Hard carbon derived from waste biomass delivering high performance for Li/Na-ion batteries and supercapacitors.

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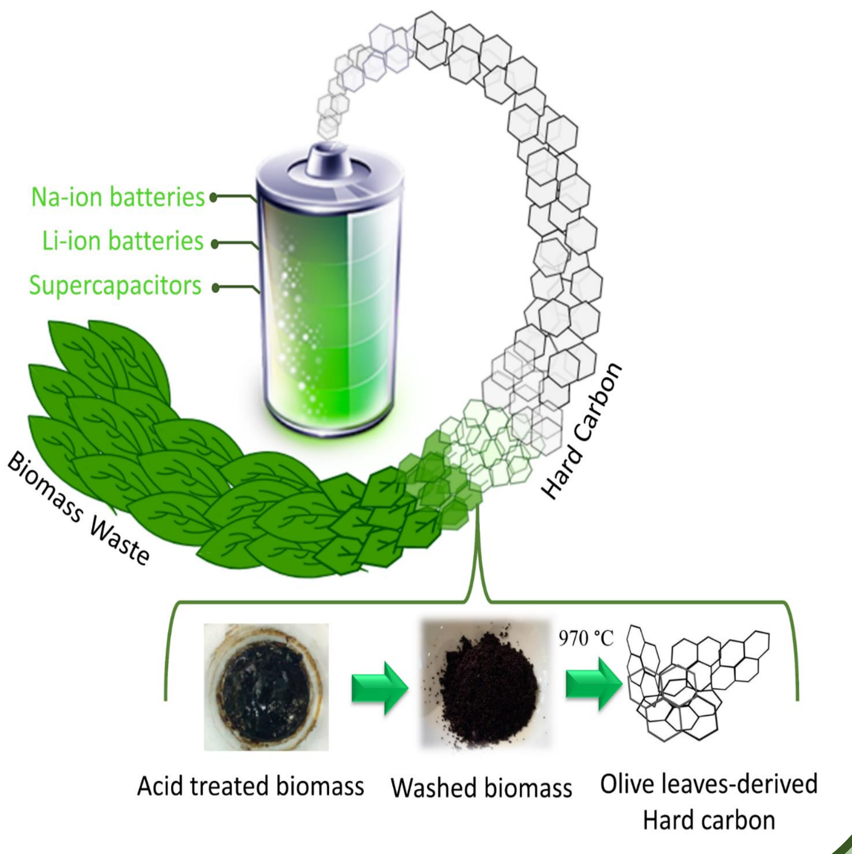
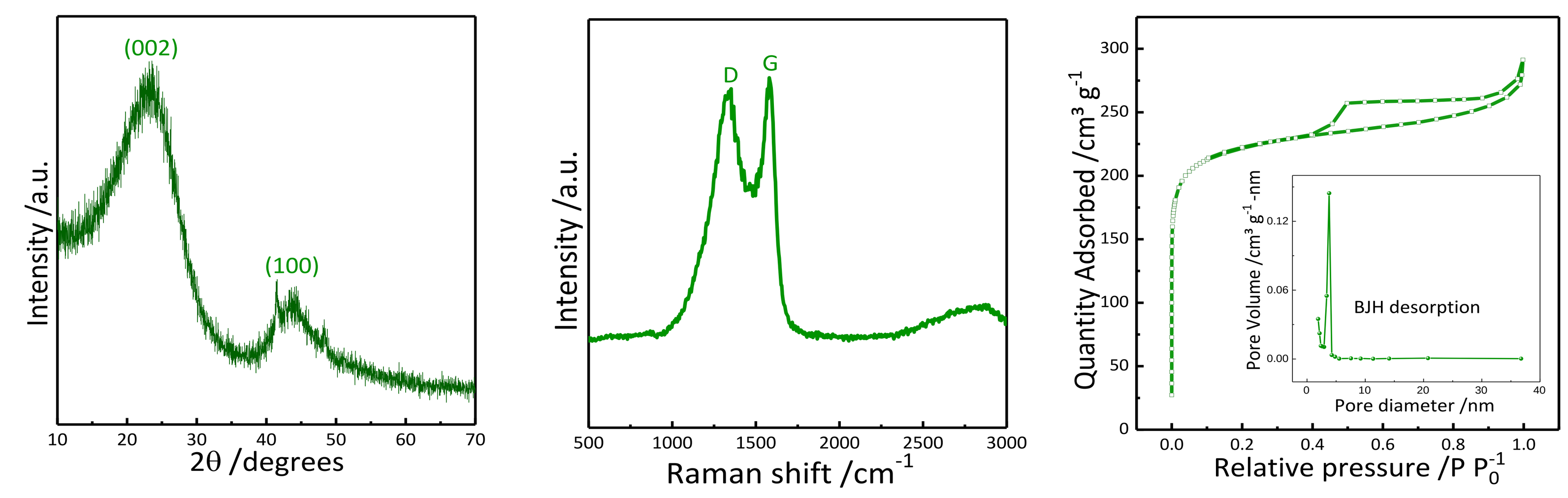
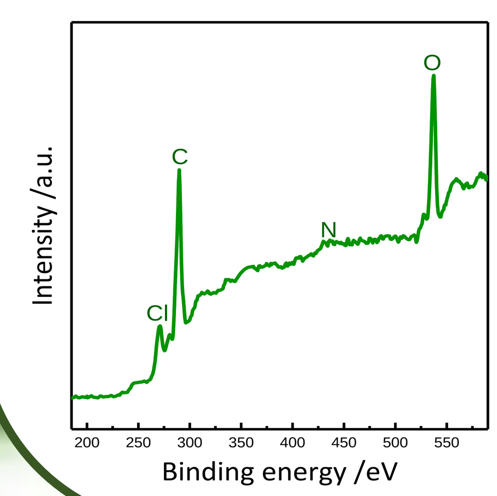
Introduction

- In many application areas, some of the most efficient and practical technologies for converting and storing electrochemical energy are: batteries, fuel cells and supercapacitors.
- Hard carbons (HC) have been considered as promising electrode materials for Li-ion batteries (LIBs), Na-ion batteries (NIBs), and supercapacitors (SCs).
- HC material was synthesized from olive leaf waste through acid and heat treatment.



Structural characterization

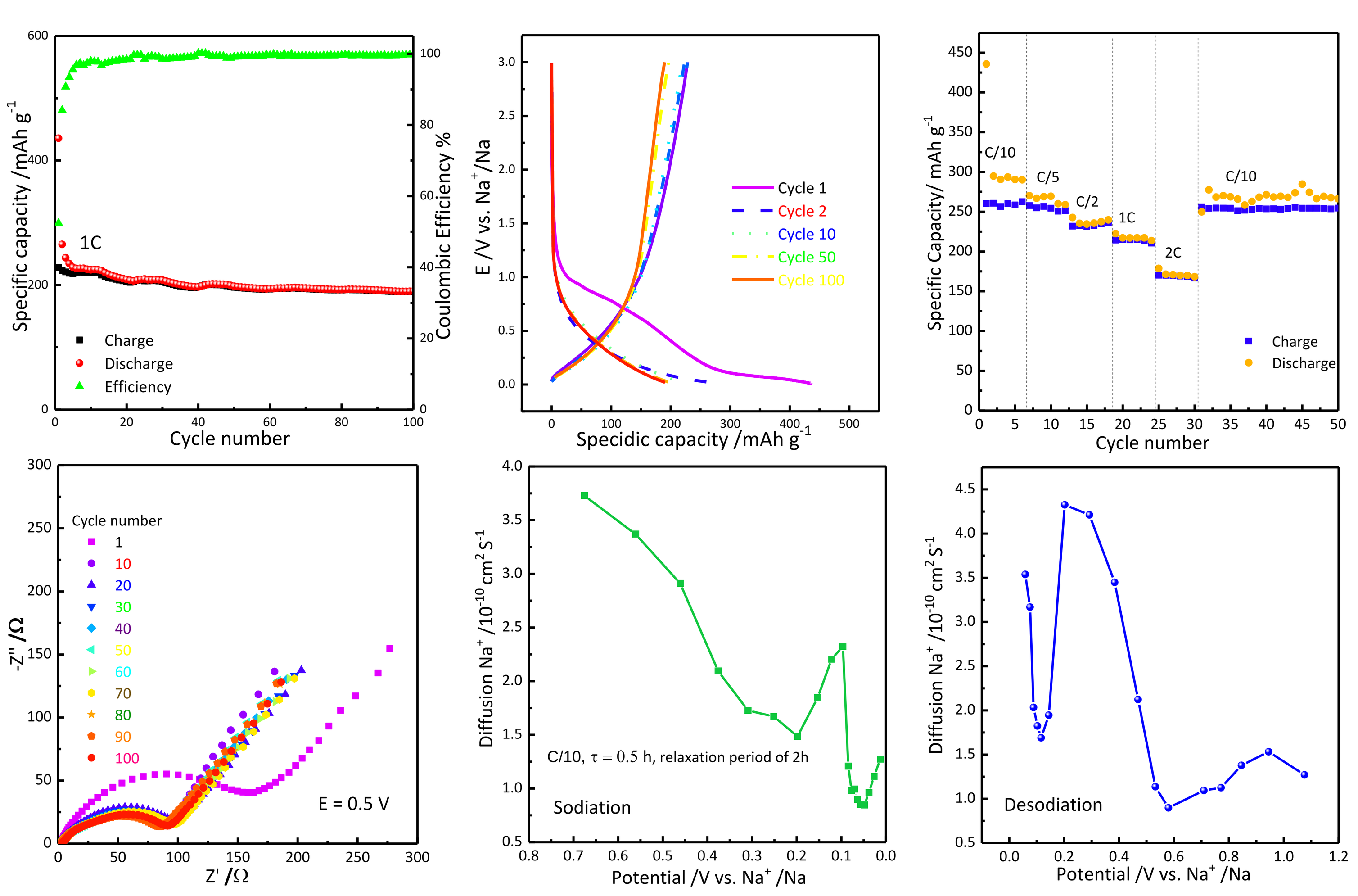


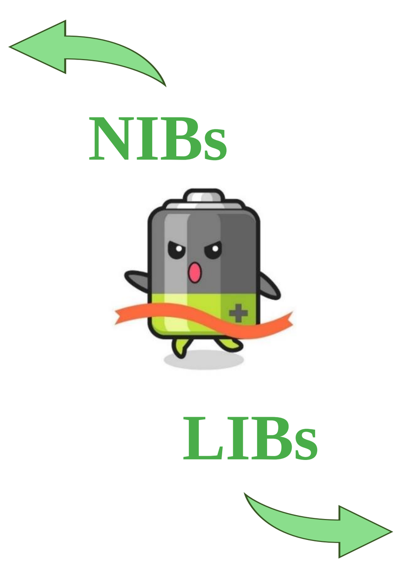


- The XRD and Raman spectra: confirm a certain degree of graphitization, together with a disordered structure.
- The nitrogen adsorption-desorption isotherms: show the Brunauer-Emmett-Teller (BET) surface area, pore diameter around 839.33 m2/g and 4.02 nm, respectively.
- The XPS results: reveal the presence of heteroatoms of O, N on the surface.

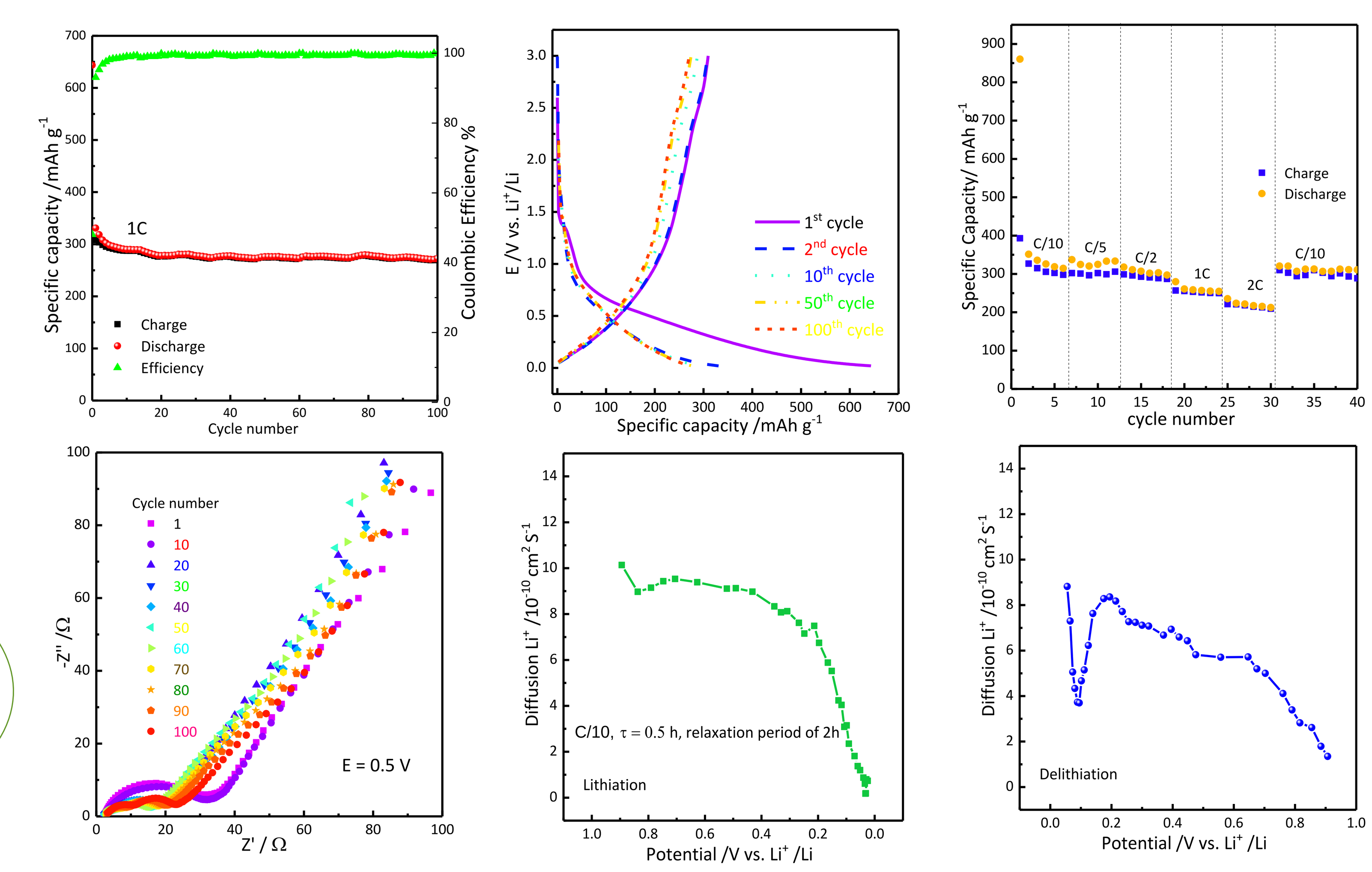
Li/Na-ion batteries

- For NIBs: a high discharge capacity of 265.37 mAh g^{-1} at 1C, cycling stability of ~ 71.7% after 100 cycles, and promising rate capability.
- For LIBs: a high discharge capacity of 331.02 mAh g^{-1} at 1C, cycling stability of ~ 82% after 100 cycles, and good rate capability.
- Investigations propose the mechanism of “adsorption-intercalation”.
- EIS measurements: show the interfacial behavior stability of the electrode for both LIBs and NIBs; different behaviors are revealed upon the first cycles → can be due to activation of the electrode.
- GITT results: show the difference of diffusion coefficient between plateau and slope area and fast ionic transport speed for both NIBs and LIBs.





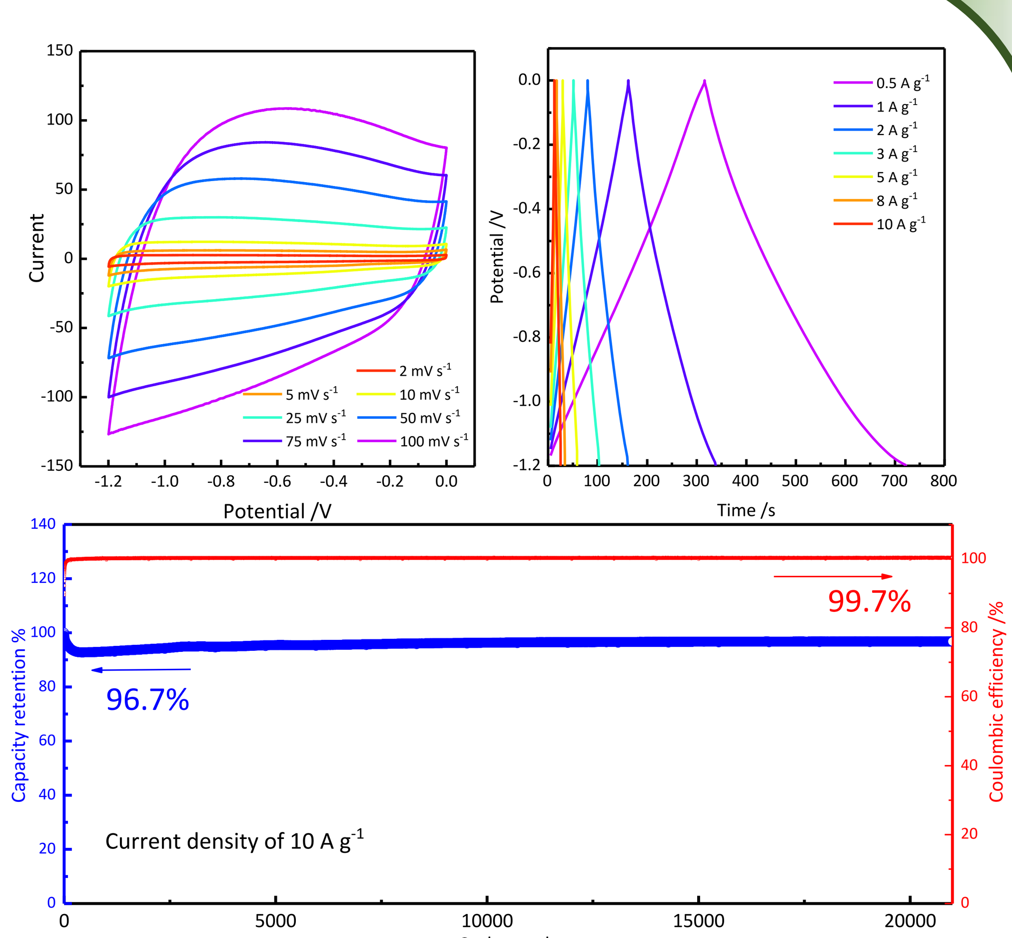
Electrode preparation: active material, cmc, conductive carbon 80:10:10 (wt.%).



- 1 M $NaClO_4$ in EC: PC electrolyte, 0.01 V ≤ E ≤ 3.00 V, 1C = 300 mA g^{-1}
- 1 M $LiPF_6$ in EC: DMC as electrolyte, 0.01 V ≤ E ≤ 3.00 V, 1C = 300 mA g^{-1}.

Supercapacitors

- SCs of this type known as electrostatic or electric double-layer capacitors.
- The CVs: display a quasi-rectangular shape with no significant distortion.
- The electrode delivers a high specific capacitance of 169.6 F g^{-1} at 0.5 A g^{-1}.
- The cyclic stability 96.7 % after more than 20,000 cycles.
- Electrode preparation: active material, PVDF, conductive carbon 80:10:10 (wt.%).



Electrochemical measurements: 6M KOH aqueous electrolyte in the potential range of -1.2 – 0 V vs. SCE in a three-electrode system.

Conclusions

- Hard carbon (HC) material was synthesized as an electrode for energy storage application.
- The HC electrodes exhibited high capacities and promising cycling performances for Li/Na-ion batteries.
- The electrodes also delivered high performance upon long cycling for supercapacitors.

References

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