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Effect of activation temperature on the properties of double layer capacitance of diatomite-templated carbon

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1 Introduction

In recent years porous carbons have been widely used in many fields such as energy storage (McCreery, 2008; Liu et al, 2009; Ho et al, 2014; Yang et al, 2015), adsorption, wastewater treatment, air purification (Lorenc-Grabowska et al, 2005) and so on due to their large specific surface area, high conductivity, thermal conductivity and chemical stability. When used as electrode materials, the pore size distribution of porous carbon obtained by traditional preparation methods (including traditional method, catalytic activation, metal salt polymer blend carbonization etc.) are not uniform, and electrolyte is difficult to enter into pores, diffuse and transfer, resulting in low utilization ratio of the specific surface area. Besides the large pore size could result in a decline in the conductivity and electrochemical properties, so it is difficult to meet the application needs. The template method can be used to change the morphology and pore size distribution of porous carbon by changing the type and structure of the template. However, the template preparation process is complex and the cost is very high in the traditional template method, which seriously restricts the application of template synthesis of porous carbon. There are many natural minerals with micro/nano porous structure, such as zeolite, montmorillonite, sepiolite, halloysite and diatomite, used as template to synthesize with carbon materials is a new exploration of the template method.

The main component of diatomite is amorphous silica ($SiO_2 \cdot nH_2O$) with a large number of large pores and some mesopores and micropores, so it's often used to prepare macroporous template carbon materials. At present, the preparation of diatomite template carbon is mostly used as adsorption material (Liu et al, 2013; Yu et al, 2015), but its electrochemical properties are rarely studied.

This article is mainly study the effect of activation temperature on the performance of electrochemical double layer capacitor (EDLC) of diatomite-templated carbon.

2 Effect of Activation Temperature on the Properties of EDLC

2.1 Cyclic voltammetry

The cyclic voltammetry curves of template carbon after activation are close to the rectangle, and as the scan rate increased, the rectangular shape of votammograms of activated carbon is maintained with slight distortion, which shows that samples possess excellent capacitive behaviour and would be suitable for quick charge–discharge operations. The current density responses and the cyclic voltammetry curve areas decrease significantly with the increase of activation temperature, suggesting the capacitive properties gets worse when the activation temperature increases.

2.2 Galvanostatic charge/discharge

The galvanostatic charge/discharge curve is seen in Fig. 1. The plots present good linearity, symmetrical triangle and lower IR drop after activation, indicating good EDLC behaviors. The specific capacitances of all ACs electrodes are ranging from 56.6 F/ g to 92.4 F/g, more than 6 times than that of diatomite-templated carbon. The specific capacitances of samples follow the order: AC-700 > AC-800 > AC-900> C-700, and there are notable decreases in specific capacitance with the increase of activation temperature. Specific capacitance of all samples are ranging from 45.4 F/ g to 79.6 F/ g at current density of 10 A/g and capacitance retention can maintain at more than 75.4%, indicating they have good fast charge/discharge properties.

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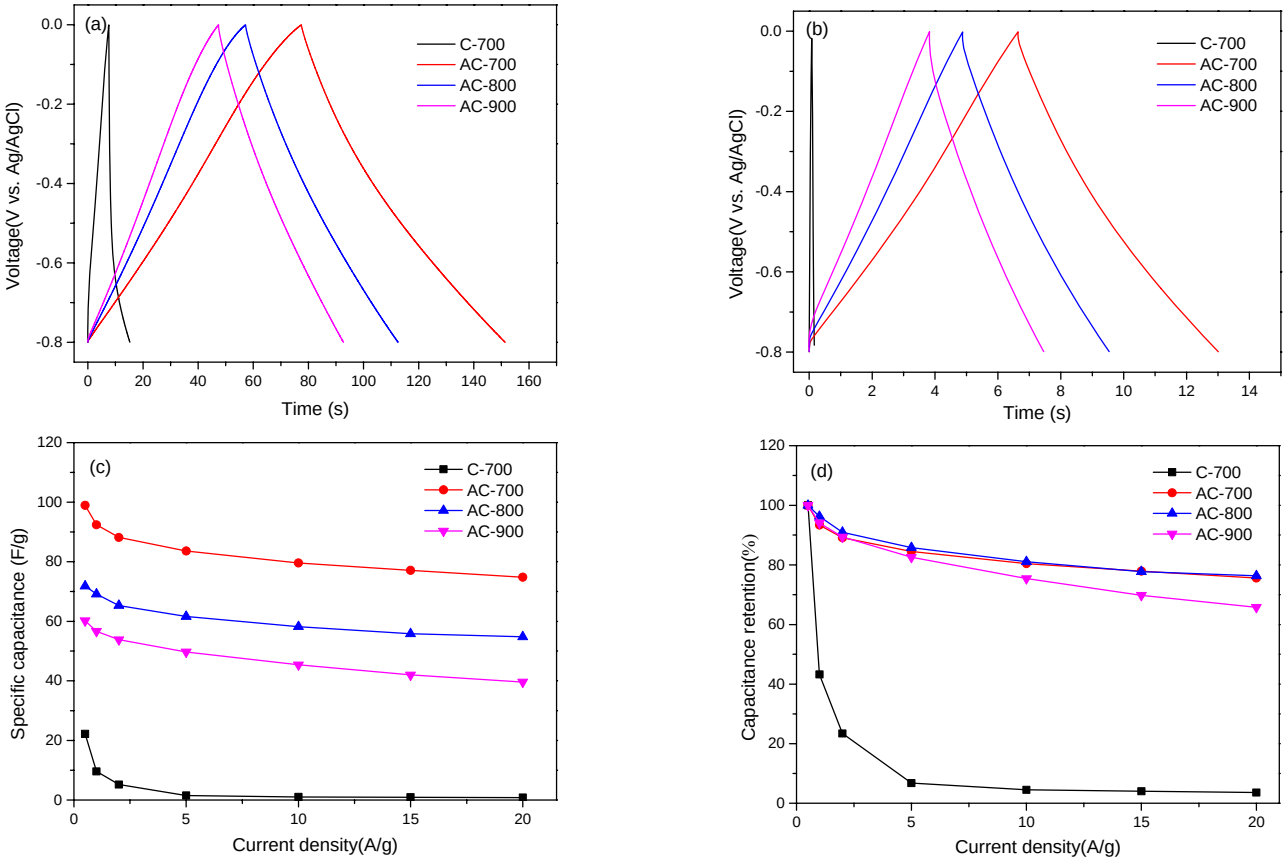

Fig. 1. Galvanostatic charge/discharge properties of diatomite-templated carbon before and after activation.
(a), GCD curves of ACs obtained at a constant current density of 1 A/g; (b), GCD curves of ACs obtained at a constant current density of 10 A/g; (c), specific capacitance of carbon materials at different current density; (d) capacitance retention of carbon materials at different current density.

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