclude that noise seems to be more sensible than electrical parameters to any mechanical stress.

REFERENCES


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