The Synergistic Effect of Nitrile and Ether Functionalities for Supercapacitor Gel Electrolytes Used in Supercapacitors

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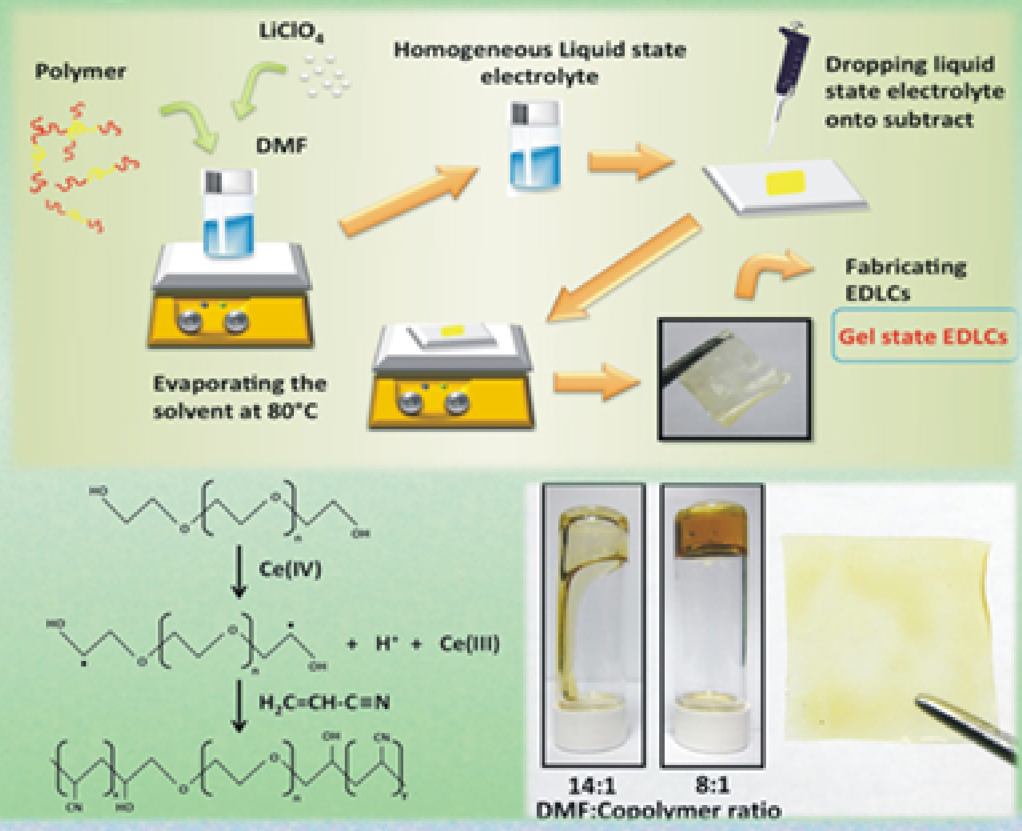
Abstract

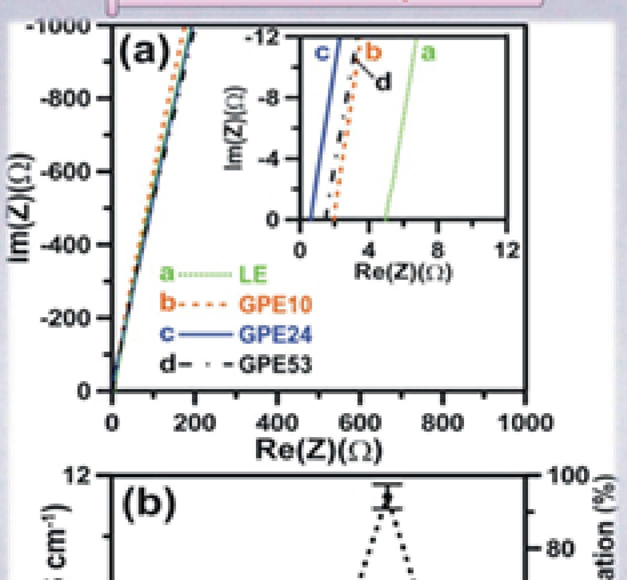
- The synthesis of a gelled polymer electrolyte (GPE) using poly(ethylene glycol) blending poly(acrylonitrile) (ie., PAN-*b*-PEG-*b*-PAN) as a host, dimethyl formamide (DMF) as a plasticizer and $LiClO_4$ as an electrolytic salt for electric double layer capacitors (EDLCs).
- Poly(acrylonitrile) (PAN)-based frameworks are exhibit high cation solvating ability and a wide electrochemical stability window. Poly(ethylene glycol) (PEG) segments in a polymer improve the coordination of polymeric framework with solvent molecules and promote ion transport in resulting GPEs.
- Adjusting the AN/EG chain length ratio produced GPEs with a maximal ionic conductivity of 1.1×10^{-2} S cm^{-1}, whereas the conductivity of $LiClO_4$/DMF LE was only 1.6×10^{-3} S cm^{-1}.

Preparation of GPEs

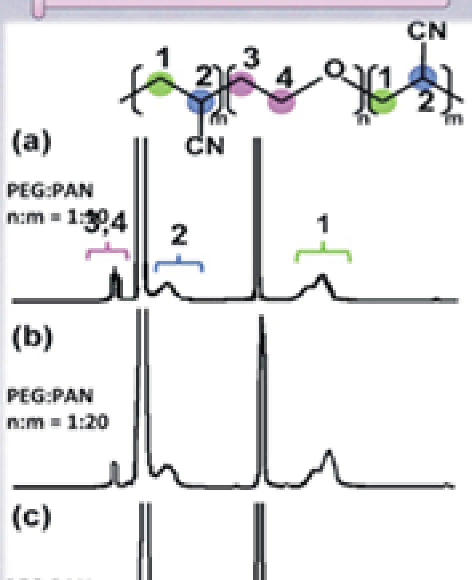


GPEs Structure and Properties

Conductivity

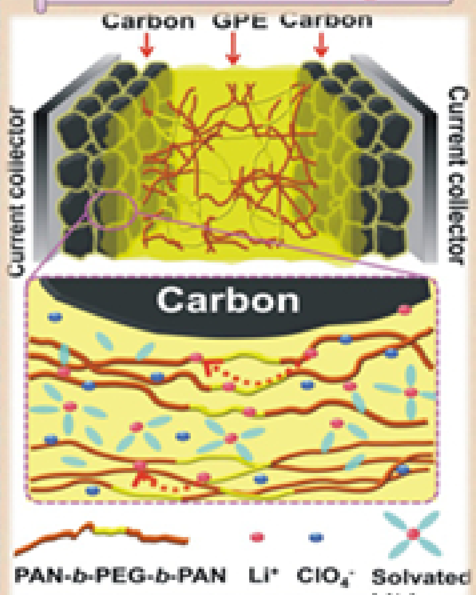


NMR

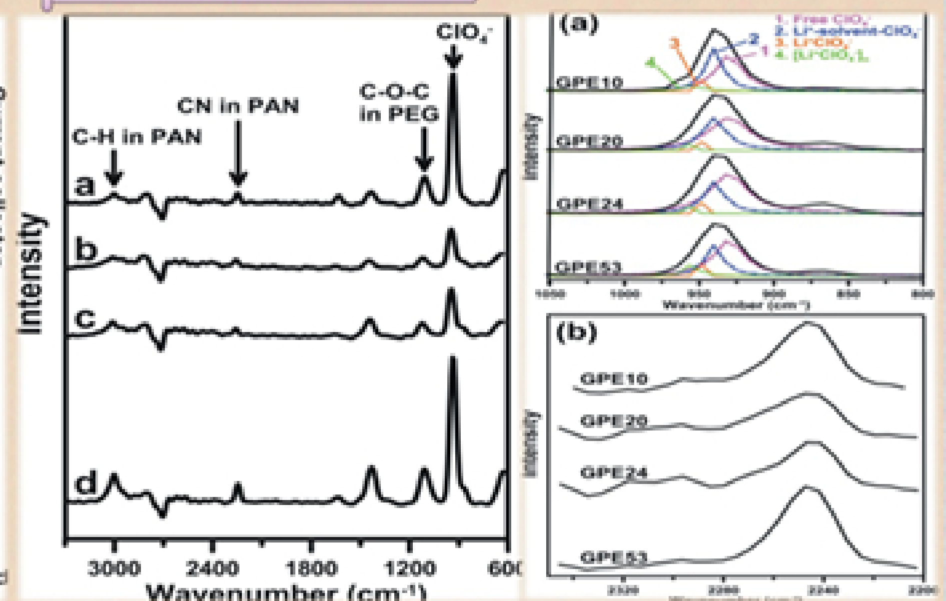


Results and discussion

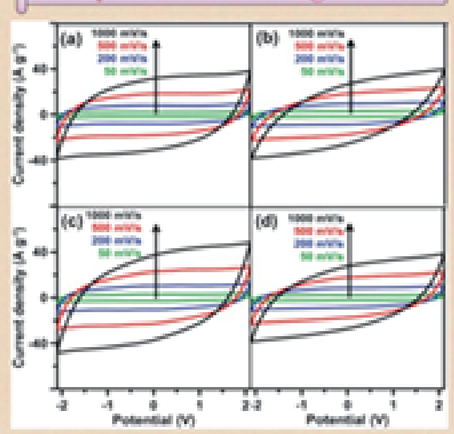
EDLCs assembling



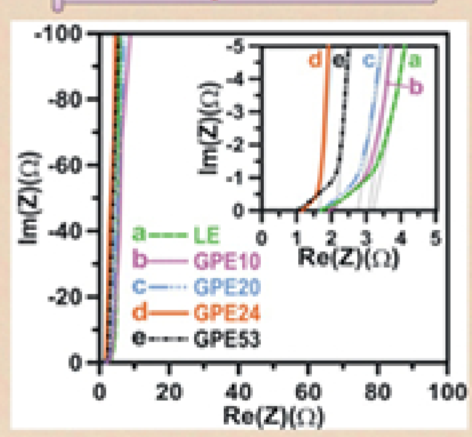
Raman

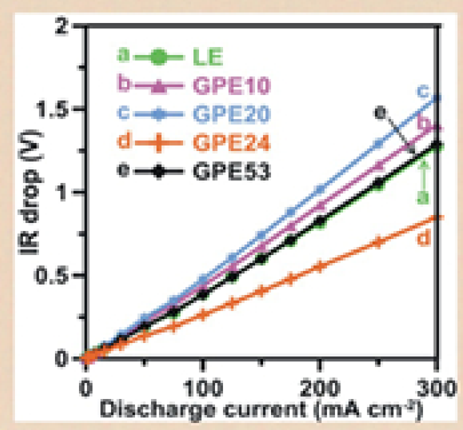


Cyclic Voltammograms

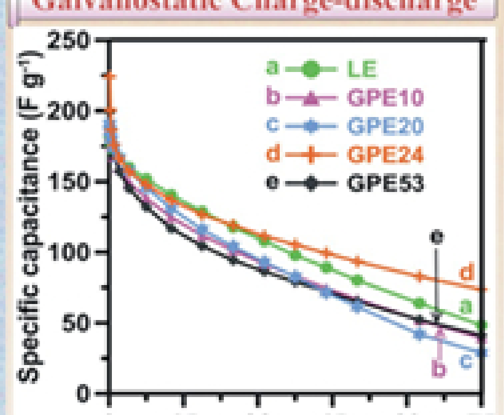


Impedance

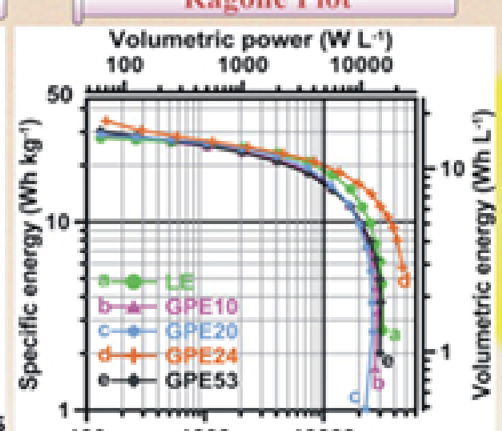




Galvanostatic Charge-discharge



Ragone Plot



Electrolyte Type	Ultimate *C* (0.5 A g^{-1})	*C* (75 A g^{-1})	Retention
GPE10	187 F g^{-1}	40 F g^{-1}	21 %
GPE20	191 F g^{-1}	29 F g^{-1}	15 %
GPE24	224 F g^{-1}	74 F g^{-1}	33 %
GPE53	199 F g^{-1}	41 F g^{-1}	21 %
LE	163 F g^{-1}	56 F g^{-1}	34 %

Conclusions

- A GPE with well-tuned nitride/ether ratio exhibits high ionic conductivity of 1.1×10^{-2} S cm^{-1}.
- The GPE24 cell delivered a high energy density of 34 Wh kg^{-1} (~17 Wh L^{-1}) and maintained 20 Wh kg^{-1} (~10 Wh L^{-1}) at a high power of 10 kW kg^{-1} (~5 kW L^{-1})
- The use of this gel system not only provides high energy and power densities and long-term stability for EDLC systems, but is also a readily scalable roll-to-roll assembly process.

Acknowledgement

This research is supported by the National Science Council of Taiwan (101-2221-E-006-243-MY3, 101-2221-E-006-225-MY3, 102-3113-P-006-012, and 102-3113-E-006-), and the "Aim for the Top-Tier University and Elite Research Center Development Plan" of National Cheng Kung University.