Lithium Power Sources Based on Porous Carbon Material

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The paper describes the possibility of using of porous carbon materials (PCM) from plant raw material as anodes of lithium power sources (LPS). The following PCM were chosen for testing: standard 1 – material obtained at carbonization temperature of 1023 K; standard 2 – thermally modified for 2.5 h at a temperature of 773 K standard 1; chemically washed with hydrofluoric (standard 3), salt (standard 4), and nitrogen (standard 5) acids standard 1. To create the laboratory samples of LPS the case details of primary lithium elements of coin design type CR2016 were used. LPS on PCM and lithium counter electrode bases are tested in galvanostatic mode at a current density of *C*/20 (for carbon *C* is 372 mA·h/g). 1 M solution of $LiPF_6$ in a solvent mixture (ethylene carbonate/dimethyl carbonate/diethylene carbonate in the ratio 1:1:1) was used as an electrolyte.

According to the results of the research, the main capacity of material spent in a voltage range of $0 \div 1.2$ V versus Li^+/Li. Specific capacity exceeds 450 mA·h/g at the first discharge for all standards. Charge and discharge capacity drastically reduced to 130-250 mA·h/g from the second cycle, but the hysteresis between the charge and discharge curves decreases. This fact points to the gradual stabilization of the electrode structure and its restructuring during cycling. The value of irreversible capacity is $21 \div 63$ % at the first cycle. A main reason is the formation of solid electrolyte interface on PCM surface. Obviously, the higher specific surface PCM has, the more charge (capacity) is spent at its formation. For example, for standard 1 (specific surface area is 343 m^2/g) irreversible capacity is 207 mA·h/g (36 %), while for standard 2 (specific surface area is 586 m^2/g) – 375 mA·h/g (59 %). The lowest value of irreversible capacity for sample 3 (110 mA·h/g or 21 %) is also associated with the lowest value of its surface (29 m^2/g).

From the second cycle, the specific capacitance is reduced almost in half. The difference in the values of the charge and discharge capacity decreases with further cycling, and Coulomb efficiency greater than 95 %. The smallest value of irreversible capacity has LPS on sample 3 base – after 93 charge/discharge cycles its value is 66 %. The highest value has a sample 2 – 86% (after 85 cycles) and sample 5 – 91% (after 90 cycles). Thus, prolonged cycling does not change the charge-discharge characteristics of the electrode, indicating the high stability of electrochemical characteristics of anode materials on PCM bases and the possibility of their use in the LPS.