Electrochemical properties and structural evolution of starch-based carbon nanostructures as Li-ion anode materials with regard to thermal treatment

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Although many different anode materials have been widely studied recently, carbonaceous materials are still the most commonly used in commercial LIBs [1,2]. Their application as Li-ion anodes in 2016 was 96% of all anode types [3]. Nevertheless to deal with the current energy challenge (increasing demand in higher energy storage and faster power delivery) and avoid further deterioration of environment, research efforts should be devoted to utilizing various carbon materials based on sustainable resources which reveal ability to obtain high-performance electrode materials. In fact, naturally abundant precursors are not only affordable and inexhaustible but often possess hierarchical structure, specific porous organization and therefore are of high interest to derive advanced carbons which exhibit unique properties [4].
In this work we report a comprehensive study on the preparation and characterization of carbon nanostructures derived from starch precursors, with particular focus on the correlation of the heat treatment with evolution of structure and electrochemical properties of carbon-based anodes.
To obtain carbon materials, different types of starch were taken as the starting materials and processed by gelatinization, exchange of solvent, drying process and pyrolysis of organic precursors under inert gas atmosphere at a temperature ranging from 600 to 2000°C. The chemical composition, structure, porosity and microstructure of the produced carbons were determined using elemental analysis (EA), X-ray powder diffraction (XRD), Raman spectroscopy (RS), nitrogen adsorption-desorption method (N_2-BET) and scanning electron microscopy (SEM), respectively. The electrochemical characterization of lithium batteries based on the fabricated carbon electrodes was carried out using the electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV) and galvanostatic charge discharge tests (GCDT).
Preparation of carbon materials which exhibit hierarchically arranged structure, high specific surface area and highly developed microporosity was successfully performed. The structural changes and electrochemical performance of the synthesized carbons in relation to thermal treatment of organic precursors were analyzed and suggested explanations for the observed dependencies were given. All things considered, the carbon materials obtained from renewable plant polysaccharides represent very attractive materials for electrochemical applications, especially for high-performance LIBs.

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