Deliverable 2.2

Generation I of electrolyte (high-liquid)

Project acronym: ECO2LIB
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Authors:	Uppsala University

Dissemination level		
PU	**Public**	x
CO	**Confidential, only for members of the consortium (including the Commission Services)**	
CI	**Classified**	

Full cells containing Si-Graphite anode combined with $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$ (NMC622) cathode have been investigated. The silicon material (L-20772) was provided by 3M and contains a mixture of amorphous silicon with crystalline iron disilicide inclusions and graphite. Both electrode materials were provided by VARTA Micro Innovation. Energy storage performance of these full cells has been studied with two different electrolyte formulations; one being highly fluorinated (1 M $LiPF_6$ in ethylene carbonate (EC)/ethyl methyl carbonate (EMC) (3:7, v/v) with 10 wt% fluoroethylene carbonate (FEC) and 2 wt% vinylene carbonate (VC)) and another one being fluorine-free (0.7 M LiBOB in EC/EMC with 2 wt% VC).

Cells with both electrolytes showed the same initial discharge capacity of 152 mAh/g and capacity retention 65 % after 400 cycles (Figure 1a). These results show the possibility to use a fluorine-free electrolyte with high performance that is more sustainable and less toxic than the conventional electrolytes.

The following step is to gradually increase battery safety by replacing the flammable solvents of the electrolyte with polymer gelifiers. In this study, half cells containing Si-Graphite composite electrodes have been tested with the fluorinated state-of-the-art electrolyte and compared with another electrolyte replacing 10 wt% of the EC:EMC mixture with polycarbonate oligomer as gelifier.

The cell with the state-of-the-art electrolyte delivered slightly higher discharge capacity and Coulombic efficiency in the first cycle (553 mAh/g and 87.4 %, respectively) compared to the 10 wt% gelified electrolyte (485 mAh/g and 85 %). Overall, both electrolytes showed similar cycling stability for 100 cycles at C/2 (Figure 1b). These results indicate the possibility to partially replace flammable solvents in the conventional electrolyte with gelifiers in order to increase the safety of the battery without compromising the electrochemical performance.

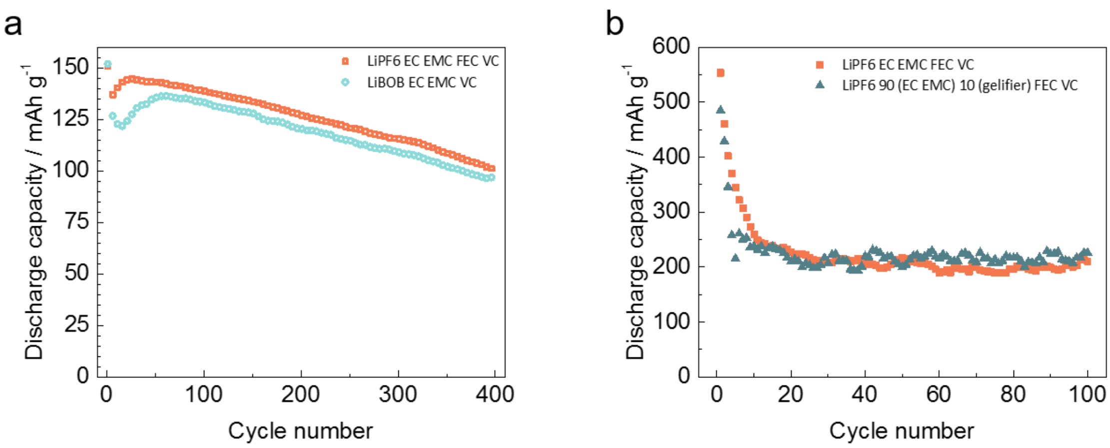

Figure 1. (a) Discharge capacity of NMC622/Si-Gr full cells containing the state-of-the-art electrolyte (1M $LiPF_6$ EC:EMC + 10% FEC + 2% VC) (orange) and fluorine free electrolyte (0.7M LiBOB EC:EMC + 2% VC) (light blue). (b) Discharge capacity of Si-Gr half cells containing the state-of-the-art electrolyte (1M $LiPF_6$ EC:EMC + 10% FEC + 2% VC) (orange) and (1M $LiPF_6$ 90 wt% EC:EMC 10 wt% gelifier + 10% FEC + 2% VC) (dark blue).

Based on these results, Deliverable D2.2 establishes that the generation I of electrolytes for ECO^{2}LIB are:

(1) 1M $LiPF_6$ in EC:EMC + 10% FEC + 2% VC

(2) 1M $LiPF_6$ in 90 wt% EC:EMC 10 wt% oligomer + 10% FEC + 2% VC

(3) 0.7M LiBOB in EC:EMC + 2% VC

On request, we are now ready to deliver these electrolytes to ECO2LIB partners. If any partner requires physical delivery of this electrolyte, it can be obtained (from one same batch) from UU. Then, please contact Daniel.Brandell@kemi.uu.se, Jonas.Mindermark@kemi.uu.se or Guiomar.Hernandez@kemi.uu.se