Lecture 5. Highly porous activated carbon materials from fibres of oil palm

Biomass-derived carbon materials present a promising, sustainable alternative to conventional carbon sources, with significant advantages for environmental and energy applications. These materials, derived from readily available organic waste and agricultural by-products, offer high surface areas and customizable porous structures, making them ideal for applications in energy storage, catalysis, and environmental remediation. Enhanced by doping with heteroatoms like nitrogen, sulfur, and phosphorus, these carbons demonstrate improved catalytic properties, comparable to precious metal catalysts, thus offering a cost-effective solution for sustainable technologies. However, further advancements in synthesis and functionalization are essential to maximize their performance and scalability. The ongoing development of biomass-derived carbons, coupled with a deeper understanding of reaction mechanisms, will be key to overcoming existing limitations and integrating these materials into next-generation energy systems. This progress will not only contribute to reducing fossil fuel dependency but also support a more sustainable, eco-friendly future in energy and environmental applications.

Farma et al. (Farma et al., 2013) prepared the highly porous binderless activated carbon electrodes from fibers of oil palm EFB for application in supercapacitors. Supercapacitors based on these electrodes exhibit excellent electrochemical performances due to the significantly increased surface area of the electrodes. Larasati et al. (Larasati et al., 2019) prepared activated nano carbon from oil palm EFB by using $ZnCl_2$ and $CaCl_2$ as a chemical activating agent during the hydrothermal process. Activated nano carbon using $CaCl_2$ as an activating agent is shown the capacitance of supercapacitor was 4.305 F/g. Rustamaji et al. (Rustamaji et al., 2022) synthesized the nitrogenated mesoporous activated carbon (N-ACU) from empty fruit bunches of oil palm by hydrothermal carbonization and CO_2 gas activation. Even though many authors have recently studied various types of biomasses for the preparation of electrode materials, RH remains the main biomass to produce electrode materials, since it has a high SSA.

Table 1. Comparison of S_{BET} of activated carbon from Oil palm EFB precursors

Raw material	SSA, m^2/g	Application	Ref.
Oil palm EFB	1704	Electrodes for application in supercapacitors	(Farma et al., 2013)
Oil palm EFB	41-1571	A working electrode in symmetric hybrid supercapacitor	(Larasati et al., 2019)
Oil palm EFB	445-640	For producing electrode materials	(Rustamaji et al., 2022)

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