Supplementary Information

1. *Battery behaviour under discharge*

When a cell or battery is discharged its voltage is lower than the theoretical voltage [1]. The difference is caused by *IR* losses due to cell (and battery) resistance and polarization of the active materials during discharge. This is illustrated in Fig. 1S. In the idealized case, the discharge of the battery proceeds at the theoretical voltage until the active materials are consumed and the capacity is fully utilized. The voltage then drops to zero. Under actual conditions, the discharge curve is similar to the other curves in Fig. 1S. The initial voltage of the cell under a discharge load is lower than the theoretical value due to the internal cell resistance and the resultant *IR* drop as well as polarization effects at both electrodes. The voltage also drops during discharge as the cell resistance increases due to the accumulation of discharge products, activation and concentration, polarization, and related factors. Curve 2 is similar to curve 1, but represents a cell with a higher internal resistance or a higher discharge rate, or both, compared to the cell represented by curve 1. As the cell resistance or the discharge current is increased, the discharge voltage decreases and the discharge shows the more sloping profile of Curve 2.
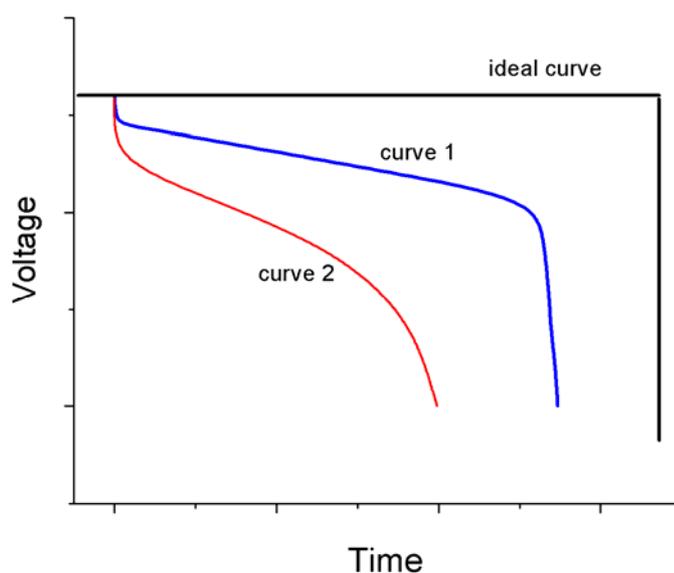

Figure 1S. Characteristics discharge curve

2. *C-rate definition*

A common method for indicating the discharge, as well as the charge current of a battery, is the C-rate [1], expressed as

$$I = M \; x \; C_n$$

Where I = discharge current, Ampers;

C = numerical value of rated capacity of the battery, in ampere-hours (Ah);

n = time, in hours, for which rated capacity is declared;

M = multiple or fraction of C.

For example, the 0.1 *C* or *C/10* discharge rate for a battery rated at 5Ah is 0.5 A. It means that discharging the battery at a current of 0.5 A the battery will deliver all its charge in 10 hours. In this example, the 1 *C* discharge rate is 5 A, which means that discharging the battery at a current of 5 A all the stored charge is released in 1 hour. The 2 *C* or *C/0.5* discharge rate for this example is 10 A, all the battery stored charge is released in 0.5 hour.

3)   *DSC measurements on gelled electrolyte*

Fig. 2S shows the DSC curve of EGPE-PVdF-CTFE membrane. As described in the paper the liquid electrolyte content of the gelled membrane is higher than 800% of the dry electrospun polymeric mat. As expected the DSC of the gelled electrolyte shown in Fig. 2S resembles that of pure liquid electrolyte [2] rather than that of the dry electrospun PVdF-CTFE mats (see Fig. 3 of the paper).
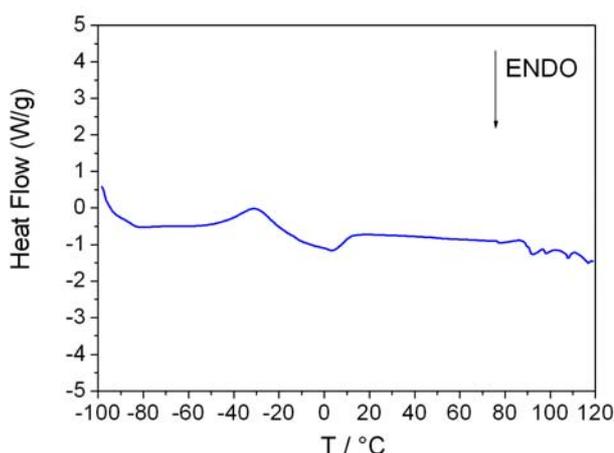

Figure 2S DSC of the gelled membrane

In fact, the curve of Fig. 2S shows a glass transition temperature around 183 K which is much lower than that of the PVdF-10 CTFE mats (around 242 K, see Table 1 of the paper) and reveals a lack of crystallinity of the gelled membrane as furthermore evidenced by the featureless of the curve in melting region of the pure PVdF-10 CTFE mats (Fig. 3 of the paper). This lack of crystallinity could explain the elevated ionic conductivity of the gelled electrolyte.

The DSC trace of the quenched sample, Fig. 2S, shows an exothermic peak on heating at around -30 °C, which is attributed to the cold crystallization of the gelled electrolyte during the warming process, and an endothermic peak at around 0 °C due to the melting of the previously crystallized phase.

Finally, worth to be noticed is that no evident solvent evaporation process is observed on the DSC trace up to temperatures as high as 100 °C, indicating an effective interaction between the polymer chains and the liquid electrolyte molecular and ionic components.

4)   *Linear Plot of the Conductivity vs Time*

The time evolution of the room temperature conductivity of the EGPE-PVdF-CTFE based membranes have been reported in a linear plot, Fig. 3S.
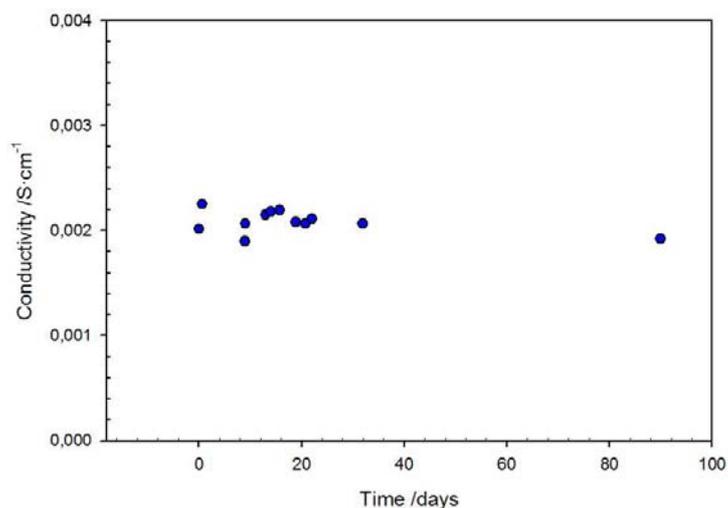

Figure 3S Linear Plot of the Time Dependence of the Conductivity

The plot clearly shows that there is no significant variation of the conductivity of the gelled membrane over an extended period of time. The modest random scattering of the experimental values, in the range of 10%, is mostly due to the room temperature oscillations as the cell was not in thermostatic conditions.

References
1)   D. Linden and T.B. Reddy – Handbook of batteries 3rd Ed. Chap. 3
        ISBN: 0-07-135978-8 McGrow Hill 2002.

2)   Y. Ahihara, S. Arai, K. Hayamizu
        Electrochimica Acta 45 (2000) 1321-1326