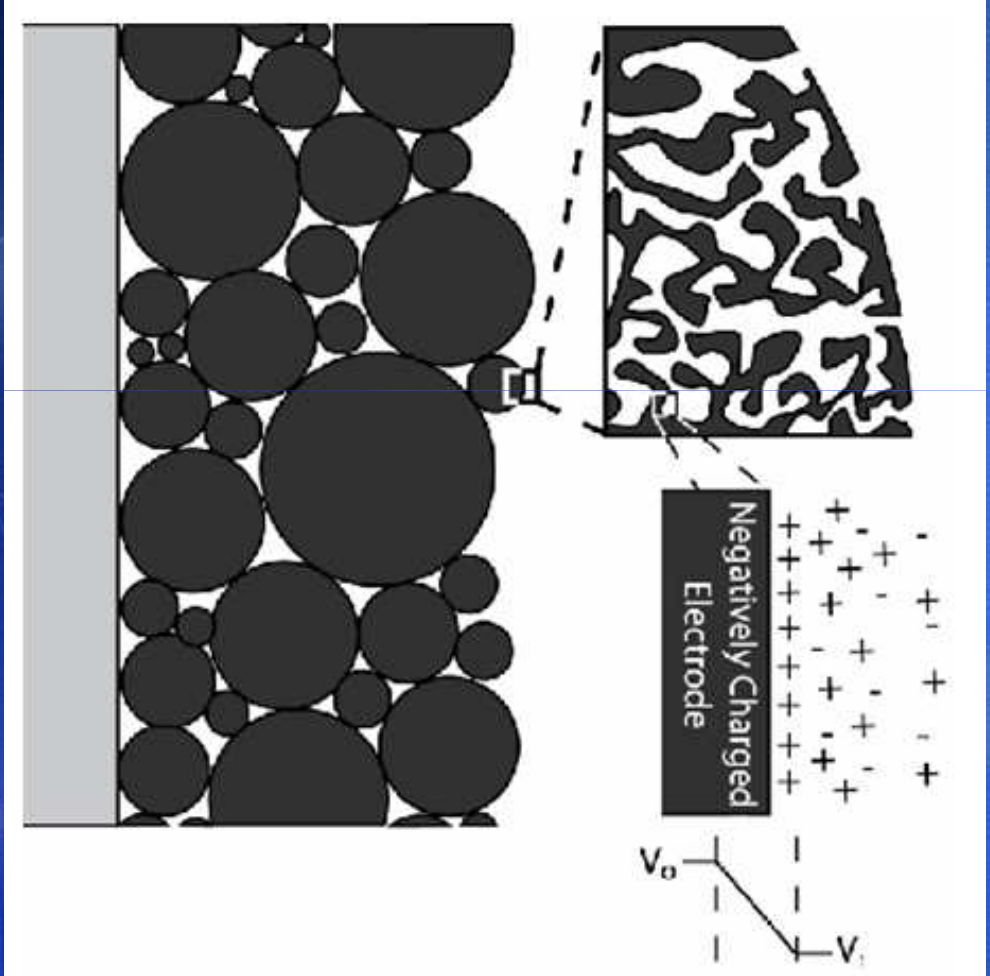
Name: Janno Torop

- PhD student at University of Tartu
- Research of electroactive properties of carbon materials

Preveiw

- Supercap and EDL formation
  - TiC-derived carbon
    - Properties
    - Synthesis
- Preparation of TiC-derived carbon-polymer films
- Experimental setup
- Results

During charging cycle dimensonal chages were observed

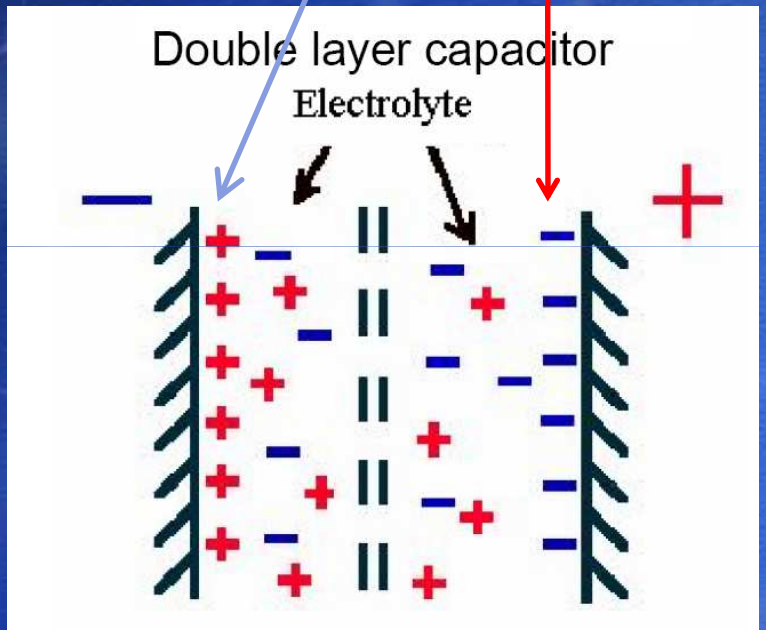


NessCap capacitor module rated at 5,000 farads.

Chem. Eur. J. 2008, 14, 6614 – 6626

Electrochemical behavior of nanoporous carbon electrodes and electrical-double layer capacitors

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$



$$C/A = \frac{\varepsilon_r \varepsilon_0}{d}$$

$$E = \frac{1}{2} C U^2 \text{ and } P = \frac{U^2}{4R_S}$$

To achieve highest **capacitance (*C*)** the capacitor should be made of CDC carbon with high **surface area (*A*)** the electrolyte used in capacitor should be with high **polarity (ε_r)**, small distance (*d*) between ion and carbon (limited by **ionic radii**) should be provided.

Carbide-Derived Carbon (CDC)

- CDC is made by chemically extracting the metal or metalloid from carbide cristal lattice

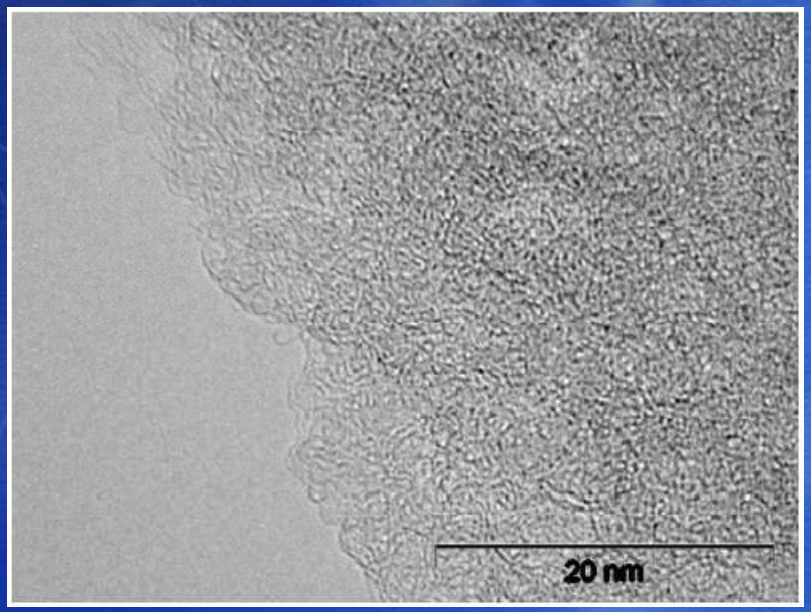
$$MC_x + yCl_2 \rightarrow MCl_{2y} + xC$$

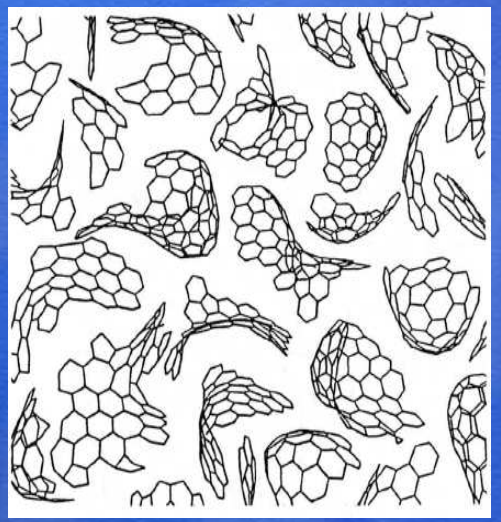
- Carbon particles retain the shape of precursor carbide. The structure and porosity of carbon is significantly infuenced by the structure and chemical composition of carbide

Carbide-Derived Carbon (CDC)- Material for Energy Storage

Notation of CDC material	$T_{Chlorin}$ [°C]	S_A [$m^2\ g^{-1}$]	Vp [$cm^3\ g^{-1}$]	V_μ [$cm^3\ g^{-1}$]	Microporosity [%] < 11 Å	Microporosity [%] < 20 Å	APS [Å]
TiC-600	600	1150	0.53	0.49	70	91	9.3
TiC-800	800	1470	0.71	0.59	50	83	10.2

$T_{Chlorin}$- Temperature of chlorination (powder synthesis)
S_A- Specific area
V_p- Volume of porosity per gram
V_μ- Volume of micropores per gram
APS- Average pore size (Measured from N_2 adsorption)





www.carbon.ee

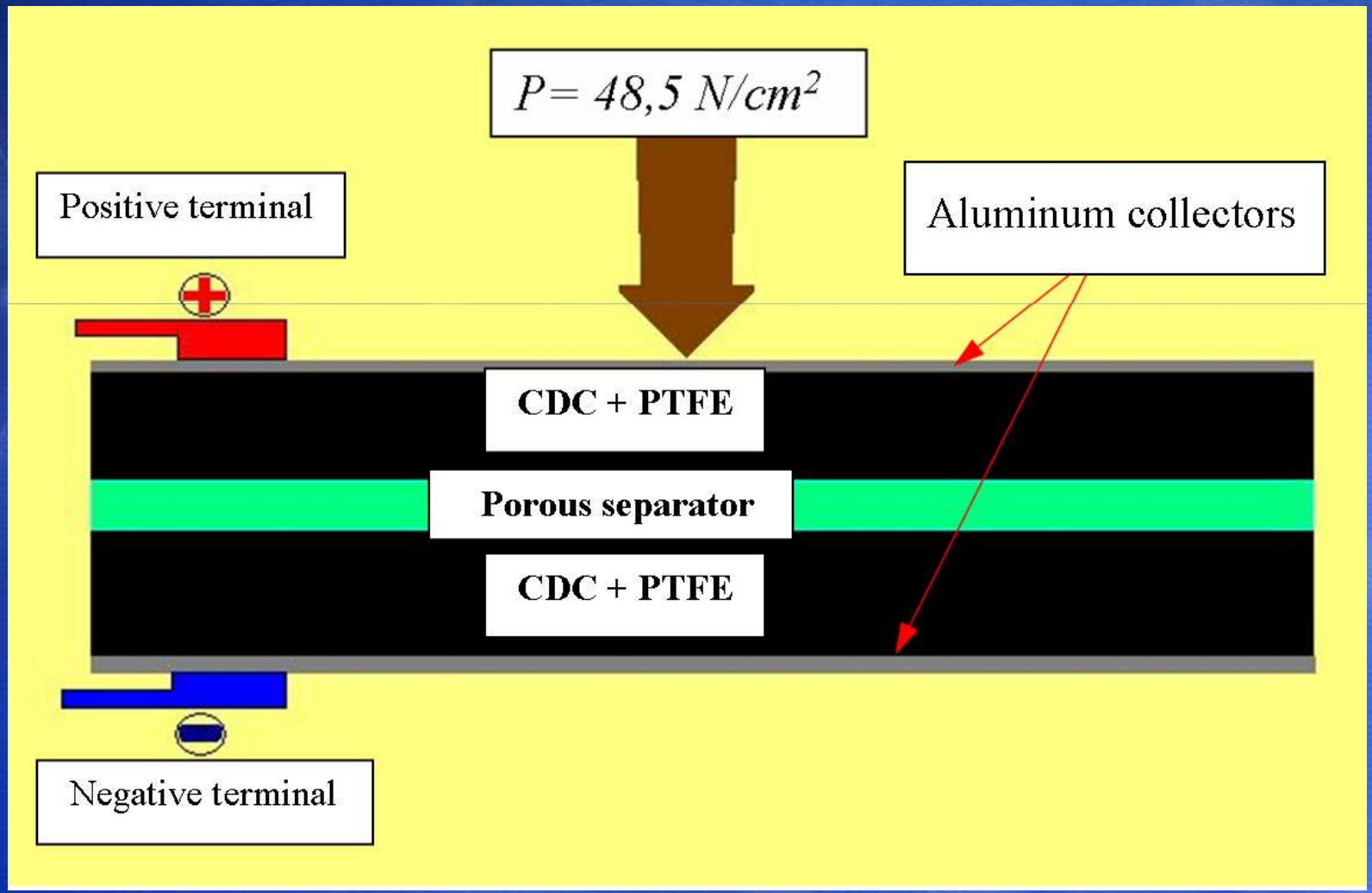
Preparation of polymer-supported carbon sheets

CDC 92 % + PTFE 8 %

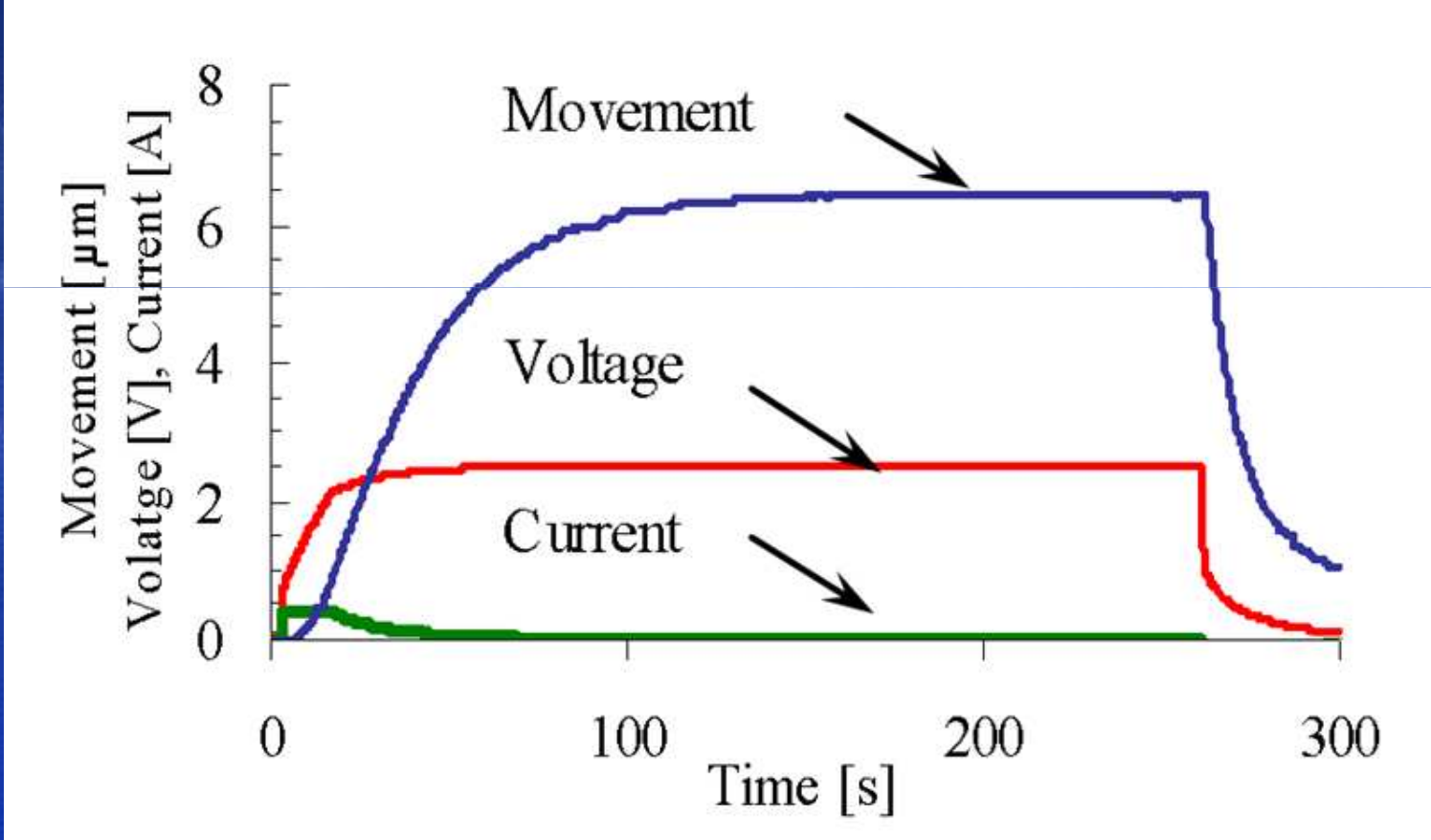
- Impregnation with ethanol and heptane
- Rolling of electrode sheets
- Evaporation of additives

- Vacuum owen to remove adsorbed gases
- Electrolyte injection
- Electromechanical mesurements

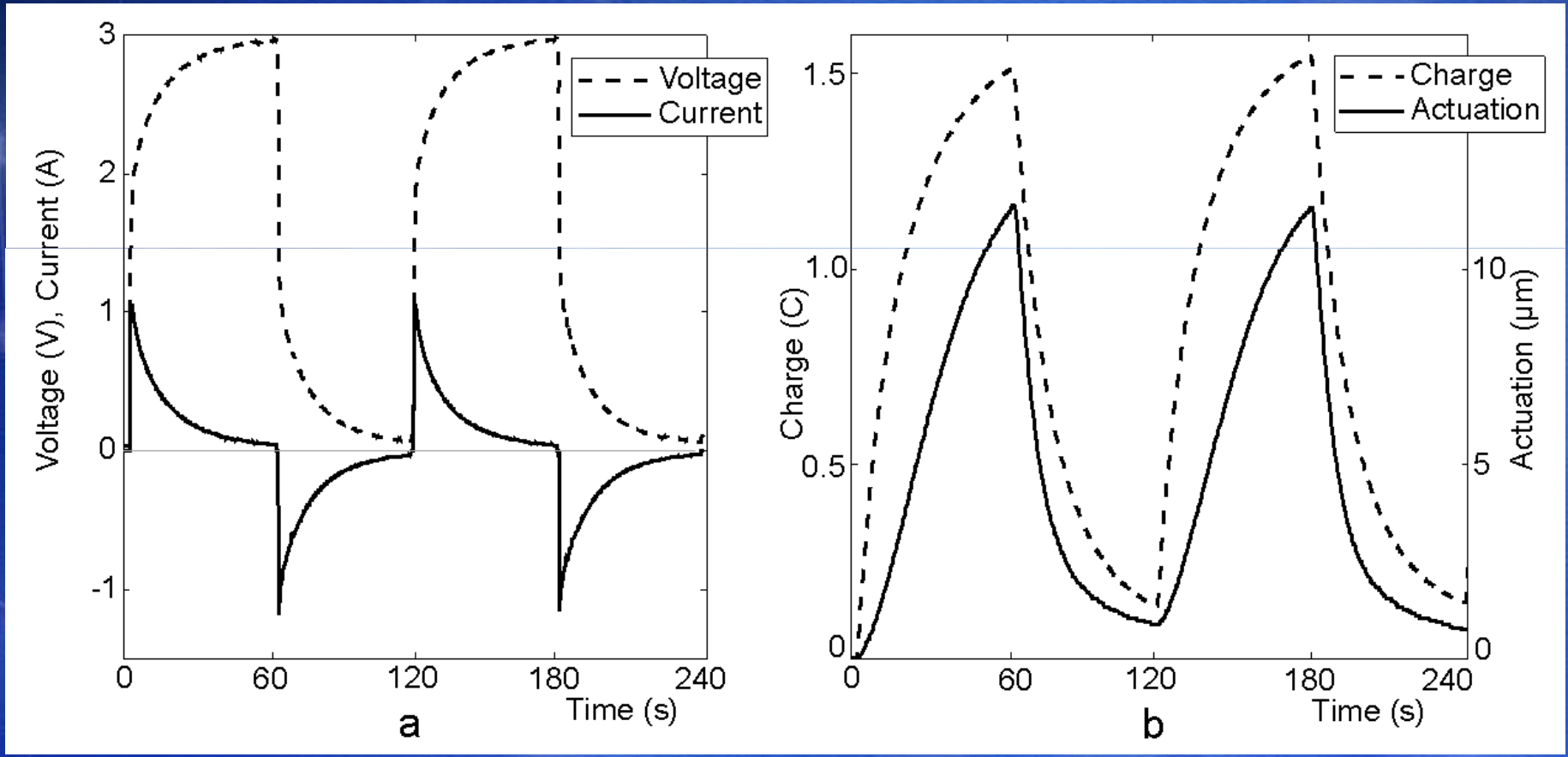
The principal scheme of linear actuators



Actuation measurements

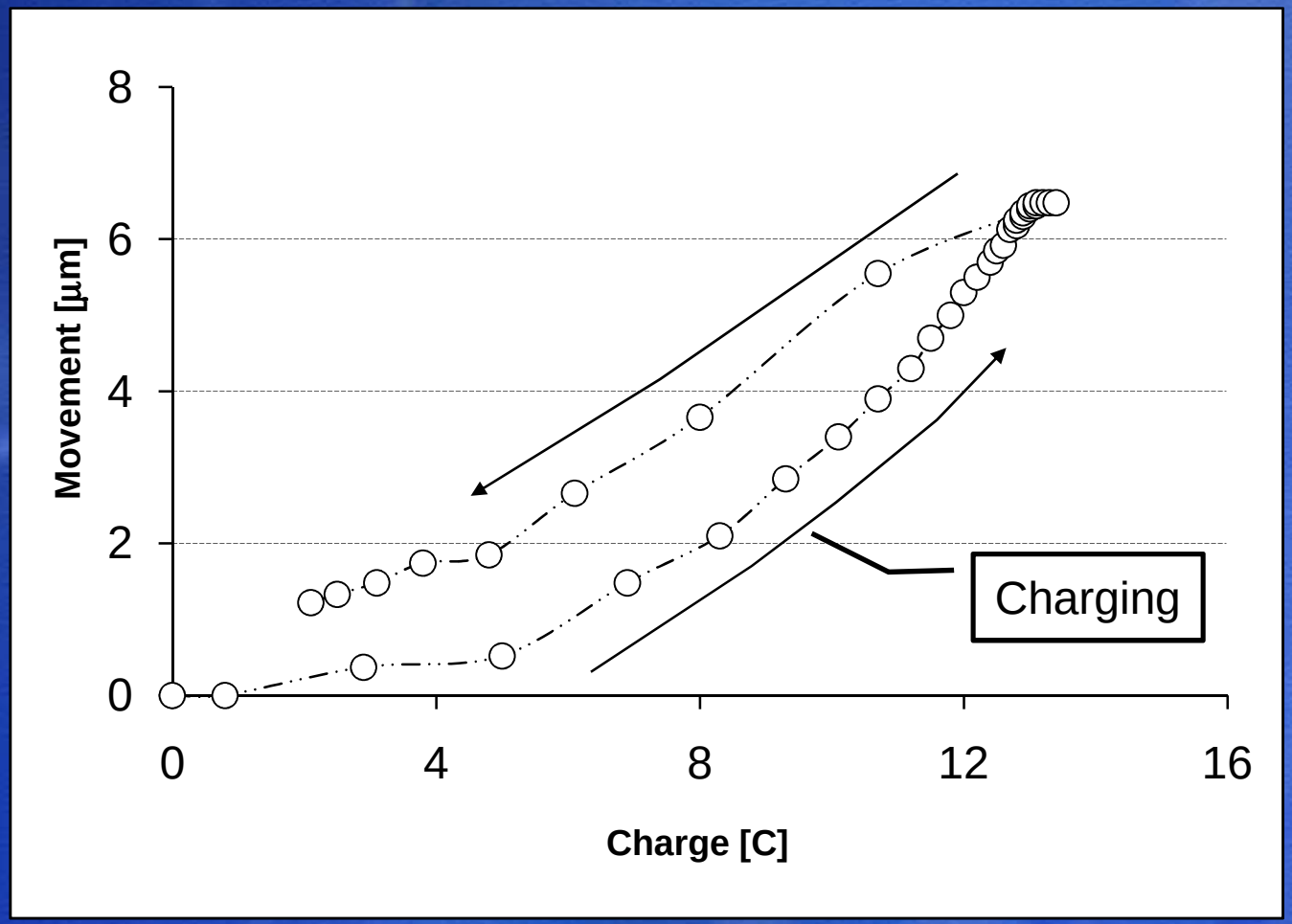


Actuation measurements

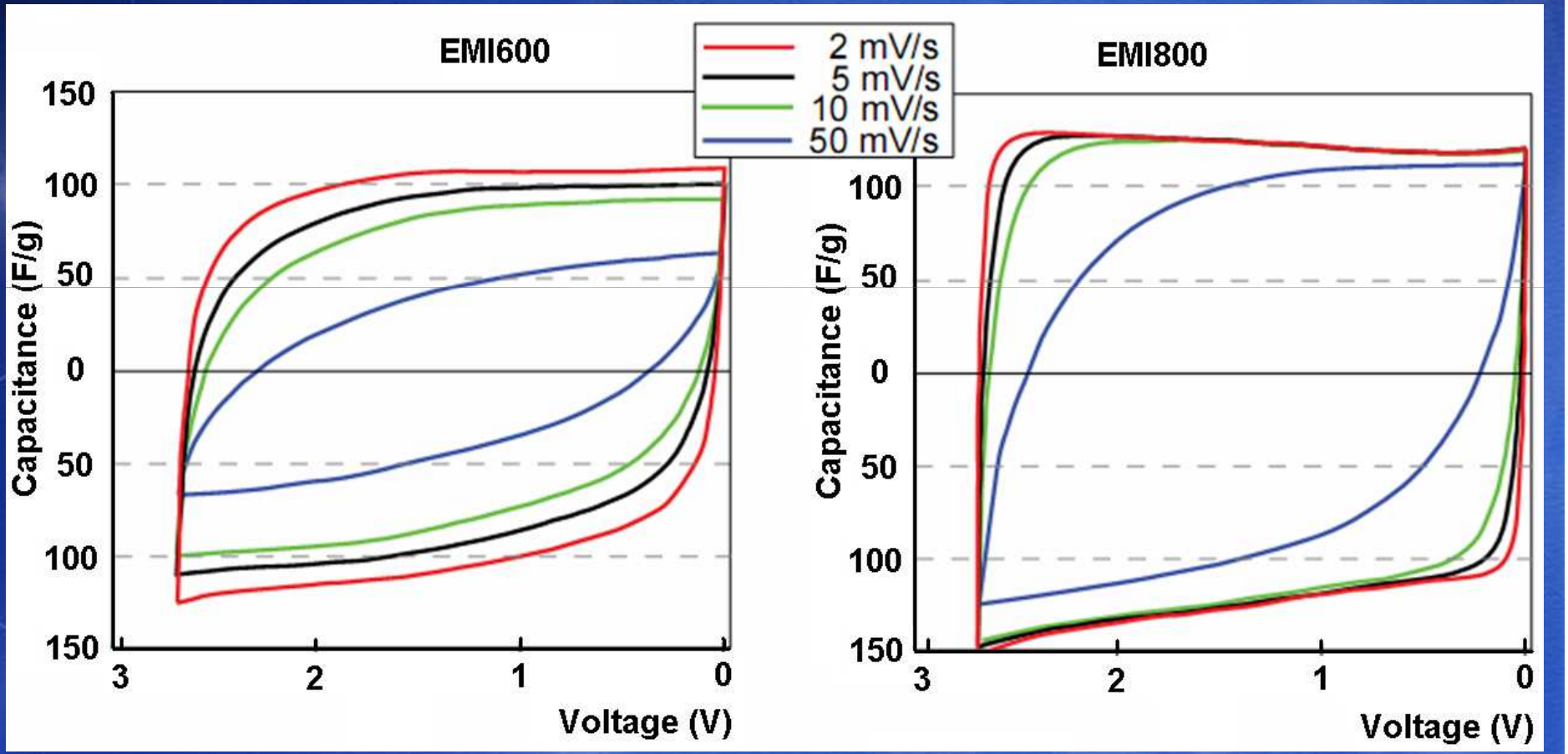


Charge and movement relationship during charging/discharging cycle

EMI800



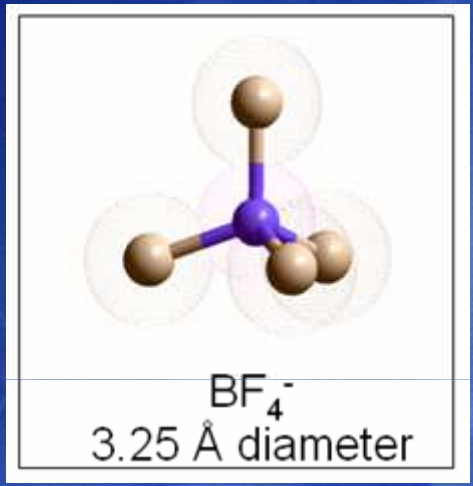
Cyclic voltammetry measurements

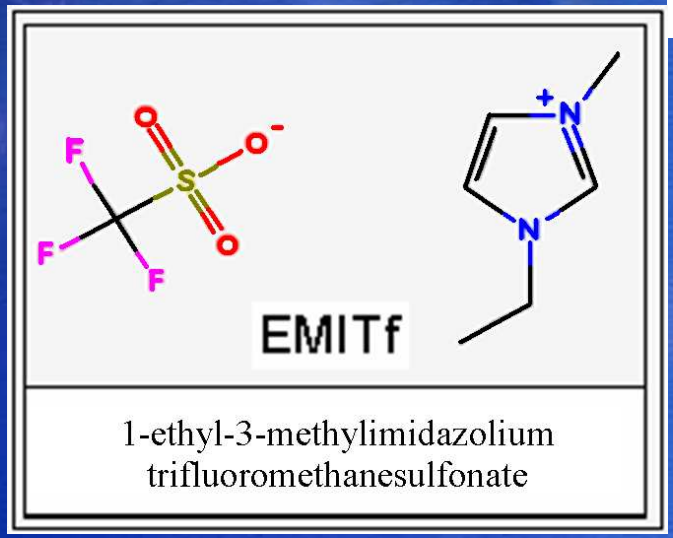


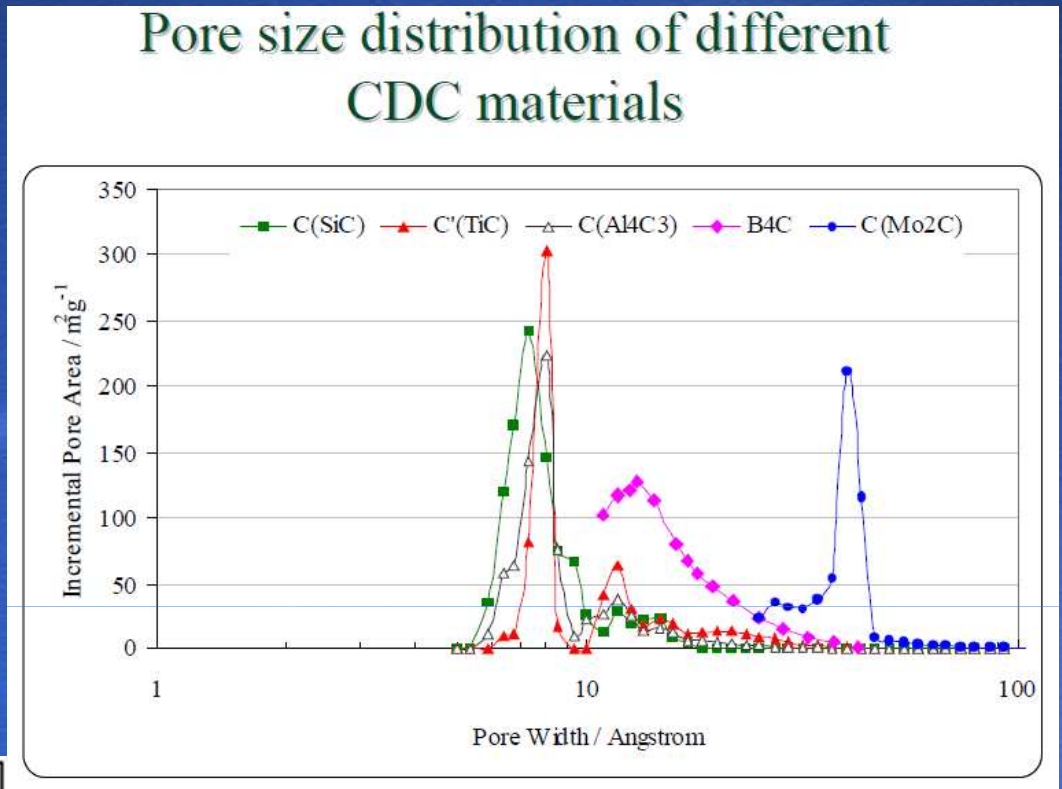
The electrochemical parameters series capacitance (C_s), series resistance (R_s), round-trip efficiecy (RTE) and actuation of linear actuators

Notation of actuator	C_s [F g^{-1}]	R_s [$\Omega \cdot cm^2$]	Actuation at 3V [μm]	RTE %
TEA600	64	3.9	10.2	84
TEA800	112	9.3	11.7	68
EMI600	75	7.3	16.2	72
EMI800	121	4.6	13.5	84

Future work


BF_4^-
3.25 Å diameter


F
F
F
O
O
O
S
N
N
EMITf
1-ethyl-3-methylimidazolium
trifluoromethanesulfonate


Pore size distribution of different CDC materials
C(SiC)
C'(TiC)
C(Al4C3)
B4C
C(Mo2C)
Incremental Pore Area / m²g⁻¹
350
300
250
200
150
100
50
0
1
10
100
Pore Width / Angstrom


$(CH_3CH_2)_4N^+$
6.75 Å diameter

Thank you!

どうもありがとう。