Lecture 4. Activated carbon materials based on coconut shell

Activated carbon derived from carbon-rich sources, such as biomass, coal, or coconut shells is a highly porous material, which is known by its large surface area and high adsorption capacity. Due to its unique properties, it is an essential material in wide range of applications, specially, in environmental remediation, water treatment, and energy storage. Activated carbon has a specific surface area that ranges from 500 to 1500 m^2/g. AC can be effective in capturing pollutants because of its porous nature, which enables a variety of compounds. Additionally, the surface of activated carbon has a variety of functional groups that can improve its interaction with other adsorbents. The substance endures high temperatures and is chemically resistant, which makes it appropriate for a variety of industrial applications [1]. Activated carbon, a highly porous material with extensive surface area, can be synthesized through physical or chemical activation methods. The synthesis of activated carbon involves two primary processes carbonization and activation. Carbonization is the thermal decomposition of organic material in the absence of oxygen, resulting in a charred product. This is followed by activation, which can be achieved through physical or chemical methods. Physical activation involves heating the carbonized material (biomass precursors undergo carbonization at high temperatures (600–1200°C) under an inert atmosphere (e.g., nitrogen or argon)) in the presence of oxidizing gases, such as steam or carbon dioxide. This process enhances the porosity and surface area of the material. On the other hand, chemical activation involves impregnating the biomass with chemical agents such as potassium hydroxide (KOH), phosphoric acid (H_3PO_4), or zinc chloride ($ZnCl_2$) before carbonization. Chemical activation generally produces a higher surface area and enhanced porosity compared to physical methods due to the dehydrating effect of the chemical agents, which also lowers the required carbonization temperature.

Sujiono et al. (Sujiono et al., 2022) fabricated a high-quality microporous activated carbon from coconut shell waste by using different activating agents. They showed the activated carbon-based on an activating agent of NaOH can potentially be applied for water purification treatment. Neerhu et al. (Neethu et al., 2019) developed an affordable low-cost durable proton exchange membrane (PEM) based on activated carbon derived from coconut shell (ACCS) and natural clay for application in a microbial fuel cell [1,2].

Table 1. Comparison of S_{BET} of activated carbon from coconut shell precursors

Raw material	SSA, m^2/g	Application	Ref.
Coconut shell	516	Water purification treatment	(Sujiono et al., 2022)
Coconut shell	420	Microbial fuel cell	(Neethu et al., 2019)

Literatures

1. Lesbayev B., Auyelkhankyzy M, Ustayeva G., Yeleuov M., Rakhymzhan N., Maltay A., Maral Ye. (2023) Recent advances: Biomass-derived porous carbon materials. South African Journal of Chemical Engineering 43:327–336. DOI:10.1016/j.sajce.2022.11.012.

2. Lesbayev B., Auyelkhankyzy M., Ustayeva G., Yeleuov M., Rakhymzhan N., Maral Y., Tolynbekov A. (2023) Modification of Biomass-Derived Nanoporous Carbon with Nickel Oxide Nanoparticles for Supercapacitor Application, Journal of Composites Science, 7:20, doi.org/10.3390/jcs7010020