



Plants: a sustainable source of electrode materials in the world of energy storage applications

Chemical Engineering

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Abstract:

The increasing need for sustainable, high-performance energy storage has driven interest in eco-friendly electrode materials. Plant-derived metals and oxides provide a renewable, low-cost, and scalable approach for producing advanced supercapacitor components. Through green synthesis, metals like Fe, Mn, Ni, and Cu can be extracted from plants and converted into porous nanostructures that enhance charge transport and cycling stability [1,2]. Recent studies on lotus leaf- and Jacaranda flower-derived carbons show excellent capacitance and rate performance. This study further explores plants cultivated in controlled soil conditions and enriched with Ni, Mn, and Na salts to promote metal uptake and electrochemical activity. The approach simplifies electrode fabrication and establishes a sustainable route for developing high-efficiency energy storage materials.

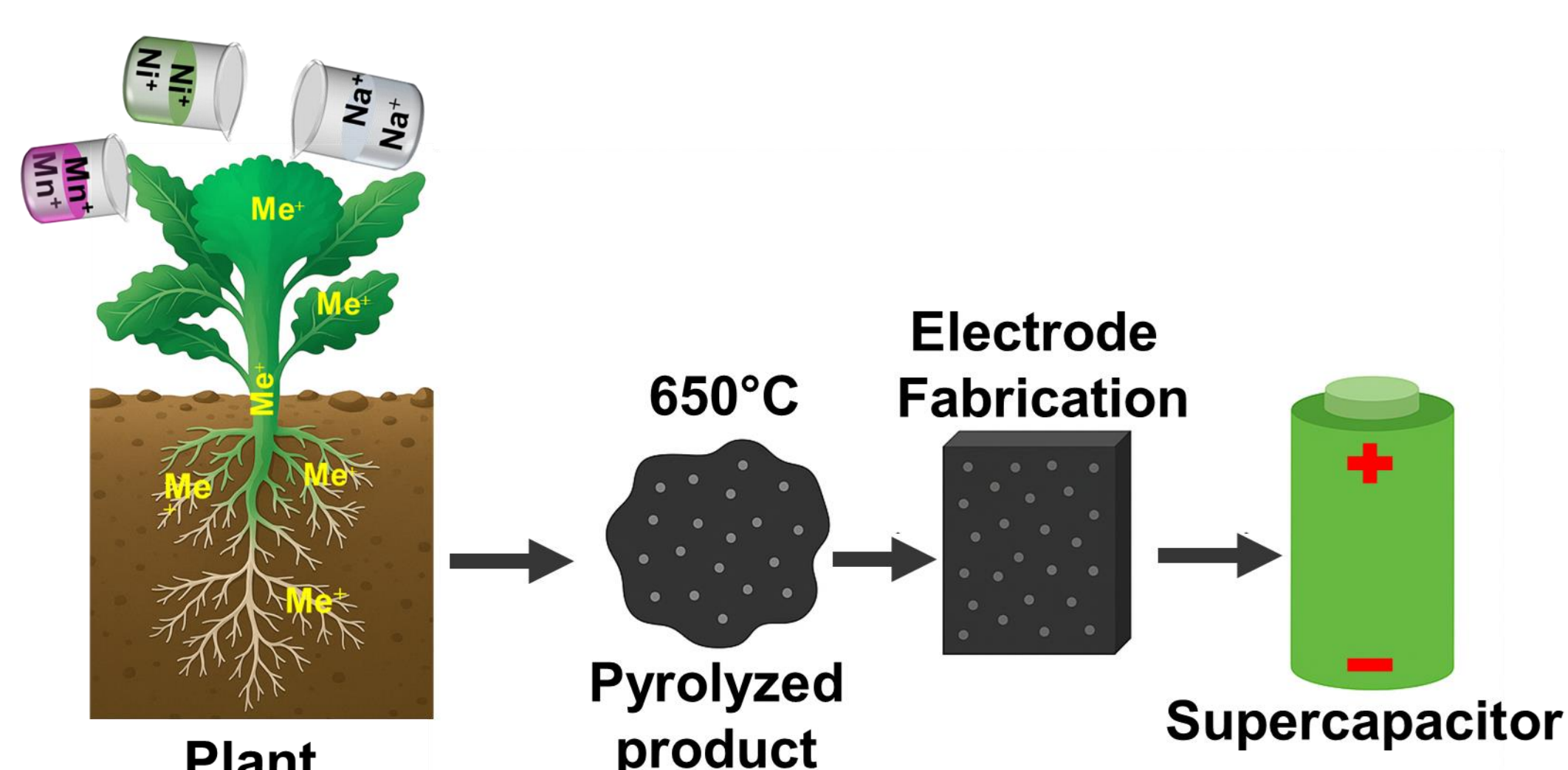


Figure 1. Schematic of electrode materials fabrication from plants for supercapacitor application

Methodology

Plants:

- Grown with Ni, Mn and Na.
- Collected and dried.
- Activated with KOH and pyrolyzed at 650°C, as indicated in figure 1.
- A1: no metals added,
- A2-A4: fed with Ni and Mn for 3,4 and 5 weeks, respectively.
- A5-A7: fed with Ni, Mn and Na for 3,4 and 5 weeks, respectively.
- Characterized of metallic and non-metallic elements.
- Electrochemically tested by CV and GCD tools in 1M Na_2SO_4 .

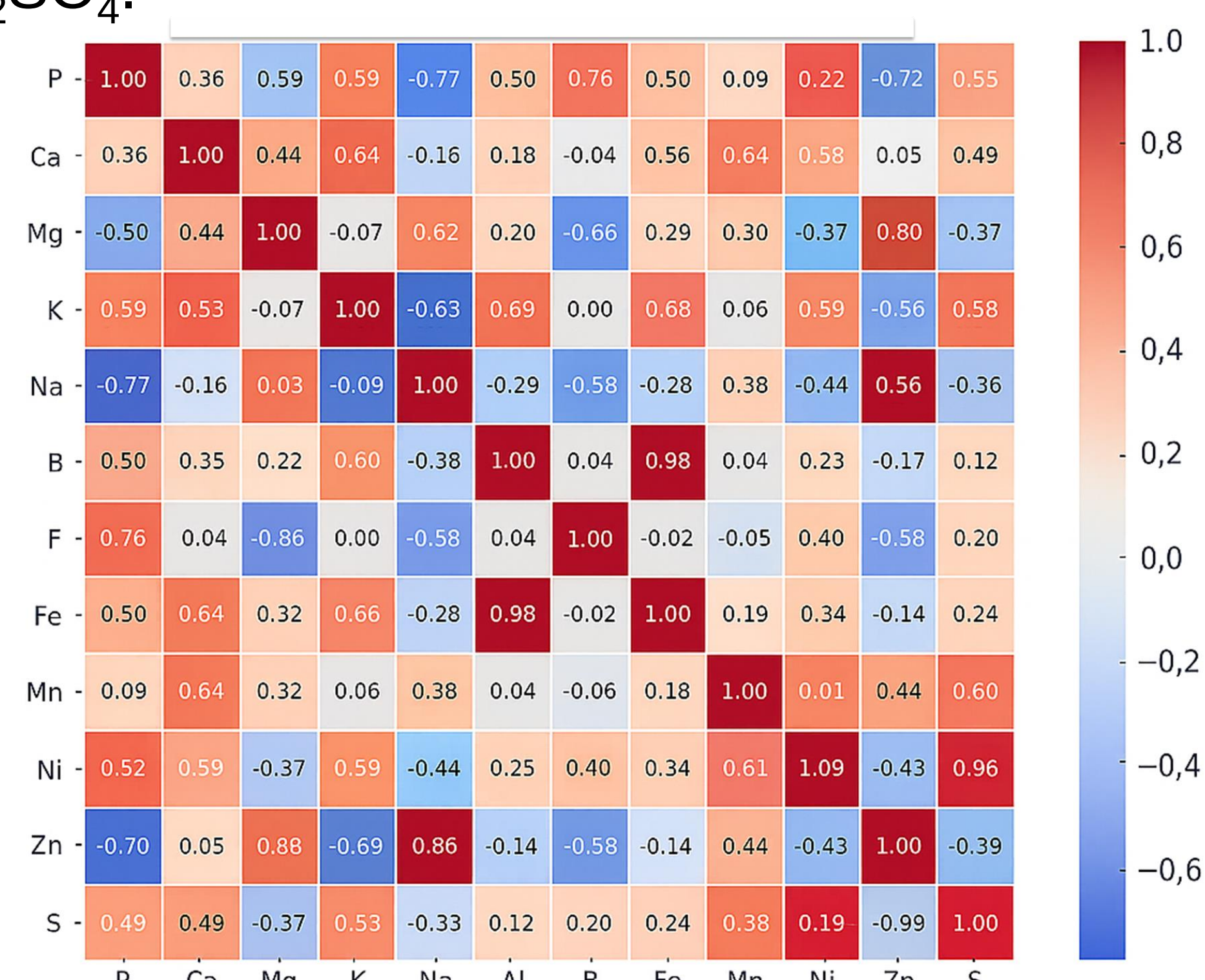


Figure 2. Pearson correlation heatmap derived from ICP result of samples.

The presence of metals inside plants are proven by the ICP results, as presented in figure 2.

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This figure indicates the successful absorption of metals by the plant during their growth period. Electrode materials derived from the respective biochar show promising electrochemical response, as shown in figure 3.

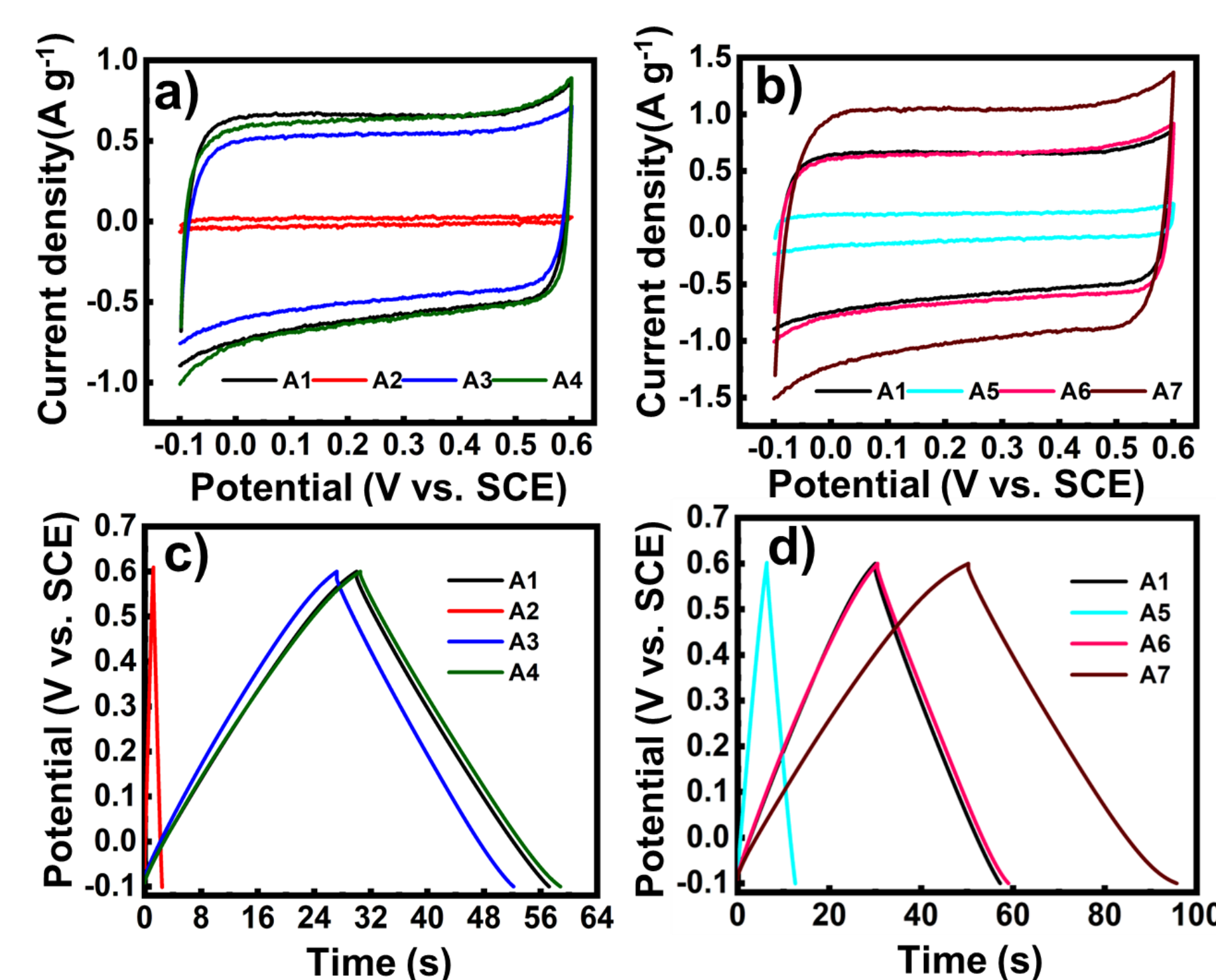


Figure 3. CV curves @ 40 mVs⁻¹ (a,b) and GCD plots @ 0.5 Ag⁻¹ (c,d) of biochar derived from plants fed (a,c) with Ni and Mn or (b,d) with Ni, Mn and Na along the time.

A closer look at the results reveals the positive effect of the feeding duration on electrochemical performance.

Conclusion:

This cost effective approach provides new path to fabricate electrode materials for high power electrochemical energy storage with interesting response.

Future work:

- Improvement of pyrolysis conditions in terms of temperature and activation agents.
- Assessment of the materials response in other applications.

References

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