High energy density Na-ion batteries through electrolyte optimization

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Large research efforts are devoted to the Li-ion battery technology, which is now mature and plays a major role in the field of portable electronics while entering the field of hybrid and electric vehicles. Aside from controversial debates on lithium supply, the development of new battery chemistries is appealing, especially in large scale stationary applications for which cost is a critical issue.

An interesting alternative is to use sodium instead of lithium. While proof of concept for full Na-ion cells was already achieved long ago,[1] the topic has re-emerged in the last few years. Current efforts are mostly devoted to the search of new electrode materials,[2] while studies dealing with the electrolyte are much more scarce.

Most electrode materials are being tested using $NaClO_4$ in PC as the electrolyte. Although some reports also exist on the use of the $NaPF_6$ salt and other solvents[3], no systematic studies have been reported on their physico-chemical properties. The results of a comparative study will be presented for electrolytes prepared using several solvents (PC, EC, DMC, DME, DEC, THF and Triglyme) and solvent mixtures in combination with various Na-salts, namely $NaClO_4$, $NaPF_6$ and NaTFSI. The viscosity, the conductivity (cf. fig. 1) and the electrochemical stability of the electrolytes were measured[4]. Results will be discussed together with solvation trends and preliminary XPS investigations on the SEI built with an optimized hard carbon[5] negative and a $Na_3V_2(PO_4)_2F_3$ positive electrode. Finally, the performance of a full Na-ion cell assembled using the above mentioned electrode materials will also be reported[6] (cf. fig. 2).

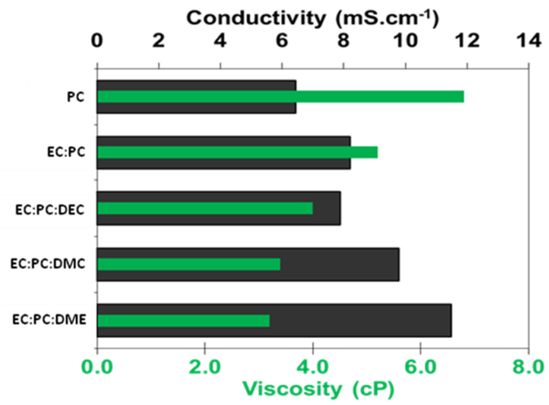

Figure 1: Conductivity (black bars) and viscosity (green bars) values of electrolytes based on 1M $NaClO_4$ dissolved in various solvents and solvent mixtures.

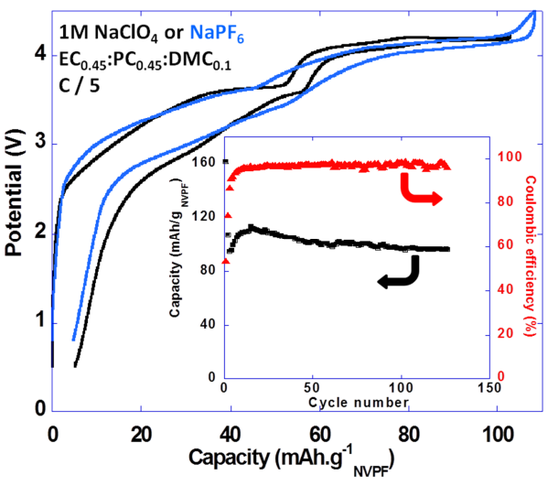

Figure 2: Potential versus capacity profiles for a full Na-ion cell with hard carbon and $Na_3V_2(PO_4)_2F_3$ as negative and positive electrodes, respectively. The inset displays the capacity (black squares) and the coulombic efficiency (red triangles) versus cycle number for the full cell.

References

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