

Nafion solvated by ethylene carbonate, dimethyl carbonate and dimethylacetamide as electrolyte for lithium metal batteries

Daria Voropaeva, Andrey Yaroslavtsev

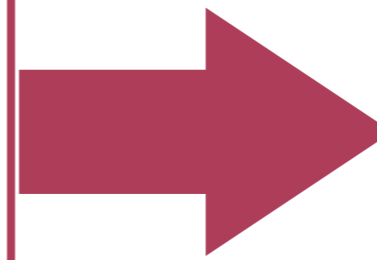
Kurnakov Institute of General and Inorganic Chemistry of Russian Academy of Sciences,
31 Leninsky Avenue, 119991, Moscow, Russian Federation
voropaeva@igic.ras.ru

Requirements for the electrolytes:

1. high ionic and low electronic conductivity; 2. wide window of electrochemical stability; 3. chemical inertness;
4. high lithium transference number; 5. mechanical strength; 6. wide operating temperature range; 7. stability and safety

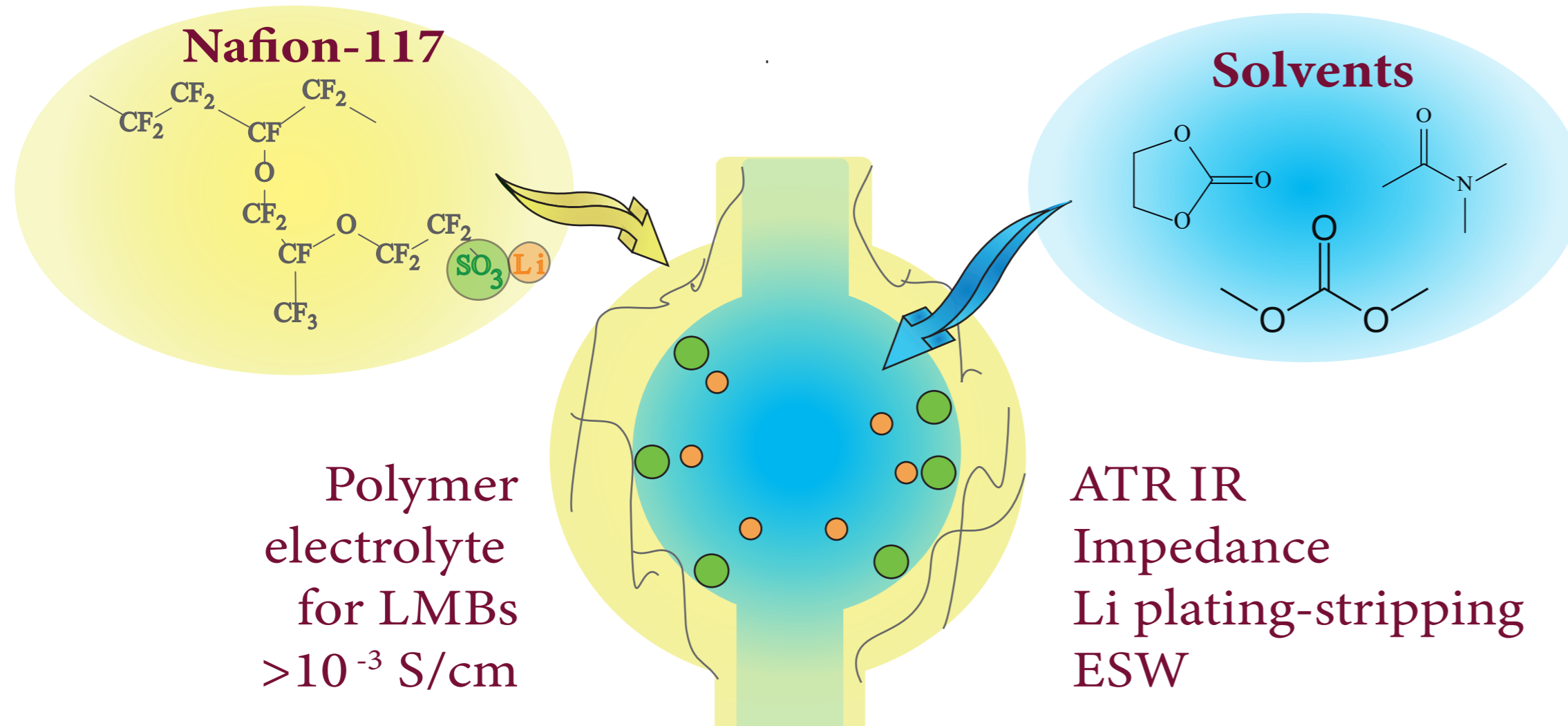
Liquid Electrolytes

LiClO₄, LiAsF₆, LiBF₄, LiPF₆, LiTf, LiTFSI etc.
+ aprotic organic solvents
-hygroscopicity
-flammable
-low thermal stability



Gel-Polymer Electrolytes

PEO, polycarbonates, cation-exchange membranes
+ polar aprotic solvents
+compactness
+safety
+longevity

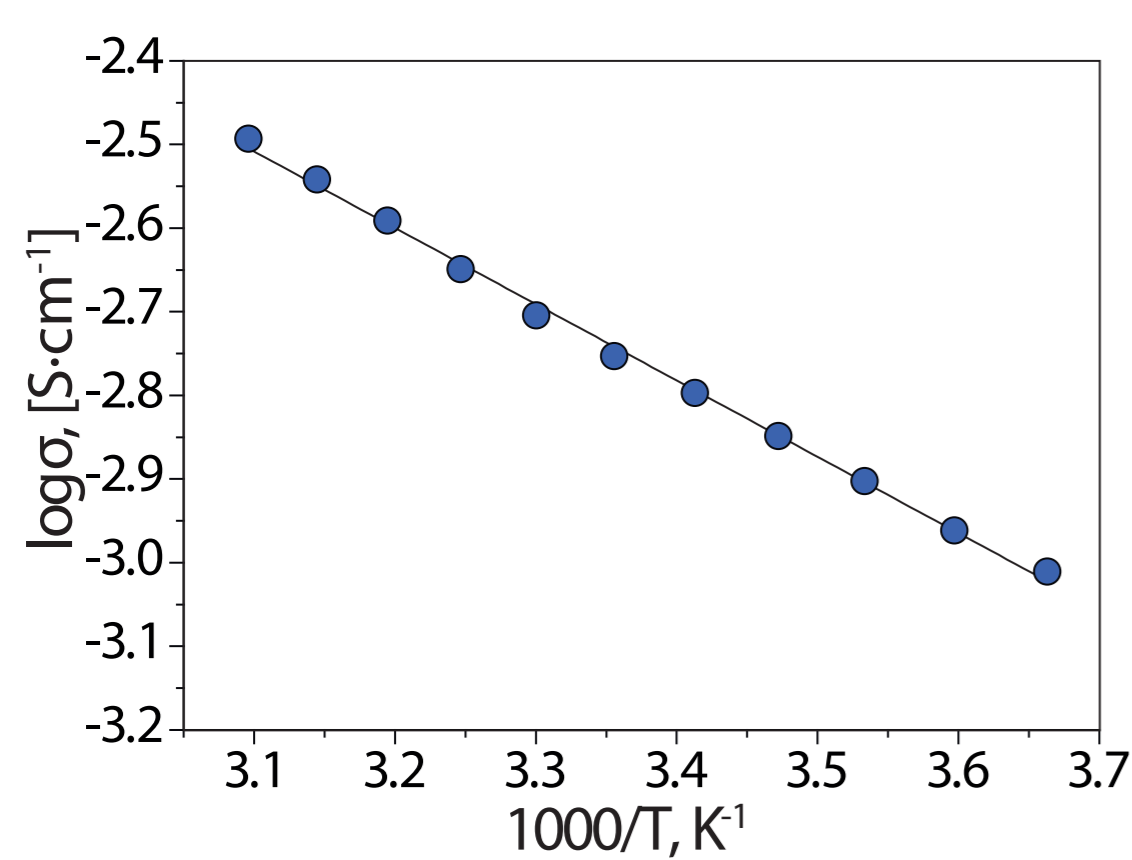


The choice of the solvent

Solvent	ϵ	η , cP
EC	90	1.9 (40°C)
DMC	3.1	0.6
DMA	42	2.0

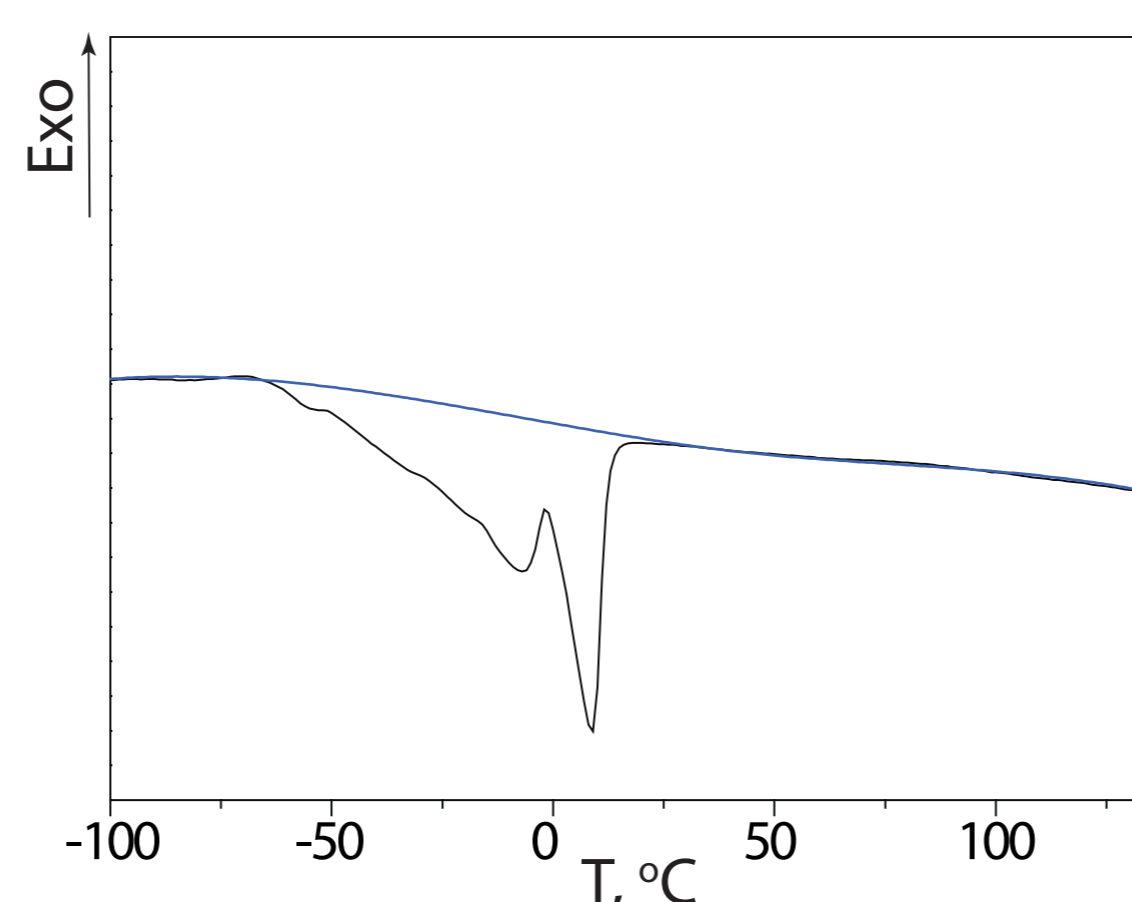
high values of dielectric permittivity and low viscosity are required to increase ionic conductivity

Ionic conductivity



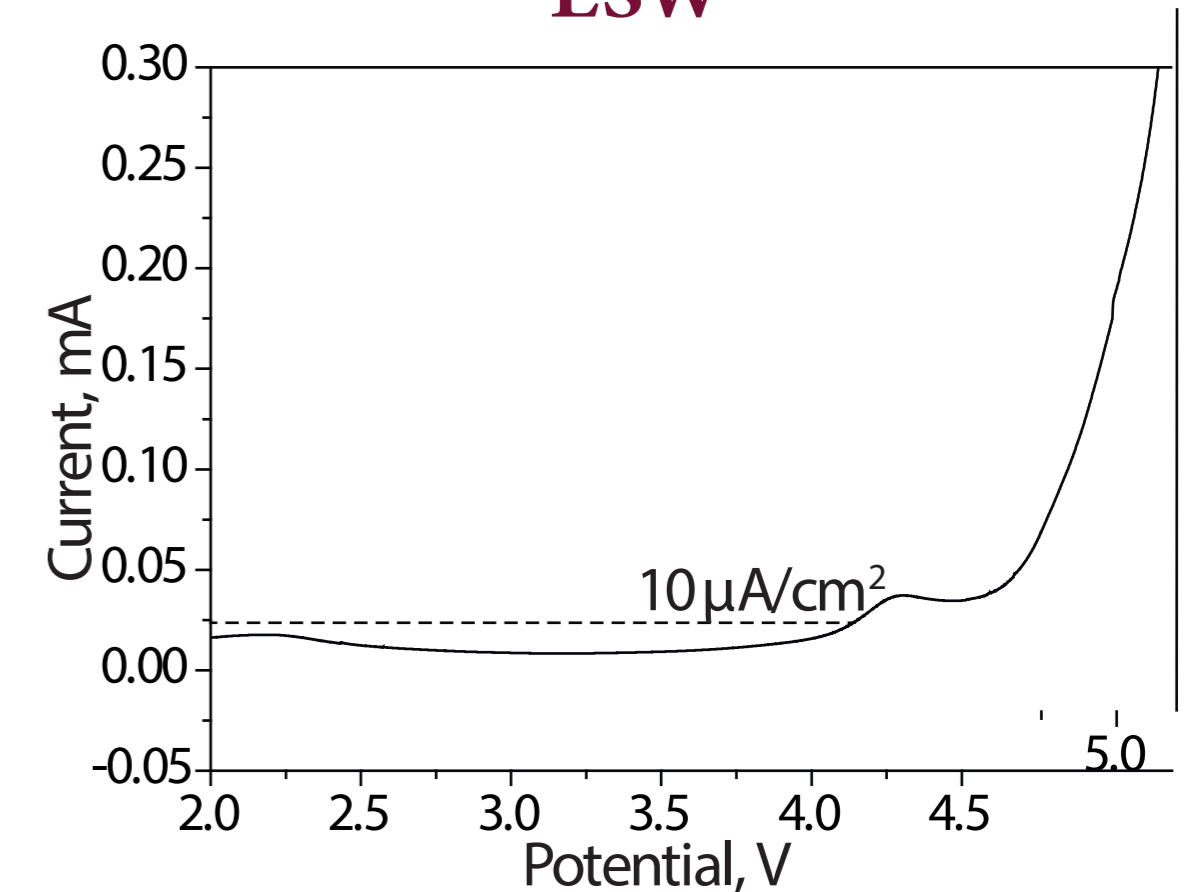
σ (25°C) = 1.8 mS/cm
 $E_a = 17.5 \pm 0.3$ kJ/mol
solvation degree = 19.4

DSC



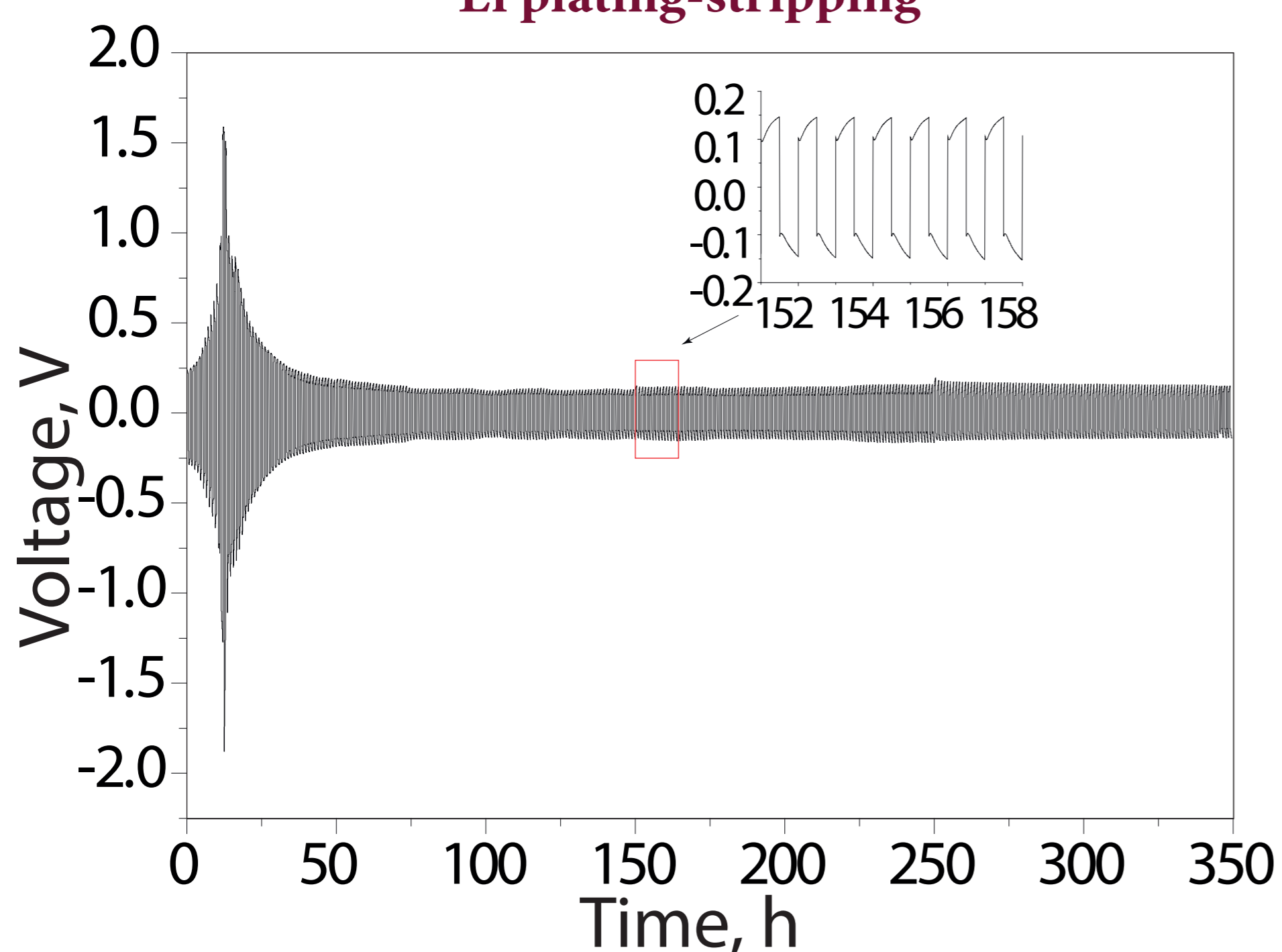
-57°C T_g of mixture of the solvents
-5°C T_m of mixture of the solvents

ESW



ESW is 4.1 vs. Li/Li⁺

Li plating-stripping



Conclusions

It is shown that the use of N,N-dimethylacetamide as one of the main solvent components allows to obtain a stable electrolyte based on the Nafion membrane, characterized by a wide window of electrochemical stability window. The resulting polymer electrolyte solvated by ethylene carbonate-dimethyl carbonate-N,N-dimethylacetamide mixture shows an ionic conductivity of 1.8 mS/cm at 25°C and an electrochemical stability window of 4.1 V (vs. Li/Li⁺), and the symmetrical Li/Li works stably at a current density of 0.1 mA/cm² for >350 h.