Characterization of electrochemical double layer capacitor electrode using self-discharge measurements and modeling

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ABSTRACT

A simple protocol to characterize the electrochemical double layer capacitors (EDLCs) using self-discharge (open circuit discharge) data and a three-branch electrical model is presented. The method relies on recording the self-discharge data of EDLCs and using it to estimate the parametric values of the variables in the model (time constants, maximum voltage, resistances, and capacitances). Porous carbon and metal oxide electrodes in three choice electrolytes are used for the experiments and the simulations are performed using MATLAB Simulink platform. The simulated and experimental self-discharge data are in close agreement for the EDLC storage mode but not for the battery type storage. The results are further validated by simulating the galvanostatic charge discharge (GCD) cycling data and fitting them to the experimental GCD of the assembled devices with high accuracies. The model presented here thus enables determination of charge storage parameters as well as whether a device is capacitive from a single self-discharge data, thereby providing an excellent tool to characterize EDLCs for both academia and industry.

KEYWORDS

Charge redistribution; Electrical energy storage systems (EESS); Electrical modeling; Supercapacitor modeling; Supercapacitors

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