Carbon Quantum Dots Derived from Spent Local Liberica Coffee Ground for Applications in Electric Double-layer Capacitor (EDLC)

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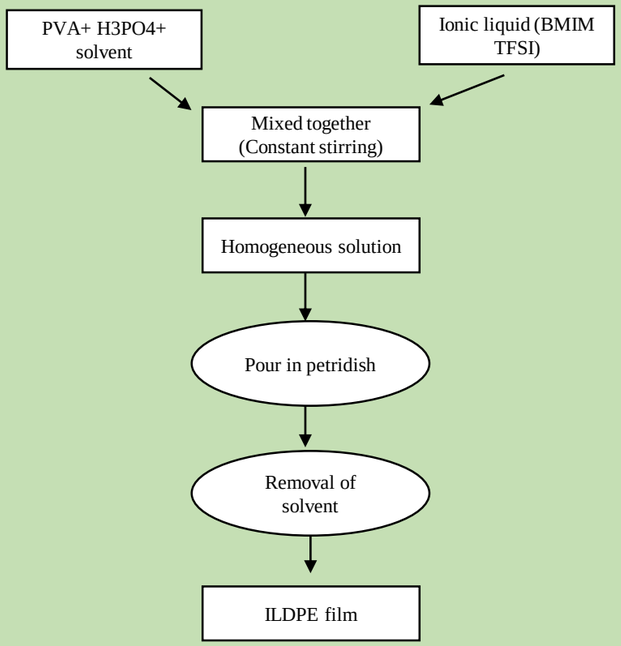
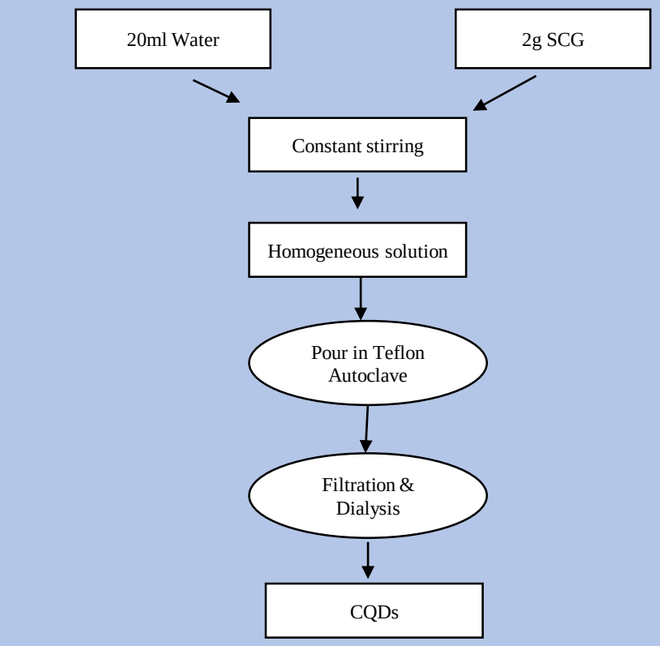
Abstract: This study aims to repurpose spent coffee grounds biomass to produce carbon quantum dots (CQDs). These CQDs are then utilized in energy storage systems for sustainable and environmentally friendly purposes due to their ability to increase the device's surface area, biocompatibility, and good optical and electrical properties. Various characterizations, including XRD, TEM, LSV, CV, and GCD, are performed. The synthesized CQDs from the hydrothermal process are incorporated into a carbon slurry and then used as electrodes in electric double-layer capacitor devices assembled with an optimized polyvinyl alcohol gel electrolyte, resulting in a specific capacitance of 125 F/g.

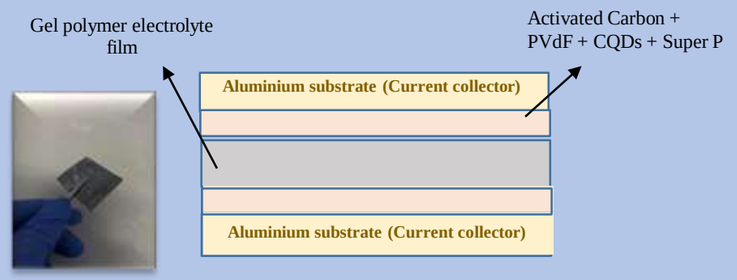
Preparation of GPE



Synthesis of CQDs

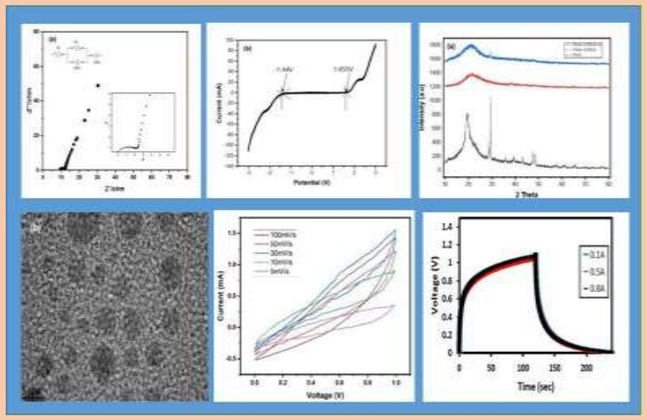


Fabrication of EDLC



Result

Some characterisations were done including Ionic conductivity, LSV, XRD, TEM, CV, & GCD. Results are given below.



Discussion and Conclusion

The PVA GPE achieved high ionic conductivity at 1.76×10^{-1} S/cm with 25 wt% BMIM TFSI. The pure PVA sample exhibits a semicrystalline nature, as indicated by the broad peak at 2θ of 29.39°. The incorporation of the ionic liquid as a plasticizer into the polymer matrix shifted the peak to a lower value at 21.44°, indicating a modification of the crystal structure, which might result from changes to the CH bond. CQDs derived from locally sourced spent coffee grounds through a hydrothermal process represent an eco-friendly and sustainable approach to nanomaterial synthesis. The fabricated CQDs exhibited a size range of 1.6-4.4 nm, making them suitable for various applications. Through comprehensive characterization using a range of techniques, EDLCs assembled with carbon electrodes containing 5 wt.% CQDs derived from spent coffee grounds demonstrated a specific capacitance of 125 F/g. The EDLC also exhibited energy and power densities of 4.3 Wh/kg and 130.6 W/kg, respectively.

Acknowledgement

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