Designing New Composite Solid Polymer Electrolytes for Li Batteries

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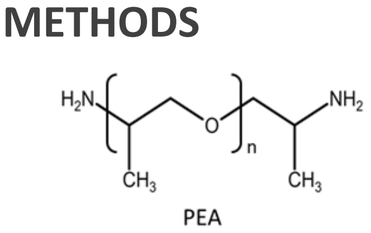
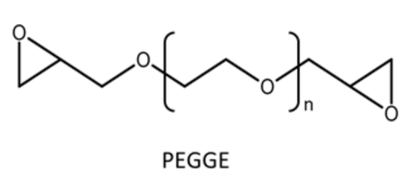
INTRODUCTION

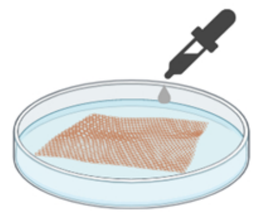
The impact of fossil fuels, global warming and widespread pollution increase the need for green, renewable, and alternative energy sources and storage systems. Thus, the development of solid state batteries are the key to enable more safe, robust and low-cost solutions that will potentiate the electrification of transportation systems and energy storage applications worldwide.

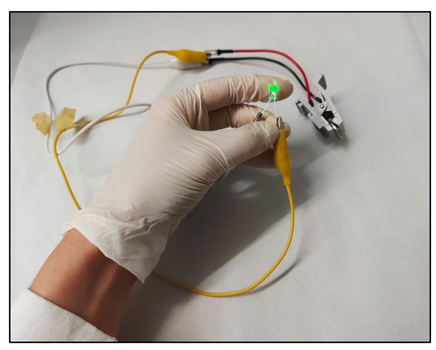
In this work, a new type of composite gel polymer electrolyte (CGPE) was proposed based on a low cost and nonflammable epoxy resin and nonflammable solvated ionic liquid (SIL) combined with glass fiber (GF) as reinforcement. This membrane can act both as matrix and separator, while providing safety and good ionic conductivity, as well as mechanical integrity.

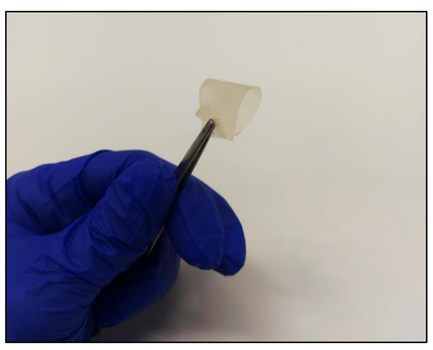
METHODS











RESULTS

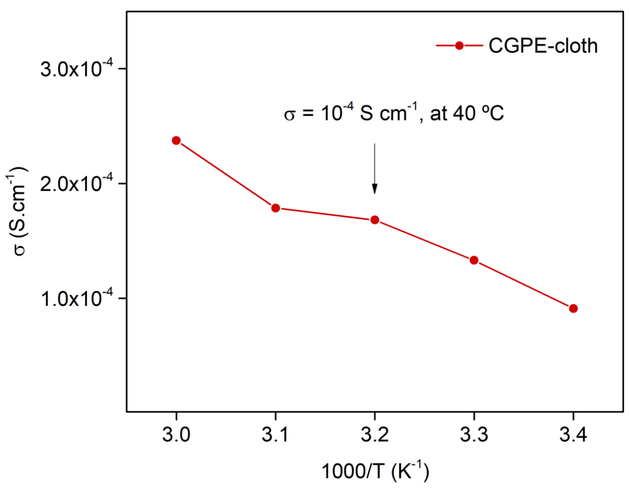


Figure 1. Ionic conductivity, σ, as a function of temperature.

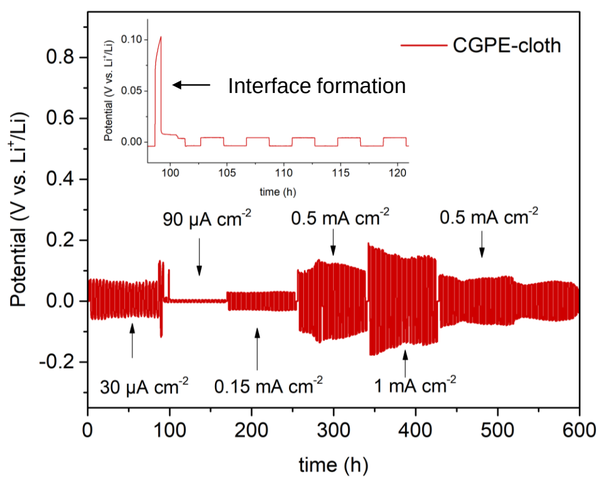


Figure 2. Cronopotentiometry of Li | CGPE | Li symmetric cell, at 40 °C.

Figure 6. (a) Schematic illustration for the CGPE synthesis with photograph of the CGPE dry thin film (thickness = 70 µm). (b) Photograph of LFP | CGPE | Li cell lighting up a green led.

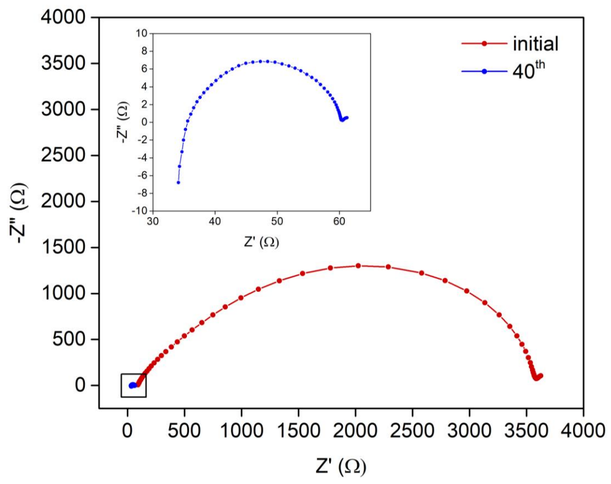


Figure 3. EIS (eletrochemical impedance spectroscopy) of Li |CGPE | Li symmetric cell before and after cycling, at 40 °C.

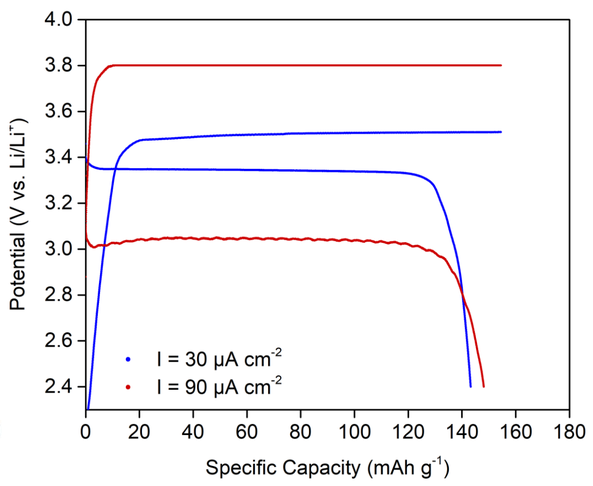


Figure 4. Charge-discharge of LFP | CGPE | Li half cell, at 40 °C.

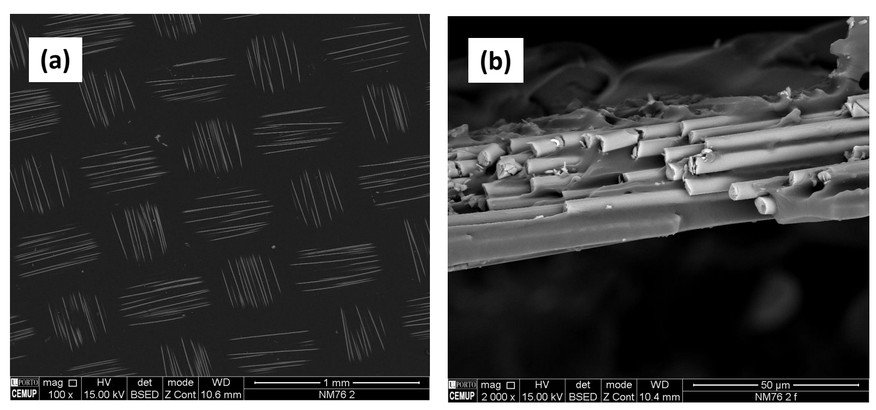


Figure 5. SEM images of (a) surface and (b) cross section for CGPE.

- Results show that CGPE delivers high ionic conductivity of 10^{-4} S cm^{-1}, at 40 °C.
- Symmetric Li | CGPE | Li cell shows lower overpotential at higher density currents (1 mA cm^{-2}), demonstrating stability against Li metal.
- After 90 h, it's visible a decrease on the overpotential of the Li symmetric cell, due to the formation of a stable Li – electrolyte interface.
- EIS after cycling demonstrates stable SEI formation, by showing lowered resistance.
- LFP | CGPE | Li cell discharge capacity reached 148 mAh g^{-1} at a density current of 90 µA cm^{-2}.

CONCLUSION AND ONGOING WORK

- Composite gel polymer electrolyte based on epoxy resin and glass fiber was fabricated with high ionic conductivity (10^{-4} S cm^{-1}), at near room temperature (40 °C).
- Cell conditioning (30 µA cm^{-2}) enables stable interface and reduced interfacial resistance.
- Optimization of cell performance is currently under work.

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