

Brought to you by [INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA](#)

Scopus

[Back](#)

Surface Treatment for Improved Electrochemical Performance of Activated Carbon Derived from Palm Empty Fruit Bunches

[IIUM Engineering Journal](#) • Article • Open Access • 2026 • DOI: 10.31436/iiumej.v27i3.4626 [Marzuki, Hasan](#)^a; [Rozhan, Alya Naili](#)^a ; [Ani, Mohd Hanafi](#)^a; [Purwanto, Hadi](#)^b^a Department of Manufacturing and Materials Engineering, Kulliyyah of Engineering,
International Islamic University Malaysia, Kuala Lumpur, 53100, Malaysia[Show all information](#)

0

Citations

[View PDF](#)[Full text](#) [Export](#)[Save to list](#) [Document](#)[Impact](#)[Cited by \(0\)](#)[References \(32\)](#)[Similar documents](#)

Abstract

Recent interests in sustainable and green technologies for energy storage systems require extensive research to develop sustainable electrode materials. This includes developing biomass-derived activated carbons. In this research, empty fruit bunch (EFB) has been selected as the precursor material to produce activated carbon by the physical activation method, performed at 500°C to 800°C. Subsequently, a surface treatment process was performed using nitric acid to introduce oxygen functional groups. This step further improved the electrochemical properties of the EFB-based activated carbon material. The resulting samples were analyzed using Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, and X-ray photoelectron spectroscopy (XPS). The electrochemical performance was examined through cyclic voltammetry (CV), galvanostatic charge-discharge, and electrochemical impedance spectroscopy (EIS). FTIR analysis confirmed successful incorporation of oxygen functional groups, enhanced surface wettability, and improved electrolyte

penetration. CV measurements showed a significant increase in the specific capacitance after treatment. Surface treatment of the activated carbon positively impacted all samples. The largest percentage increase was observed in sample AC ST 500, with a 71 increase in specific capacitance from 24Fg^{-1} to 71Fg^{-1} . AC ST 800 displayed the highest overall capacitance after surface treatment, at 183Fg^{-1} , a 9 increase from 166Fg^{-1} before surface treatment. This result shows that adding oxygen functional groups improves these properties by increasing surface wettability, which increases ion penetration within the activated carbon. Copyright (c) 2026 IIUM Press. This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License. <https://creativecommons.org/licenses/by-nc/4.0/>

Author keywords

acid surface treatment; activated carbon; Empty fruit bunch; physical activation; supercapacitor

Corresponding authors

Corresponding
author

A.N. Rozhan

Affiliation

Department of Manufacturing and Materials Engineering, Kulliyyah of
Engineering, International Islamic University Malaysia, Kuala Lumpur, 53100,
Malaysia

Email address

alyanaili@iium.edu.my

© Copyright 2026 Elsevier B.V., All rights reserved.

Abstract

Author keywords

Corresponding authors

About Scopus

[What is Scopus](#)

[Content coverage](#)

[Scopus blog](#)[Scopus API](#)[Privacy matters](#)

Language

[日本語版を表示する](#)[查看简体中文版本](#)[查看繁體中文版本](#)[Просмотр версии на русском языке](#)

Customer Service

[Help](#)[Tutorials](#)[Contact us](#)

ELSEVIER

[Terms and conditions](#) ↗ [Privacy policy](#) ↗ [Cookies settings](#)

All content on this site: Copyright © 2026 [Elsevier B.V.](#) ↗, its licensors, and contributors. All rights are reserved, including those for text and data mining, AI training, and similar technologies. For all open access content, the relevant licensing terms apply.

