Pomegranate: An Eco-Friendly Source for Green Energy Storage Devices

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Overview

- Supercapacitors are known for their exceptional energy storage with rapid charge/discharge, long cycle-life, and wide temperature range.
- Biowaste material can be used as material for supercapacitor electrode.
- Accumulation of charges on the surface of the electrode leads to electrical energy storage. Therefore, electrode with larger surface area is necessary to maximize the charge storage capacity.
- The limitation of the supercapacitor is a relatively low energy density. Using organic and ionic liquid electrolytes are good way to solve this supercapacitor's drawback
- Our research focuses on developing high performance carbon from pomegranate with various electrolytes for energy storage devices.

Current Issues

- Metal oxides and sulfides are mostly being used as electrode materials for energy storage devices, however, their wide applications are precluded due to their higher cost, low stability, and adverse effect on the environment.
- Carbon based materials such as graphene, carbon nanotubes and carbon nanofibers show good charge storage capacity, however, tedious synthesis processes and relatively high cost of these carbon allotropes have limited their extensive uses in commercial energy storage devices.
- Therefore, development of environment-friendly supercapacitors with low cost, high performance, and stable performance is a big challenge.

Experimental

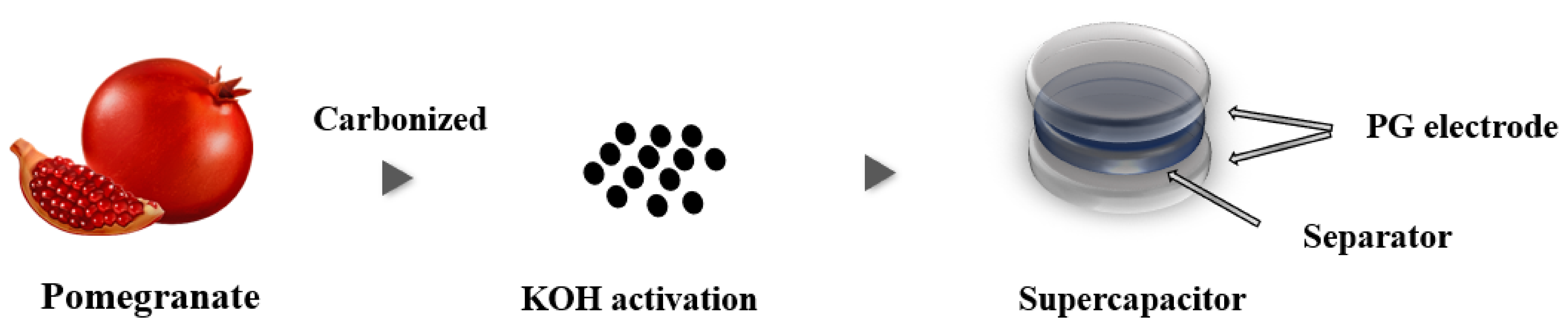

Figure: Schematic of pomegranate derived activated carbon.

Structural Characterizations

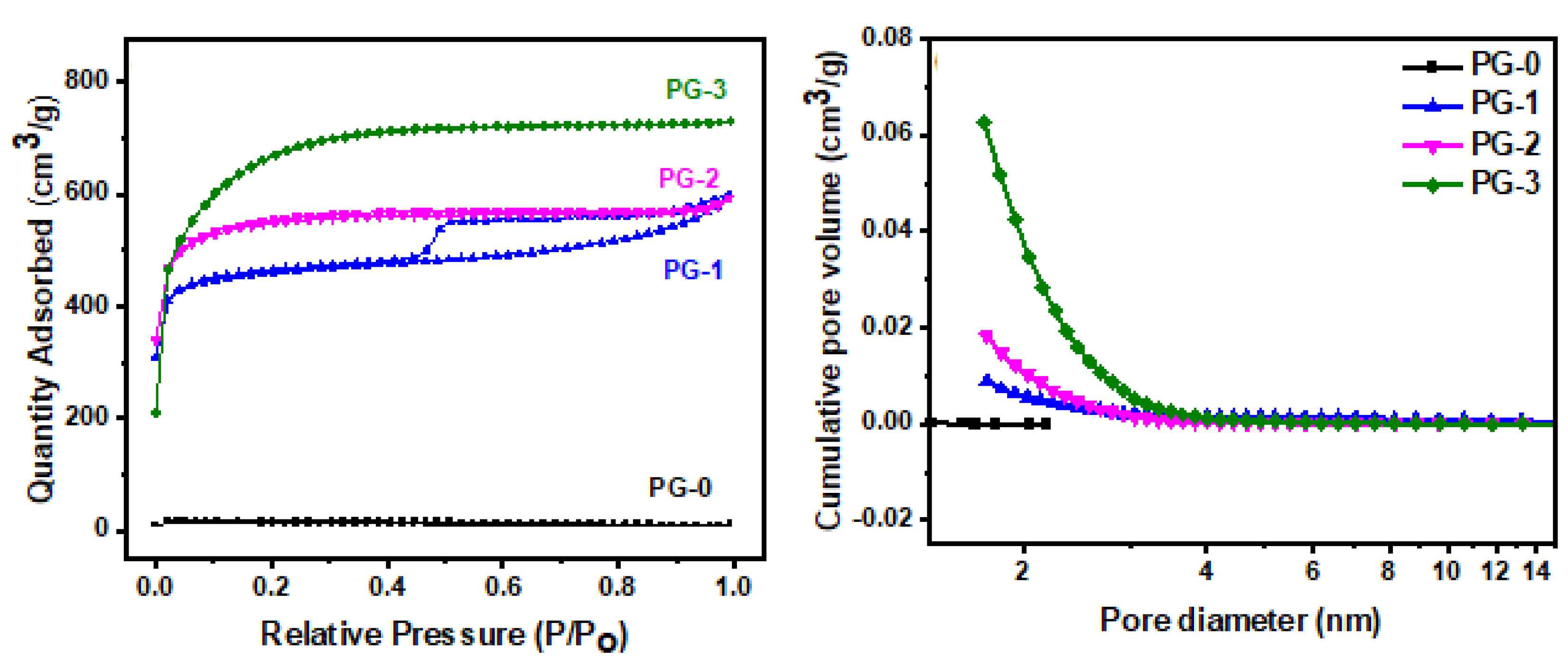

Figure: Nitrogen adsorption-desorption isotherms, and BJH pore size distributions of pomegranate derived carbons.

Results and Discussion

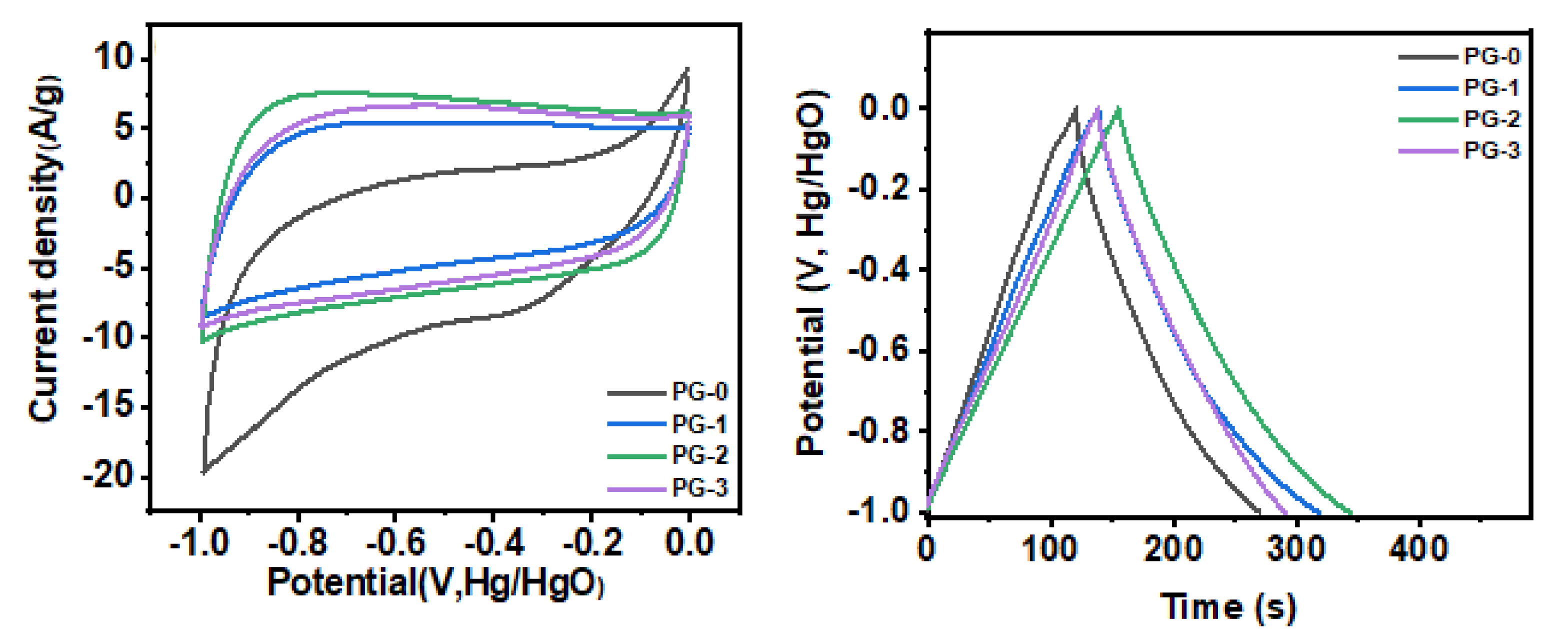

Figure: cyclic voltammogram at 50 mV/s, charge-discharge curve at 1 A/g for all samples.

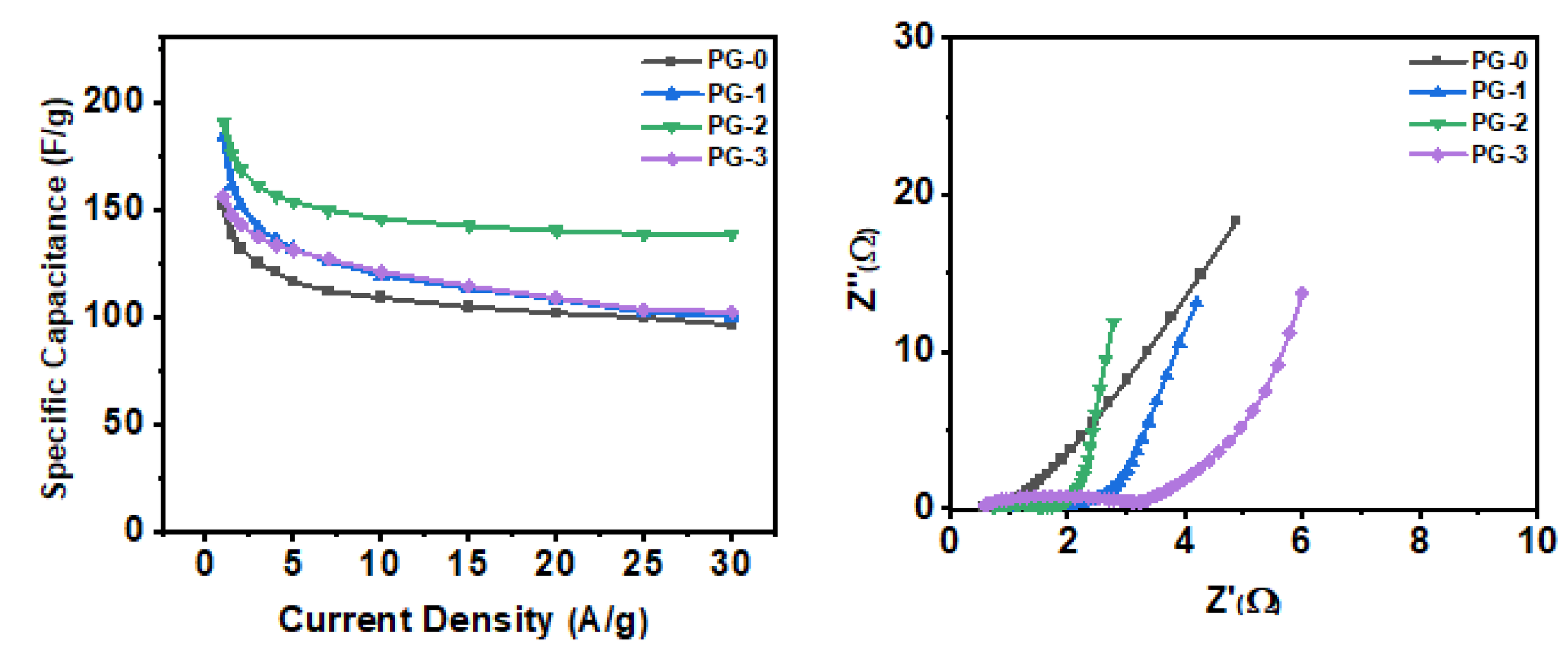

Figure: specific capacitance versus applied current, Nyquist plots for all samples

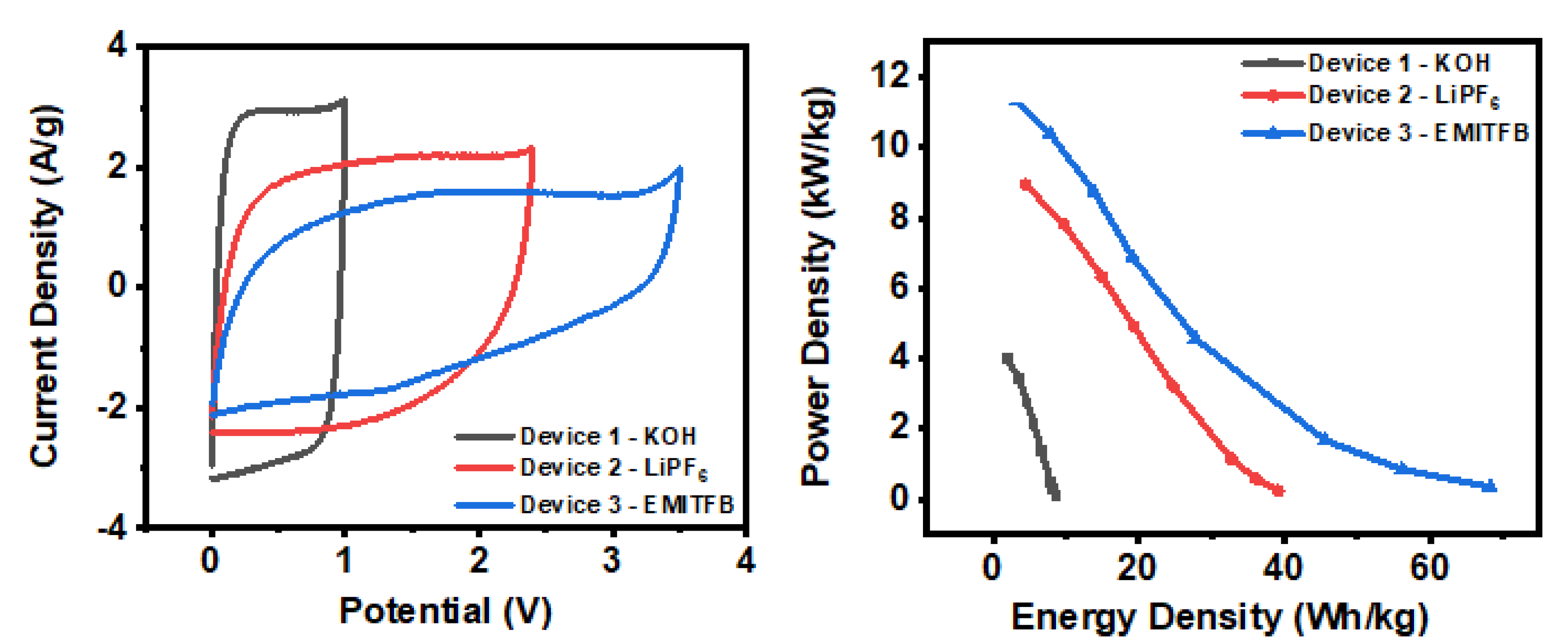

Figure: cyclic voltammogram at 50 mV/s , Ragone plot of all PG devices.

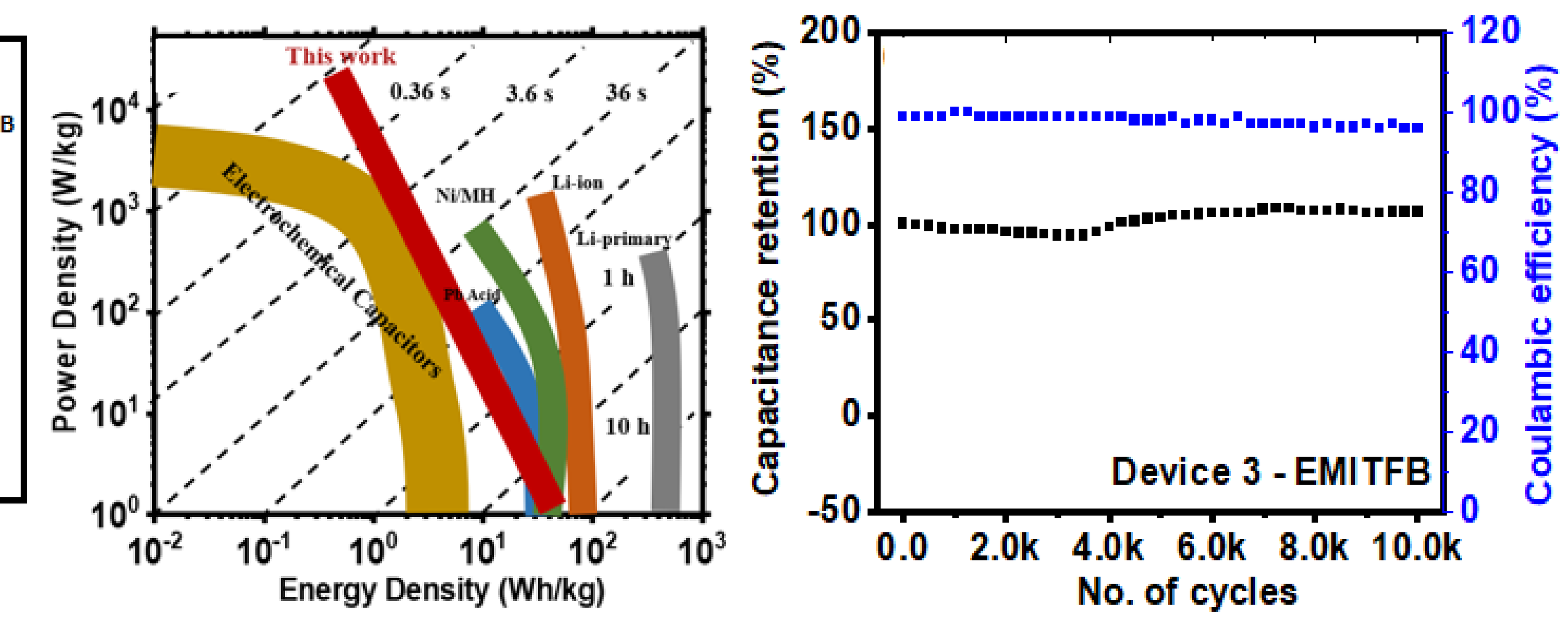

Figure: Ragone plot comparison of PG device with various energy storage devices, and stability curves for the Device 3- EMITFB

Conclusion

- Activated carbon was produced from pomegranate using a facile chemical activation process.
- The produced carbon resulted in a very high surface area of 2,189 m^2/g (1:3 ratio of pomegranate: activating agent)
- The activated carbon derived from pomegranate showed high specific capacitance of 190 F/g at a current density of 1 A/g.
- PG-2 electrode was used for symmetrical coin cell device with aqueous, organic, and ionic liquid electrolytes
- The symmetrical coin cell device with ionic liquid electrolyte has the highest energy and power density of maximum 68 Wh kg^{-1}, 11,316 W kg^{-1}.
- The stability test of the device resulted in capacitance retention of 108 % after 10,000 cycles while maintaining its coulombic efficiency of 100%.

Future Research

- Future research focuses on making composite of these carbons with metal oxide to further improve energy and power densities.

Acknowledgement and References

- Sincere acknowledgment to the Polymer Chemistry Program, Pittsburg State University for providing financial and research support for this project.