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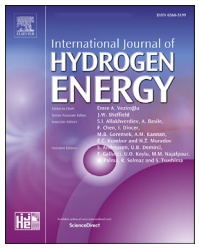

Electrochemical hydrogen storage in a nitrogen-doped uniformed microporous carbon

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ABSTRACT

A nitrogen-doped carbon material with uniformed micro-porosity structure was synthesized by carbonized a copolymer made with a molecular-scale template, octa(aminophenyl)silsesquioxane , and phenolic resol and the silica domain removing. High nitrogen content as well as unimodal micropore with narrow size distribution were achieved. This nitrogen doped well-defined microporous carbon exhibited high electrochemical hydrogen storage and superior stability over those in regular active carbon material.

Introduction

Hydrogen, widely regarded as a clean, highly abundant and non toxic renewable energy carrier, is a promising candidate to replace the fossil fuels and then reduce the greenhouse effect. However, the major impediment, which limited its practical application, is to find a safe, effective, inexpensive and high capacity hydrogen storage medium. In order to meet the requirements of fast hydrogen adsorption/desorption, stable thermodynamic, light weight and long cycle life, many storage medium have been developed, such as metal alloys, boron nitride and metal–organic frameworks [1–15]. Comparing to the conventional hydrogen storage technology at low temperature and high pressure, electrochemical hydrogen storage has been proved as more efficient at ambient temperature and pressure [16–18]. Moreover, it was

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demonstrated that carbonaceous material is indeed a good candidate for electrochemical hydrogen storage through the insertion of atomic hydrogen into its interlayer [19–38]. Furthermore, It was also demonstrated that the porosity of carbon and the heteroatom doping are the important factors affecting the electrochemical hydrogen storage capacity [26,27,39]. In our previous study, a nitrogen doped micro-pore carbon material (NMC) was designed and constructed [40]. In this carbon materials, the micro-pores were formed with uniformed size and mono-dispersed within the carbon matrix. Such well-defined micro-porosity structure cannot be obtained through the general activation processes which were widely used in micro-pores generation. Through this approach, as shown in Fig. 1, octa(aminophenyl)silsesquioxane (OAPS), an organic/inorganic hybrid structure with an cubic inner cage core of siloxane (Si_8O_{12}) and an outer aromatic amine, was selected as the self-template. The OAPSs were then cross-lined with the phenolic resol to form a 3D network by the generation of the hydrogen bonds between the acidic phenolic hydroxyl groups of the resol and the basic amino groups of OAPS as well as the C–N bonds through the condensation reaction between the amino groups of OAPS and the hydroxymethyls of the resol in the mixing and thermal curing process, respectively. After the pyrolysis, the formed polymer network transferred into a nitrogen doped carbon material with mono-dispersed amorphous silica domains which were decomposed from the inner core of siloxane. The further HF etching caused the formation of well-defined micro-porous carbon with nitrogen functionality on it [40,41]. In this study, this unique carbon material was characterized and then investigated as the electrochemical hydrogen storage carrier. In the mean time, a commercial active carbon (AC) is also investigated along with the synthesized NMC as comparison. The results indicated that the synthesized NMC showed high capacity and good stability of electrochemical hydrogen storage.

Experimental section

Phenyltrichlorosilane ($PhSiCl_3$) was purchased from Aladdin Reagent Co., Ltd. Other chemicals were purchased from

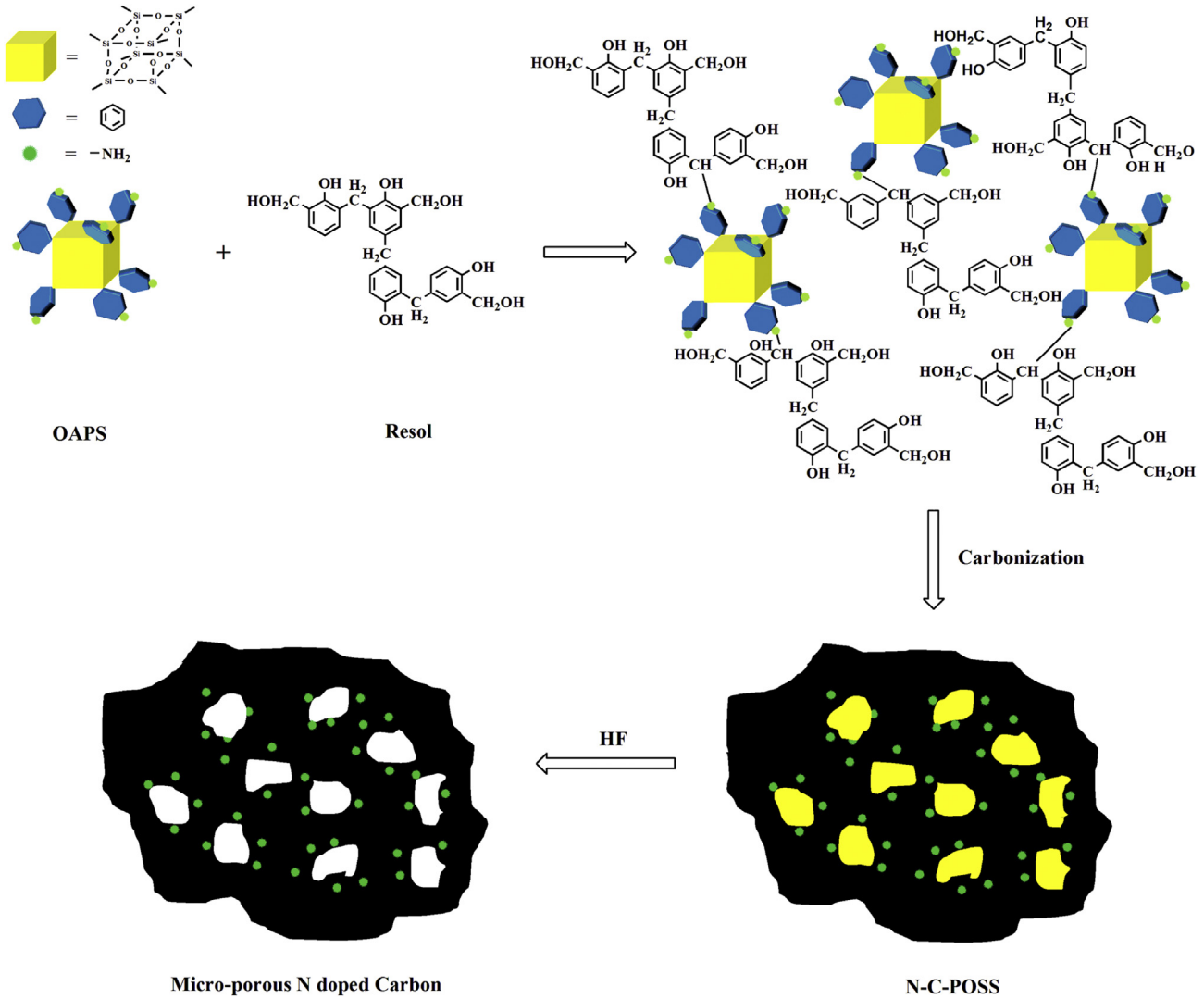

Fig. 1 – Schematic illustration of synthesis of nitrogen-doped carbon with well-defined microporosity structure.

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