

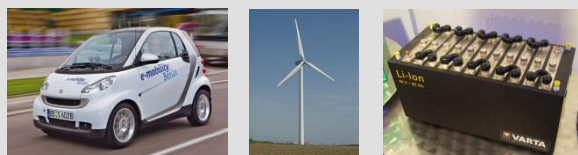


# New ionic liquid-based gel polymer electrolytes for Lithium ion batteries

M. Tosoni<sup>1</sup>, A. Hofmann<sup>1</sup>, M. Schulz<sup>1</sup>, T. Hanemann<sup>1,2</sup><sup>1</sup> KIT Campus Nord, Institute for Applied Materials - Material Process Technology, Karlsruhe Germany<sup>2</sup> Laboratory for Materials Process Technology, Department of Microsystems Engineering (IMTEK), University of Freiburg, Germany

## Introduction

The need for high performance and environment-friendly rechargeable batteries is of major global interest. For high power applications, like electric vehicles (EV) and energy storage for wind / solar plants, a safe and efficient accumulator is needed. Lithium ion batteries offer a great energy density, but have safety limitations due to their flammable electrolytes.



## Motivation

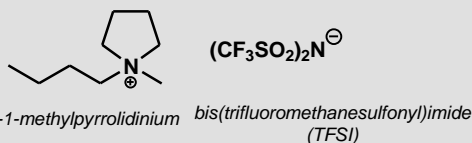
Gel polymer electrolyte films are frequently used as excellent substitutes for liquid electrolytes for batteries, which help to improve the safety and reliability. [1]



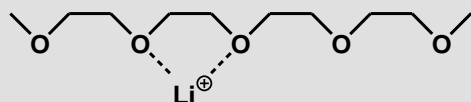
### Ionic liquids (ILs) have many attractive properties:

- negligible vapor pressure
- high ionic conductivity
- high thermal stability
- high electrochemical stability

ILs typically consist of bulky organic cations and anions. Therefore ionic liquid based gel polymer electrolytes are studied for application as promising new electrolytes.



Poly(ethylene oxid) (PEO) polymer electrolytes are promising and extensively studied systems. [2] The good  $\text{Li}^+$ -conductivity is manifested by the complexation of  $\text{Li}^+$ -ions at the PEO groups. The  $\text{Li}^+$ -ions can reach other O-atoms nearby via "hopping mechanism".

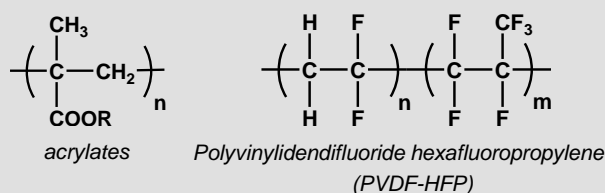


## Materials

A major disadvantage of these PEO based systems is the crystallinity till 60 °C. This is the reason, why these systems offer good conductivities not until 60 °C. Acrylates offer many possibilities to synthesize other copolymers with expectant  $\text{Li}^+$ -conductivities.

### Polymers

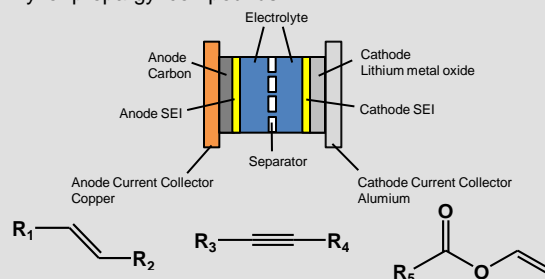
Acrylates are common used for technical purposes. The synthesis are easy to handle and offer possibilities to create copolymeres. PVDF is a well known polymer and is used f.e. as binder in electrodes of lithium ion batteries.



The polymerisation of acrylates can be started by various modes: thermal, UV-radiation and radiation.

### Additives for solid electrolyte interphase (SEI)

The SEI-formation process is not well known but is an important parameter regarding cell performance and long term stability. Therefore various additives for SEI are investigated to obtain good cycling behavior. The additives are based on vinyl or propargyl compounds.



### Processing

Common films can be obtained by tape casting and UV-exposure. The transfer to the battery-cells can be done by a roll-to-roll process.



[1] A. Manuel Stephan, Eur. Polymer J. 42 (2006) 21-42.

[2] M. Armand, Solid State Ionics 9-10 (1983) 745.