The Mechanism of Ca-supported Graphitization of Banana Biomass

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Introduction:

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Natural Graphite:

- Mining

Synthetic Graphite:

- From petroleum coke
- Requires extreme temperatures (~3000 °C)

Structure of carbons:

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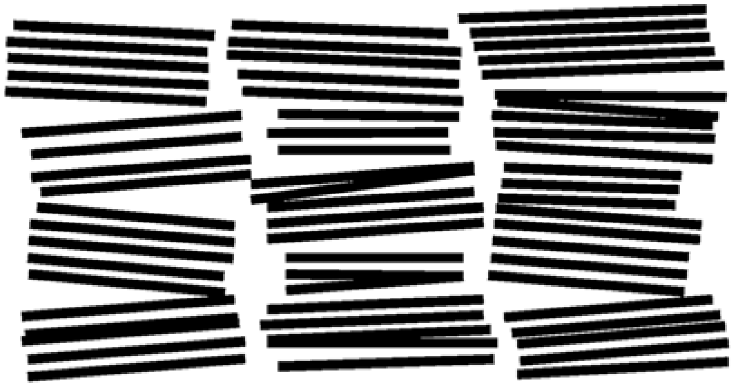

(a) graphitizing carbon
(soft)

(b) non-graphitizing carbon
(hard)

Crabtree, G., Kócs, E., & Trahey, L. (2015). The energy-storage frontier: Lithium-ion batteries and beyond. Mrs Bulletin, 40(12), 1067-1078.

Structure of carbons:

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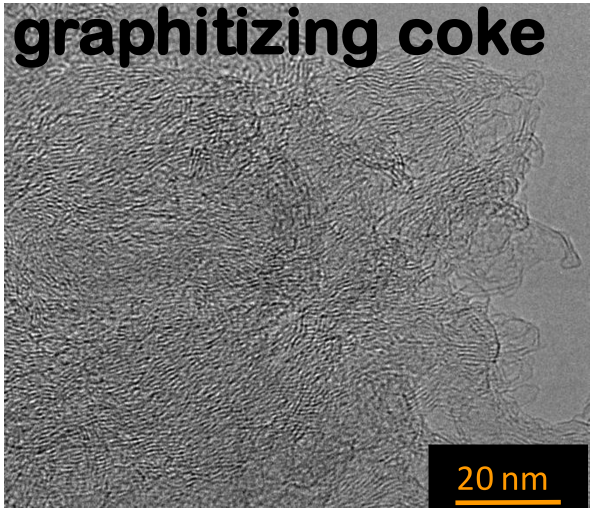
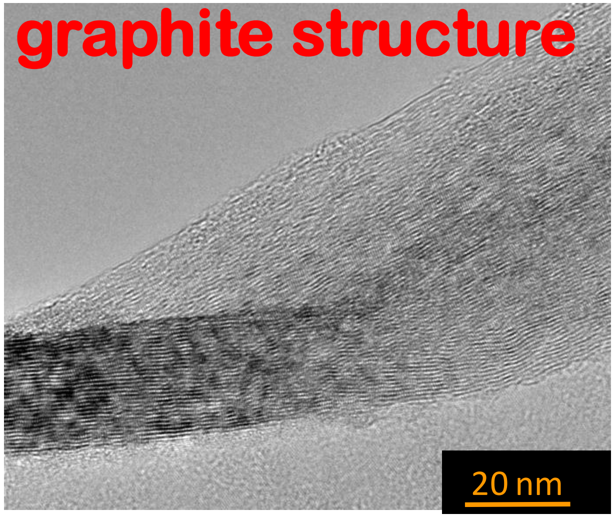
(a) graphitizing carbon

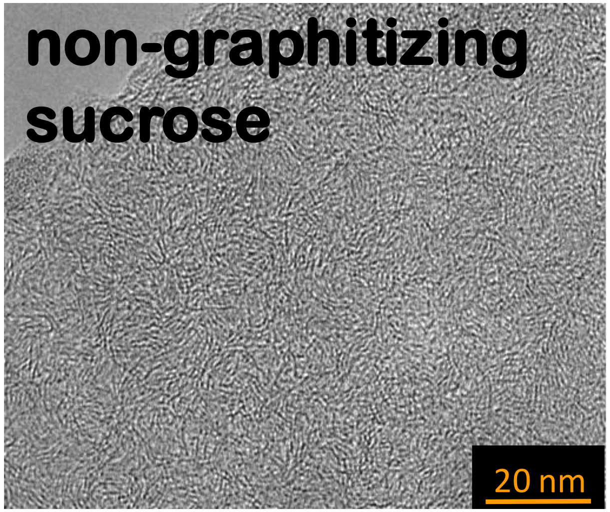


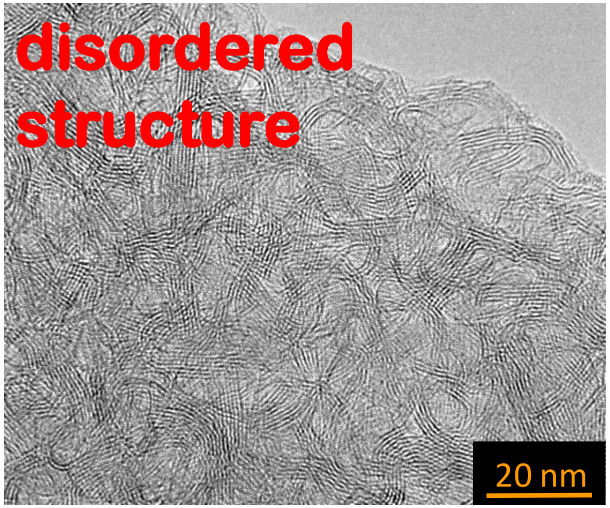


1000 °C

2500-3000 °C

non-graphitizing carbon





Graphitization catalysts:

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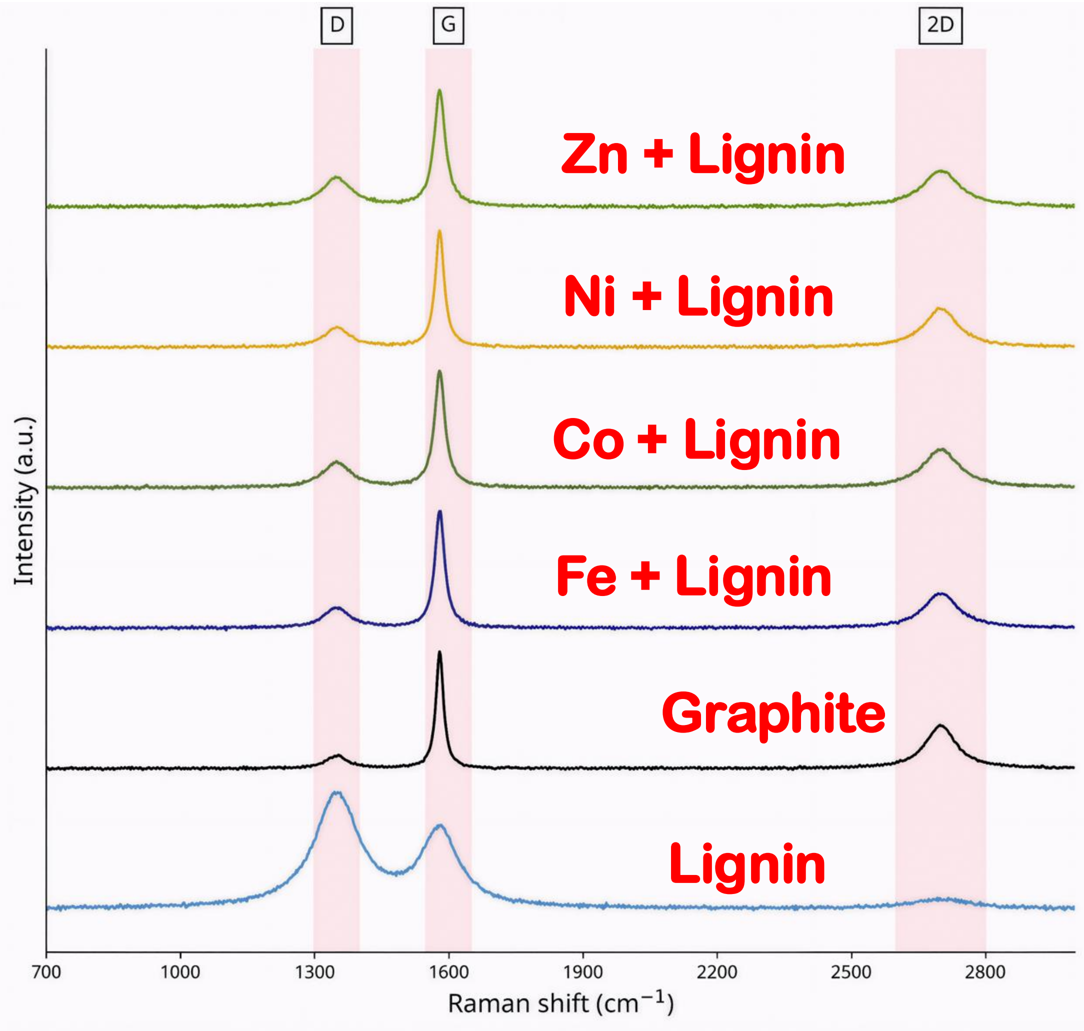
The most effective graphitization **catalysts** :
Fe, Co, Ni, and Zn.

1100 °C



Farid, M. A. A., Zheng, A. L. T., Tsubota, T., & Andou, Y. (2023). Journal of Analytical and Applied Pyrolysis, 173, 106064.

Graphitization catalysts:

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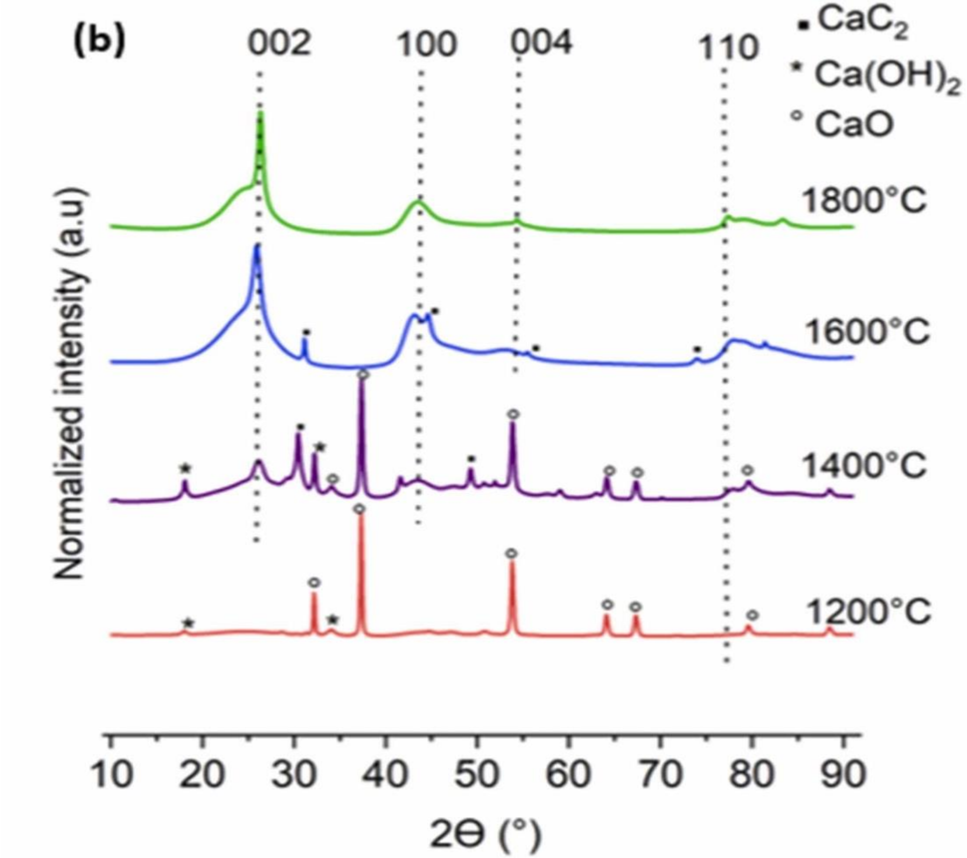
Over the last few decades, calcium (Ca) has been introduced as an excellent catalyst that is abundant, inexpensive, environmentally friendly, and has a low boiling point.



Ngene GI, et al., Materials Today Communications (2025): 113240.

Aim of PhD Project:

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source: https://carboncredits.com/

Biomass precursor:

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Banana peel

reasons:

- abundant, cheap, easy to get
- rich in cellulose and lignin, which are well-known precursors for the production of carbons
- contain also minerals which may accelerate the graphitization

Method of preparation:

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Composition of banan peel :

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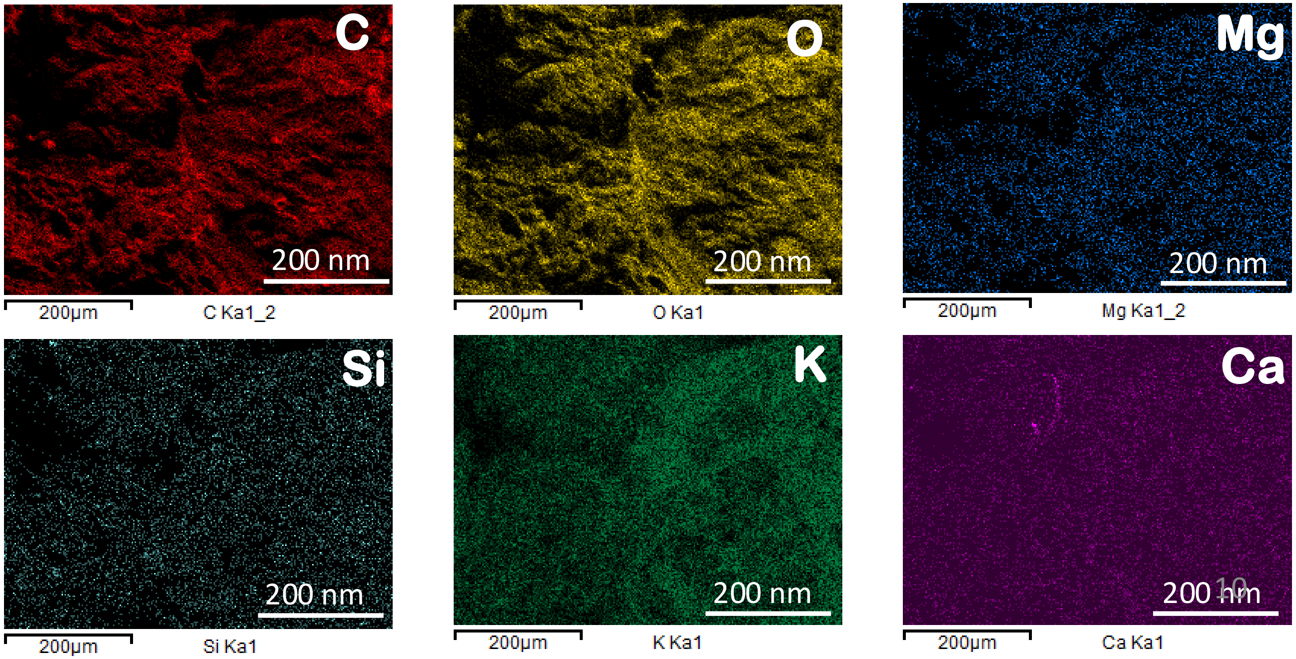

X-ray diffraction:

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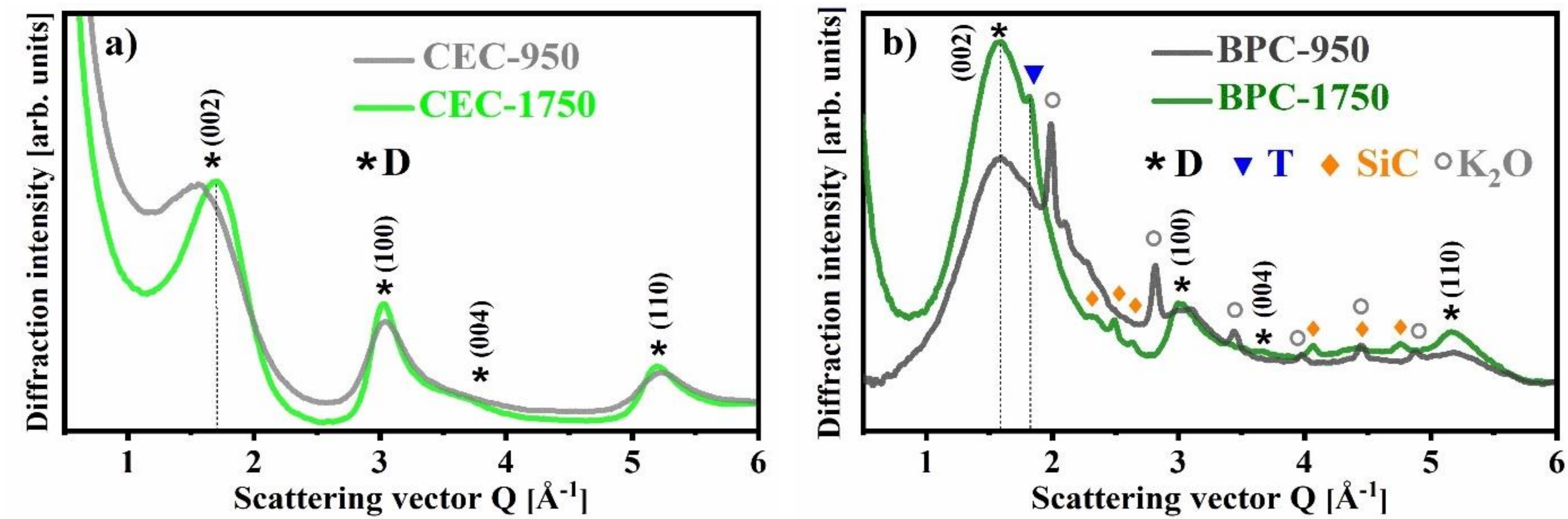

X-ray diffraction pattern of hard carbon derived from cellulose and banana peel, heat-treated at 1750 °C.

X-ray diffraction:

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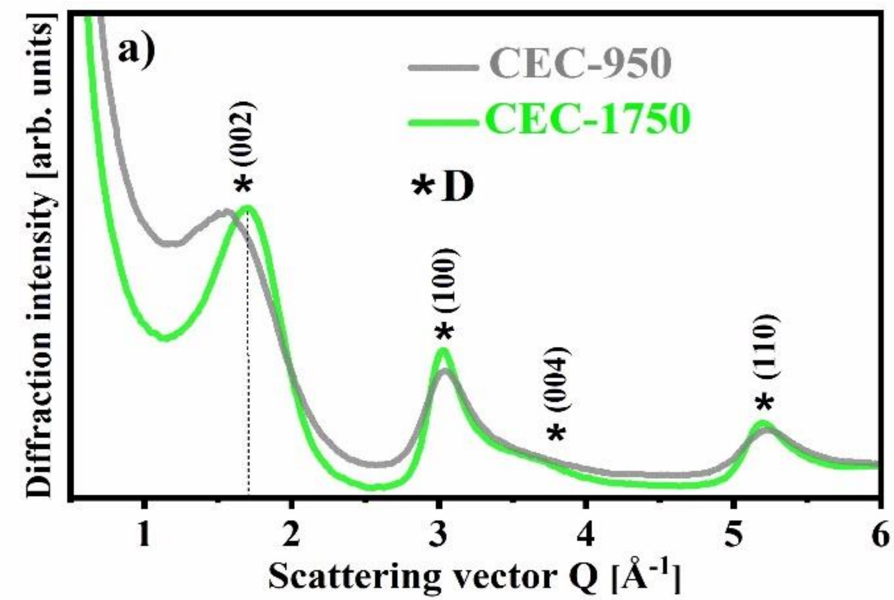
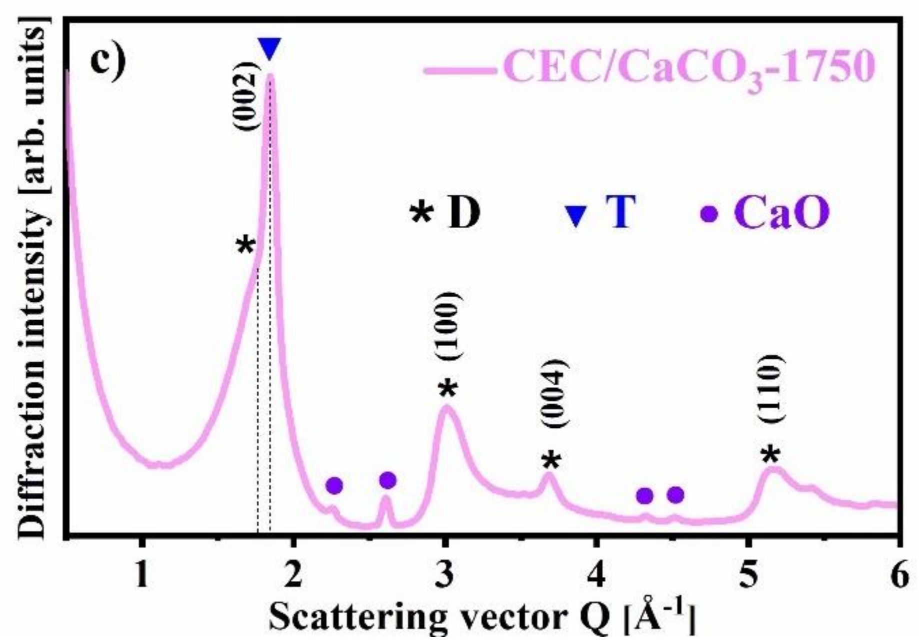
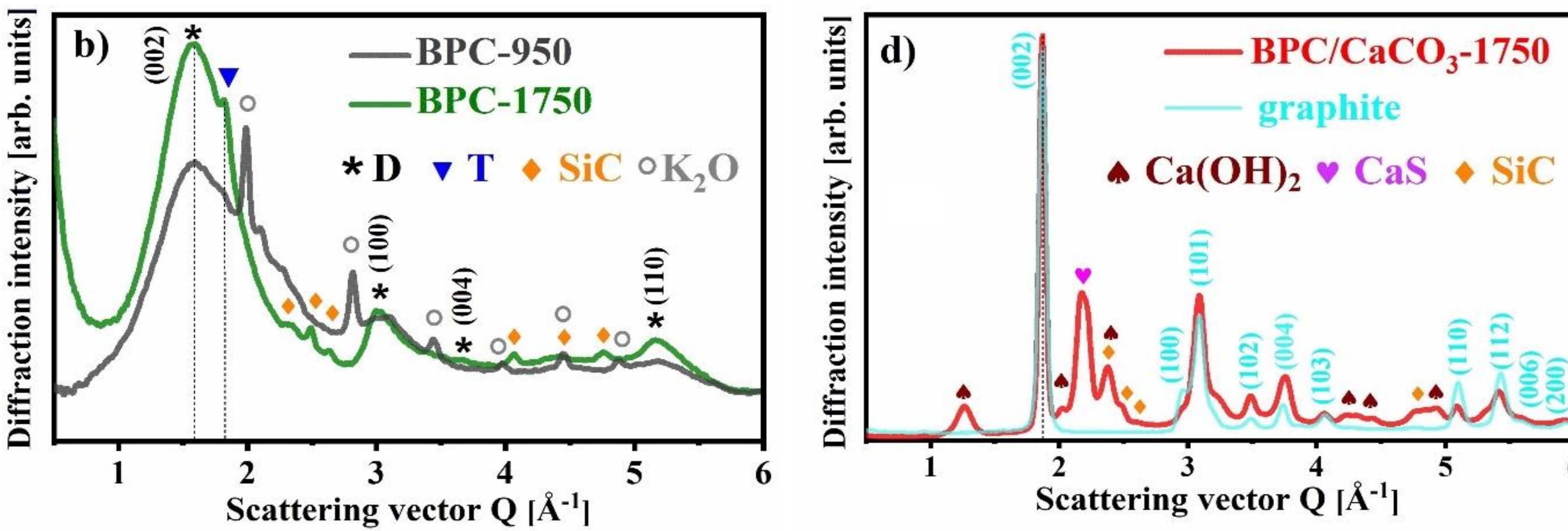




X-ray diffraction pattern of hard carbon derived from cellulose with and without $CaCO_3$, heat-treated at 1750 °C.

X-ray diffraction:



X-ray diffraction pattern of hard carbon derived from banana peel with and without $CaCO_3$, heat-treated at 1750 °C.

Raman spectroscopy:

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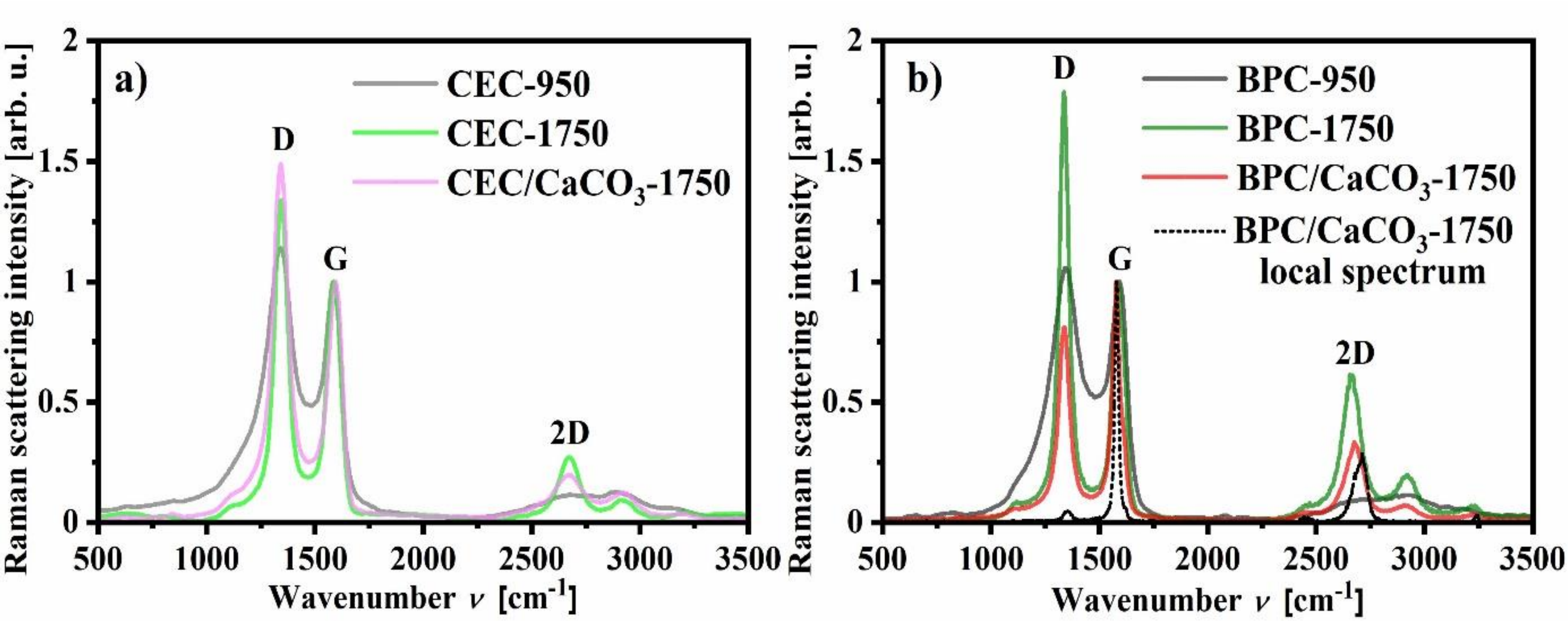

Raman spectra of carbon materials obtained from cellulose (a) and banana peel (b). All data were normalized to a G-mode intensity of 1.

Small-angle Scattering:

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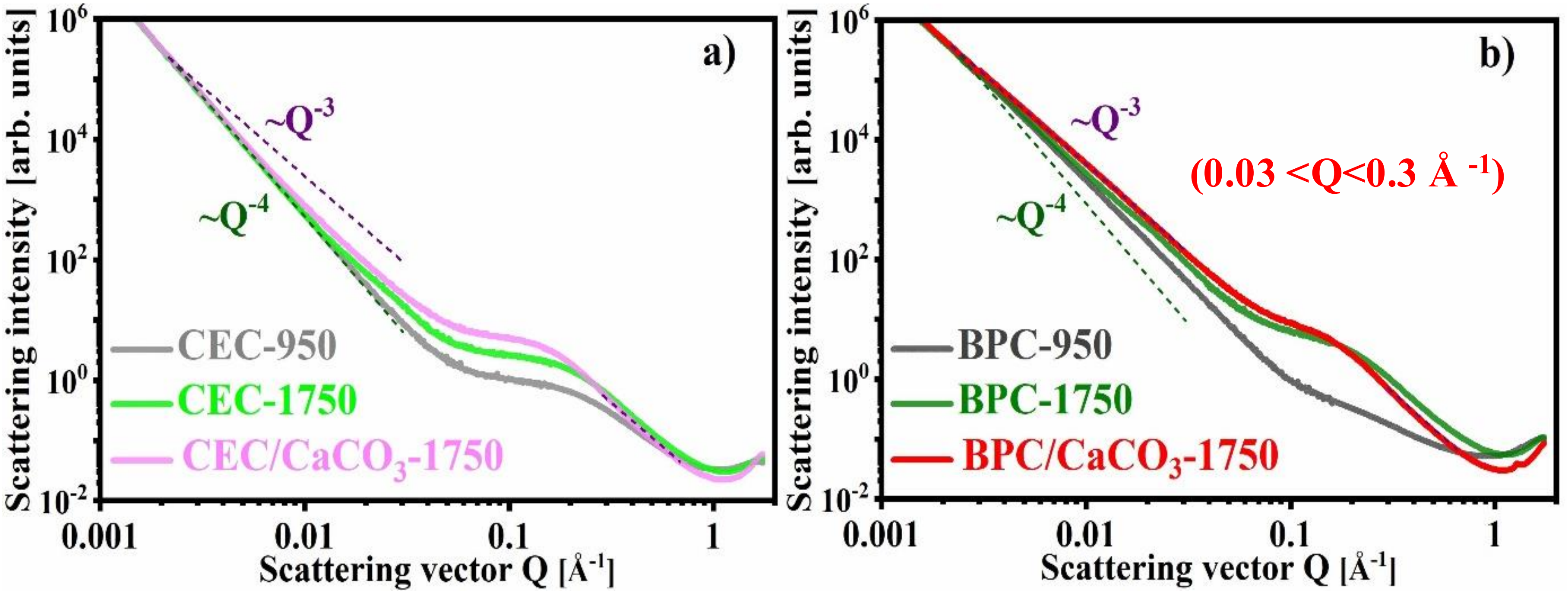
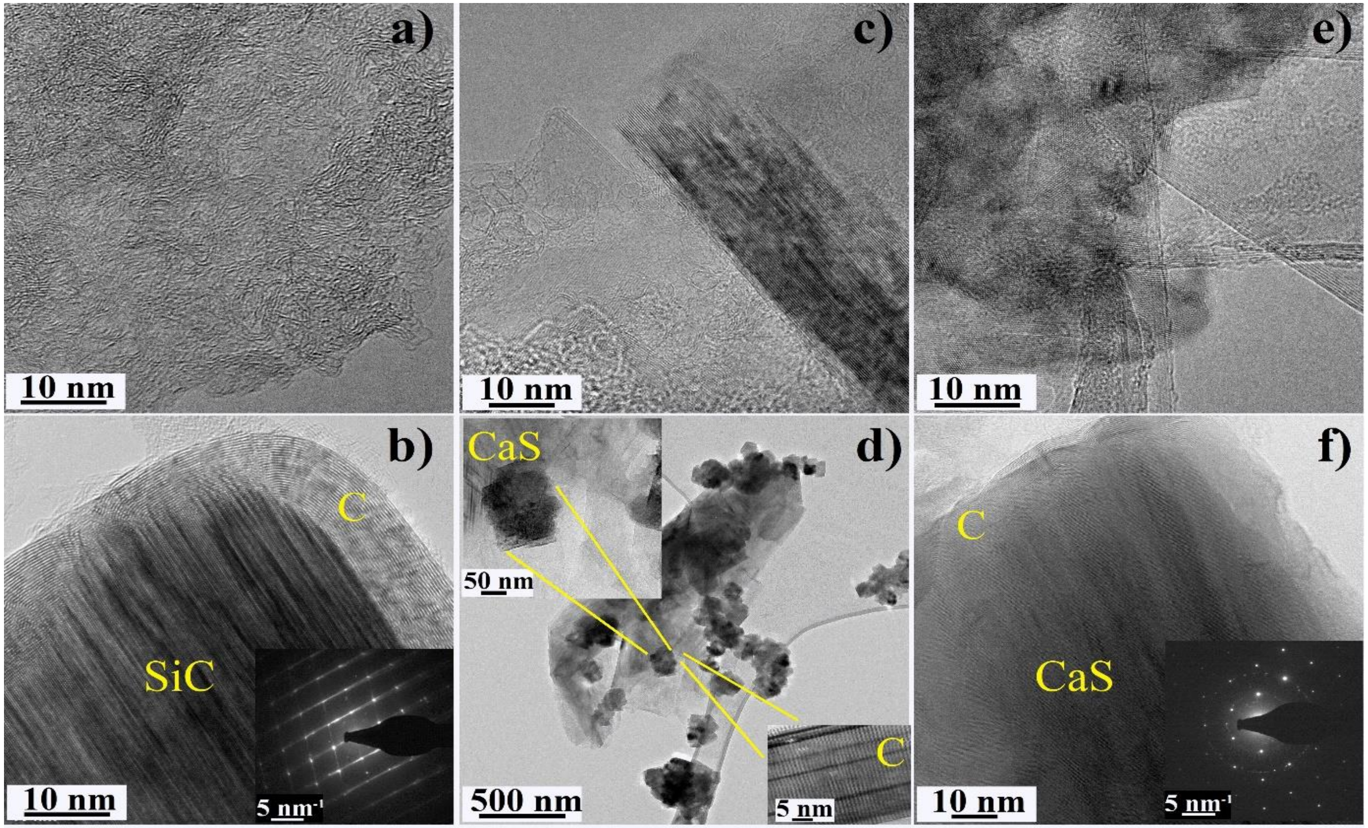


SAXS curves of carbon materials obtained from cellulose (a) and banana peel (b).

Transmission Electron Microscopy:



TEM images collected for BPC-1750 (a,b) and BPC/$CaCO_3$-1750 (c-f). On panels (b) and (f), the SAED patterns registered near the imaged area are displayed in the lower right corner

Conclusions:

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- The effectiveness of **calcium (Ca)** as a catalyst for graphitization.
- **Banana peel** as a sustainable and cheap biomass precursor for carbon production.
- Banana peels containing intrinsic mineral phases can achieve a markedly higher degree of graphitization, compared to pure extracted cellulose precursor,.
- The potential applications of this eco-friendly graphite in fields like **energy storage**.

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Thank you for your attention!