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<InlineShape1>

Communication

Natural nanomaterial as hard template for scalable synthesizing holey carbon naonsheet/nanotube with in-plane and out-of-plane pores for electrochemical energy storage

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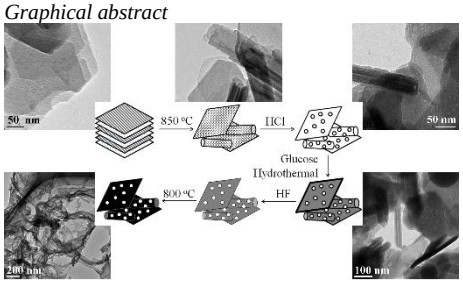
Graphical abstract



By tuning the structure of hard template kaolinite, we have achieved a template directed synthesis of holey carbon nanosheet/nanotube material. This carbon nanomaterial with in-plane and out-of-plane pores has shown promising electrochemical energy storage capacity.

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ABSTRACT

Tuning porous structure of carbon nanomaterials has been found to be important for their performance enhancement in electrochemical energy storage applications. In this work we employed a natural nanomaterial kaolinite, which is abundant and cheap, as hard template to synthesis porous carbon nanomaterial. By tuning the structure of hard template kaolinite, we have achieved a template directed formation of holey carbon nanosheet/nanotube materials. This carbon nanomaterials with hierarchical in-plane and out-of-plane pores have shown electrochemical energy storage capacity of 286 F/g (equal to 314 F/cm^3) at 0.1 A/g and 85 F/g (equal to 93 F/cm^3) at 100 A/g, which is comparable to variety of reported carbon based electrochemical energy storage electrode materials.

Low dimensional carbon nanomaterials with good electrical conductivity, high surface area and porous structure are excellent electrode materials for electrochemical energy storage and conversion applications [1-5]. Quasi-one dimension carbon nanotubes [6], quasi-two dimension grapheme [7] and carbon nanomaterials synthesized from variety of organic precursors [1,3,8-12] have thus been intensively studied. One important issue for electrode materials design is tuning pore architecture of carbon naonmaterials to achieve fast ion transportation and sufficient interface electrochemical area that can effectively enhance their energy storage performance [13]. Manipulating porous nanostructure of carbon materials has thus attracted great attentions for scientific researches recent years [14-18]. Very recently, some successful strategies have been developed. One strategy is to create in-plane pores of carbon nanosheet especially graphene *via* chemical activation [19-20]. This method is highly effective on enhancing porosity of graphene based materials. Another strategy is hybridization of quasi-one dimensional carbon nanotube with quasi-two dimensional graphene into material with out-of-plane pores [21,22]. Though scalable synthesis these materials is still a challenge for their vigorous synthesis conditions, the in-plane and out-of-plane porous structure

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