ECSOC-29
2025
Conference

The 29th Intl Electronic Conference on Synthetic Organic Chemistry

14–28 November 2025 | Online

MDPI

Nanostructured Algerian Coal: A Sustainable Carbon Source for Advanced Synthetic Applications

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INTRODUCTION & AIM

Coal, historically central to energy production, is increasingly marginalized due to its environmental footprint. However, coal is also a carbon-rich, structurally complex miner-al that can be transformed into functional nanomaterials. Recent work on Algerian coal revealed nanoscale porosity, crystallinity, and functional groups that make it a valuable raw material for sustainable applications (Ferfar et al., 2024). This study shifts from de-scription to application-oriented interpretation, showing how intrinsic features of Algeri-an coal can be harnessed in remediation, catalysis, energy storage, and composite engi-neering. The aim of this work is to reinterpret the physicochemical characterization of Algerian coal by transforming raw spectroscopic and structural data into statistical, graphical, and conceptual representations.

METHOD

Coal samples were collected from Algerian deposits and analyzed by SEM, XRD-Rietveld refinement, FTIR, and Raman spectroscopy. Detailed procedures are available in Ferfar et al. (2024). In this work, characterization results are reprocessed into statistical and conceptual representations (histograms, ratio charts, correlation heatmaps, schematic diagrams) to emphasize functional applications rather than duplicating raw spectra and images.

RESULTS & DISCUSSION

1. Particle Size Distribution

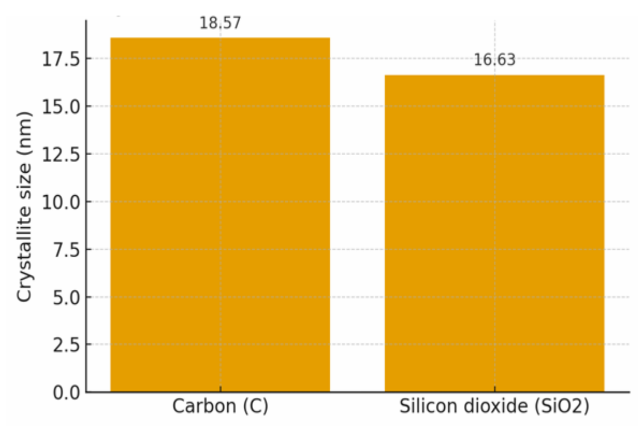

Figure 1. Bar chart of crystallite sizes (C vs SiO_2).

2. Crystallinity and Phase Composition

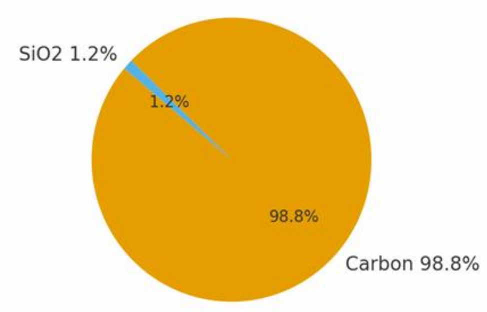

Figure 2. Pie chart of phase composition.

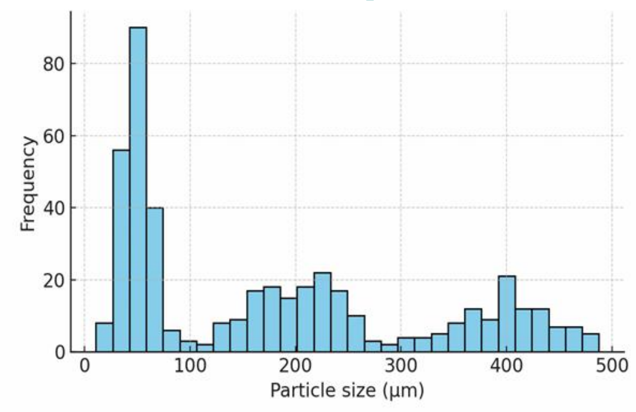

Figure 3. Histogram of simulated particle size distribution.

3. Raman Spectroscopy and FTIR Functional Groups

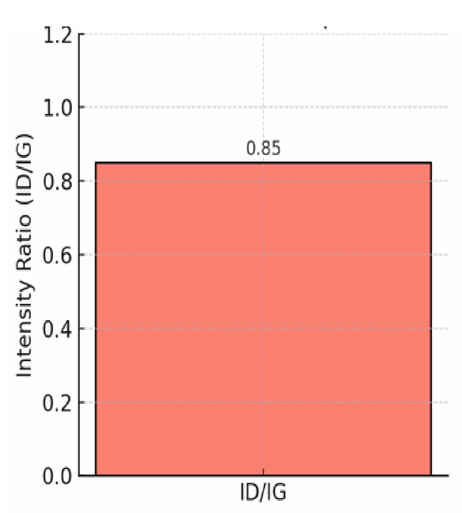

Figure 4. Raman ID/IG ratio bar chart.

Table 1. Raman and FTIR key features

Feature	Value(s) (cm⁻¹)
Raman D band	1350.16
Raman G band	1586.01
FTIR peaks	667.19; 1975.49; 2031.40; 2158.13; 2568.14; 2922.23

4. Correlation of Parameters

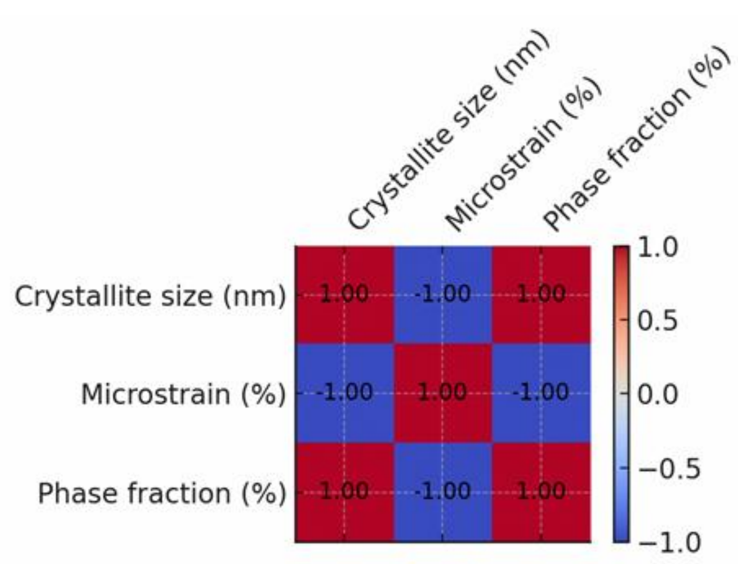

Figure 5. Correlation heatmap of structural parameters.

Applications of Nanostructured Algerian Coal

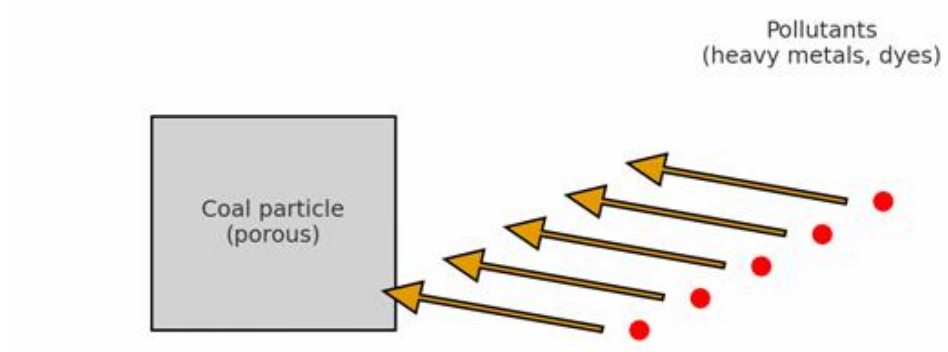

Figure 6. Schematic of pollutant adsorption by porous coal.

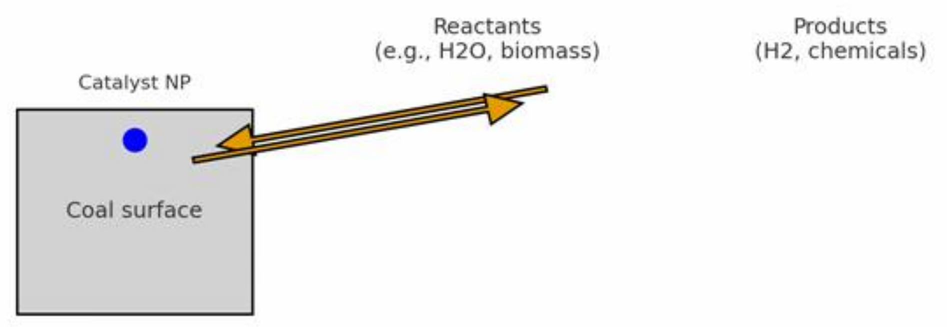

Figure 7. Schematic of coal-supported catalysis pathway.

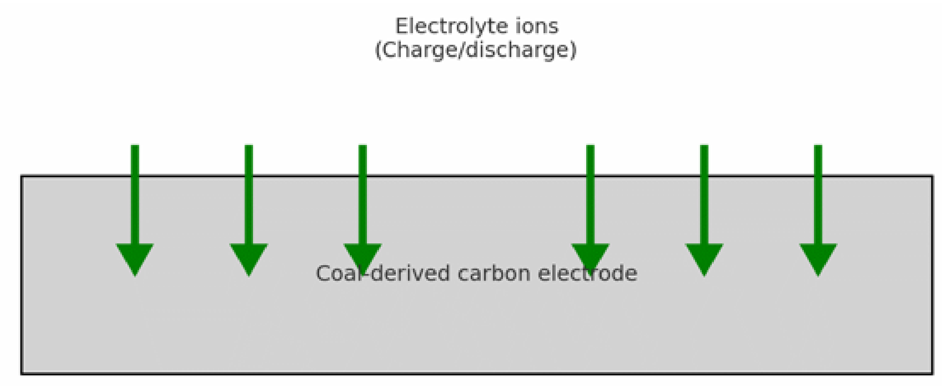

Figure 8. Coal-derived carbon electrode for supercapacitors.

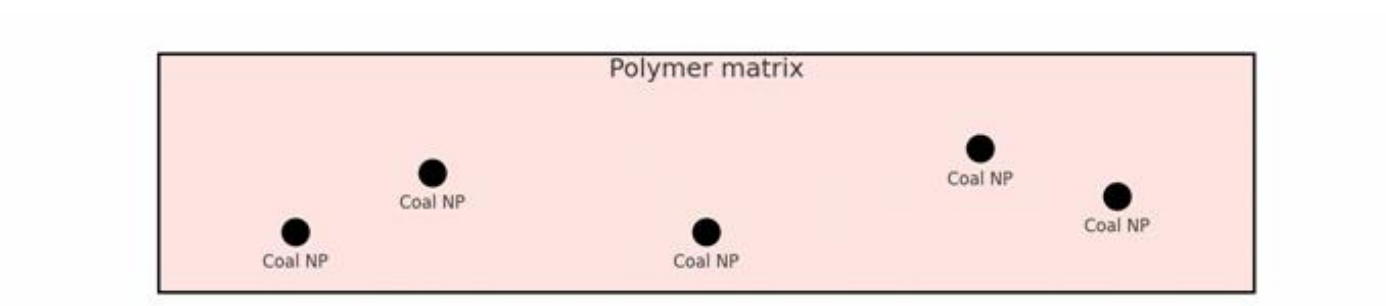

Figure 9. Coal-based nanoparticles reinforcing polymer composites.

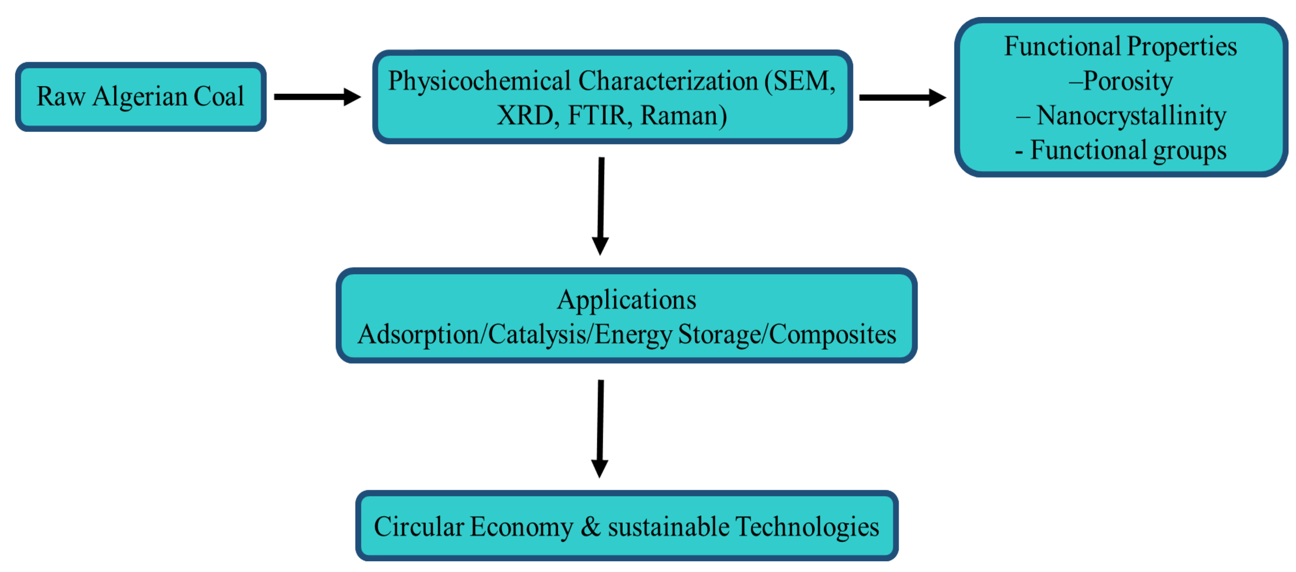

Figure 10. Conceptual framework: coal to circular economy applications.

CONCLUSION

Reinterpreted data confirm that Algerian coal offers nanoscale crystallinity, porosity, and functional chemistry. Presented in statistical and schematic forms, these features demonstrate clear application pathways in adsorption, catalysis, energy storage, and nanocomposites. Future work should include experimental validation of adsorption isotherms, electrode cycling tests, and composite performance, enabling Algerian coal to be positioned as a renewable nanocarbon resource within circular economy strategies.

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