Renewable Carbon

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Renewable carbon is one of the most important materials which have been used in a wide range of applications, such as chemical catalysis, medicinal purification, environmental cleaning and metal extraction. Meanwhile, with the development of technology, the use field of renewable carbon keeps expanding to new areas, such as electrode and super-capacitors for energetic cell, as well as many other innovative industries. Similar to carbon nanotube (CNT) or graphene, it has variable characteristics of surface groups, along with high interface reactivity. These surface groups provide abundant reaction sites for chemical modification via electrostatic/van der Waals force, chemical bonding or noncovalent π-π interactions, thus imparting carbon particles with excellent natural affinity toward a large number of substrates. Moreover, the highly developed porous structure renders renewable carbon with a large range of surface area (500-3000 m^2/g). It consists of thin graphite layers with exceptional mechanical strength, which highlights its great potential to be used as reinforcement agent in advanced packaging composites.

Keywords: Renewable Carbon ; Intersurface Activity ; Classification

1. Introduction

Renewable carbon is a complex product, and this makes its classification difficult. Many different ways have been reported by considering the various features of renewable carbon, such as surface characteristics, reactivity and physical behaviors [1]. Based on the geometry, renewable carbon can be classified into granular renewable carbon and powdered renewable carbon, and each type has its own application area, such as gas adsorbent (granular renewable carbon) and water cleaning (powdered renewable carbon).

2. Granular Renewable Carbon

Granular renewable carbon has been widely used as a functional adsorbent for a wide range of applications. The particle size of granular carbon is relatively larger, thus with smaller specific surface area. Figure 2 shows the bamboo-derived granular renewable carbon prepared via KOH activation. Large pores can be observed from the scanning electron microscopy images (SEM, JSM-6460LV, JEOL) [2].

As for the application, granular renewable carbon can be employed for gas purification or for the separation of components in flow systems, due to its high diffusion rate [3]. Yang et al. used granular carbon to accelerate the syntrophic metabolism of a batch-mode anaerobic sludge treatment, via enhancing the electron exchange between syntrophs and methanogens (Figure 3). An increase of 17.4% for the methane production was achieved, as the dosage of granular carbon increased from 0 to 5.0 g [4].

3. Powdered Renewable Carbon

Renewable carbon in its particular powder form is generally with larger internal surface. It has an average diameter between 0.1 and 25 mm, with a length of less than 100 mm. Figure 4 shows the microstructure of a typical powdered carbon with large conchoidal cavities and smooth surfaces (Figure 4a,b) [5]. Its porosity is made up of randomly distributed pores, as displayed in Figure 4c,d. The inset Fast Fourier Transform (FFT) pattern further confirms the amorphous structure of generated powder carbon. The high surface area, as well as the small diffusion distance, allows the carbon powder to be directly used in the process units.

Recently, a new type of superfine powdered renewable carbon has been emerging as an effective adsorbent material with a size of 0.1–1 μm, which is an order of magnitude smaller than the conventional powdered carbon. Partlan et al. prepared the superfine powdered carbon from both wood and coconut-shell sources [6]. A wet mill with yttrium-stabilized zirconium oxide beads (dimension of 0.3–0.5 mm) was used to grind the raw materials into different sizes by controlling the milling time. The results revealed that both wood-based and coconut-shell-based carbons had their particle size decreased at a longer milling time. However, the specific surface area and pore volume distributions remained independent of the milling time. Comparing with regular powdered renewable carbon, superfine carbon showed an increased adsorption capacity for contaminants in the drinking water.

Besides the aforementioned two types of carbon, impregnated renewable carbon and extruded renewable carbon are also popular in the market. As for their application, the former can be used for air-pollution control [7], while the latter is suitable for gas-phase applications [8].

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