A Acronyms

Table A.1 presents the constants and variables used in the calculations for this project.

Table A.1: Constants and variables used in the calculations.

Symbol	Description	Unit	Value
$\overline{C}_{\text{carbon black}}$	Aimed concentration of carbon black	wt%	2
$\overline{C}_{\text{CMC}}$	Aimed concentration of CMC	wt%	1.5
$\overline{C}_{\text{graphite}}$	Aimed concentration of graphite	wt%	95
$\overline{C}_{\text{SBR}}$	Aimed concentration of SBR	wt%	1.5
$A_{\text{electrode}}$	Area of an electrode	cm^2	-
C_{CMC}	Concentration of CMC- solution	%	-
C_{graphite}	Concentration of graphite in the electrode	%	
C_{SBR}	Concentration of SBR- solution	%	15
C_{sol}	Concentration of solution	mol/L	-
σ	Conductivity	mS/cm	-
ρ_{DMC}	Density of DMC	g/cm^3	1.07 [87]
ρ_{EC}	Density of EC	g/cm^3	1.32 [88]
ρ_i	Density of a component i	g/cm^3	-
$m_{\text{active graphite}}$	Mass of active graphite on an electrode	mg	-
m_A	Mass of active material	g	-
$m_{\text{carbon black}}$	Mass of carbon black	g	-
m_{CMC}	Mass of CMC-powder	g	-
$m_{\text{CMC-solution}}$	Mass of CMC-solution	g	-
m_{i}	Mass of component i	g	-
m_{Cu}	Mass of Cu-foil	g	-
m_{water}	Mass of deionized water	g	-
m_{graphite}	Mass of graphite powder	g	-
$m_{\text{electrode}}$	Mass of electrode	g	-
m_{liquid}	Mass of liquid in the slurry	g	-
$m_{\text{SBR-solution}}$	Mass of SBR-solution	g	-
m_{solid}	Mass of solid active materials in the slurry	g	-
$m_{\text{Bu}_4\text{NPF}_6}$	Mass of Bu_4NPF_6	g	387.43 [89]
$M_{\text{Bu}_4\text{NPF}_6}$	Molar mass of Bu_4NPF_6	g/mol	387.43 [89]
$C_{\text{specific cap.}}$	Specific capacity of powder	mAh/g	-
R	Resistance	Ω	-
T_{Cu}	Thickness of Cu-foil	cm	-
$T_{electrode}$	Thickness of electrode	cm	-
TD	True density	g/cm^3	-
V_{i}	Volume of a component i	mL	-
$wt\%$	Weight percentage	%	-

B Calculations for experimental procedure

B.1 Slurry production

B.1.1 CMC-solution

The CMC-solution was made by mixing CMC-powder and deionized water. Batches of 50 mL solution was made by assuming a density of 1 g/cm^3 with a target concentration of 1.5 %. The amount needed of each component is given by

$$m_{\text{CMC}} = 50g \cdot \frac{15\%}{100\%} = 7.5g$$

$$m_{\text{water}} = 50g \cdot \frac{85\%}{100\%} = 42.5g$$

were m_{CMC} and m_{water} is the mass needed of CMC-powder and deionized water respectively.

B.1.2 Calculations of slurry components

Multiple slurries were made during this project in which the amount of active material varied. The amount of active material for each slurry depended on the amount of anode laminates made and the used gap-size. Therefore, in the following, a general explanation is given, in which m_A is used as the variable for active material.

The amount of graphite is given by following equation

$$m_{\text{graphite}}[g] = m_A \cdot \frac{\overline{C}_{\text{graphite}}}{100\%}$$

were $\overline{C}_{\text{graphite}}$ is the aimed wt % of graphite. Similar calculation was used to calculate the amount of carbon black, and is given by

$$m_{\text{carbon black}}[g] = m_A \cdot \frac{\overline{C}_{\text{carbon black}}}{100\%}.$$

were $\overline{C}_{\text{carbon black}}$ is the aimed wt % of carbon black.

The amount of CMC- and SBR- solution needed were based on the aimed wt % of CMC ($\overline{C}_{\text{CMC}}$) and SBR ($\overline{C}_{\text{SBR}}$), and the concentration of the specific CMC-solution (C_{CMC})

and SBR-solution (C_{SBR}) respectively. The calculations are given below.

$$m_{\text{CMC-solution}}[g] = m_A \cdot \frac{\overline{C}_{\text{CMC}}}{C_{\text{CMC}}}$$

$$m_{\text{SBR-solution}}[g] = m_A \cdot \frac{\overline{C}_{\text{SBR}}}{C_{\text{SBR}}}$$

The amount of water added depended on the desired loading, and was calculated based on the solid/ liquid-ratio. This ratio is given by

$$\text{solid/liquid-ratio} = \frac{m_{\text{solid}}[g]}{m_{\text{liquid}}[g]}$$

in which m_{solid} is the mass of solid active materials in the slurry, and m_{liquid} is the mass of liquid in the slurry. This parameters can be calculated based on the following two equations

$$m_{\text{solid}}[g] = m_{\text{graphite}} + m_{\text{carbon black}} + m_{\text{SBR-solution}} \cdot \frac{C_{SBR}}{100} + m_{\text{CMC-solution}} \cdot \frac{C_{CMC}}{100}$$

$$m_{\text{liquid}}[g] = m_{\text{water}} + m_{\text{SBR-solution}} \cdot \left(1 - \frac{C_{SBR}}{100}\right) + m_{\text{CMC-solution}} \cdot \left(1 - \frac{C_{CMC}}{100}\right)$$

B.2 Loading and C-rates

The loading of an electrode is defined by the amount of active material per area. This is given by Equation B.1.

$$\text{Loading}[mg/cm^2] = \frac{m_{\text{active graphite}}}{A_{\text{electrode}}} \tag{B.1}$$

Here, $A_{\text{electrode}}$ is the surface area of the electrode, and $m_{\text{active graphite}}$ is the mass of active graphite in the electrode. This can be found by

$$m_{\text{active graphite}} = \left[m_{\text{electrode}} - m_{Cu}\right] \cdot \left(\frac{C_{\text{graphite}}}{100}\right) \tag{B.2}$$

in which $m_{\text{electrode}}$ is the mass of the electrode, m_{Cu} is the mass of Cu-foil and C_{graphite} is

the percentage of graphite in the electrode.

Based on the mass of active graphite $m_{\text{active graphite}}$ on the electrode, the C-rate can be calculated. Equation B.3 shows the calculation for 1C. Other C-rates can be found based on the 1C value.

$$1C = m_{activegraphite} \cdot C_{\text{specific cap.}} \tag{B.3}$$

To find the aimed loading needed to obtain a capacity of 2 mAh/cm^2 for both powders during the slurry optimization, the specific capacities were used. The calculation are shown in Equation B.4

$$\text{Aimed Loading } [mg/cm^2] = \frac{\text{desired capacity}[mAh/cm^2]}{\text{specific capacity}[mAh/g]} \tag{B.4}$$

B.3 Calendering

All graphite electrodes used in the 3-electrode experiments were calendered to a preferred geometrical density. The total thickness of the electrode including the Cu-foil needed to obtain a specific geometrical density is given by Equation B.5

$$T_{\text{electrode}} = \frac{\text{loading of the electrode}[g/cm^2]}{\text{geometric density of the electrode}[g/cm^3]} + T_{Cu} \tag{B.5}$$

where T_{Cu} is the thickness of the copper-foil.

B.4 Porosity

The porosity of an electrode was calculated based on the geometrical density of the electrode and the true electrode density as shown in Equation B.6

$$\text{Porosity } [\%] = \left[1 - \frac{\text{Geometrical density of the electrode } [\text{g/cm}^3]}{\text{True electrode density } [\text{g/cm}^3]}\right] \cdot 100 \tag{B.6}$$

The geometrical density of electrode is based on the thickness and loading of the electrode as described in Equation B.5, while the true electrode density is based on the density of the slurry as shown in Equation B.7. Here TD is the true density and $wt\%$ is the

exact weight percentage of each component in the slurry. The wt% is unique for each slurry as the exact aimed concentration varies due to unaccuracy during weighting. The theoretical density of each component is presented in Table B.1.

$$\text{True electrode density} = (\text{TD}\cdot\text{wt\%})_{\text{graphite}} + (\text{TD}\cdot\text{wt\%})_{\text{carbon black}} + (\text{TD}\cdot\text{wt\%})_{\text{CMC}} + (\text{TD}\cdot\text{wt\%})_{\text{SBR}} \tag{B.7}$$

Table B.1: The theoretical density of the slurry components.

Component	**True density**$[g/cm^3]$
Carbon (s48)	2.24 [90]
Carbon black (C45)	2.00 [91]
CMC	1.60 [92]
SBR	0.98 [93]

B.5 Electrolyte

The electrolyte was made by mixing ethylene carbonate (EC) and dimethyl carbonate (DMC) in a 1:1 (wt%) ratio. Two solutions were made having a concentration of 0.01 mol/L and 0.1 mol/L of Bu_4NPF_6. The aimed volume of each electrolyte was 6 mL. Based on the density of EC and DMC which are 1.32 g/mL and 1.07 m/mL respectively, a targeted weight equal 3.5g was set for each component. TableB.2gives an overview of the target and actual mass of EC, DMC and Bu_4NPF_6 for each solution.

Table B.2: The composition of the two electrolytes used for the tortuosity measurements.

Concentration [mol/L]		**0.1**	**0.01**
Mass [g]	EC	3.5065	3.5027
	DMC	3.4993	3.5129
Volume [mL]	EC	2.6564	2.6536
	DMC	3.2704	3.2831
	Total	5.9268	5.9366
Mass of Bu_4NPF_6 [g]	Target	0.22960	0.02300
	Actual	0.22987	0.02333

The volume of each compound was calculated based on the mass and density of EC and DMC, according to Equation B.8. The density of EC and DMC is presented in the list of Acronyms in Table A.1.

$$V_i = \frac{m_i}{\rho_i} \tag{B.8}$$

Based on the total volume of EC and DMC, the amount of Bu_4NPF_6 to achieve the two solution of 0.01 mol/L and 0.1 mol/L was calculated based on Equation B.9.

$$m_{\mathrm{Bu_4NPF_6}} = C_{sol} \cdot V_{tot} \cdot M_{\mathrm{Bu_4NPF_6}} \tag{B.9}$$

C Cycling programs

To obtain a better visual of the different cycling programs used in this work, this section presents detailed explanation of the charge- and discharge- current with corresponding potential limitations. Additionally, for each program the potential as a function of time is presented.

C.1 Determination of the specific capacity

The specific capacity of the S48- and S93- powder was found by cycling coin cells with charge- and discharge- rate equal C/30. The cells had graphite and lithium metal as the working- and counter- electrode respectively. Figure C.1 shows the cell potential vs.Li/Li$^+$ as a function of time for this cycling program. Table C.1 presents the cycling program with corresponding potential limitations. Because coin cells were used, the only controllable potential was the cell potential.

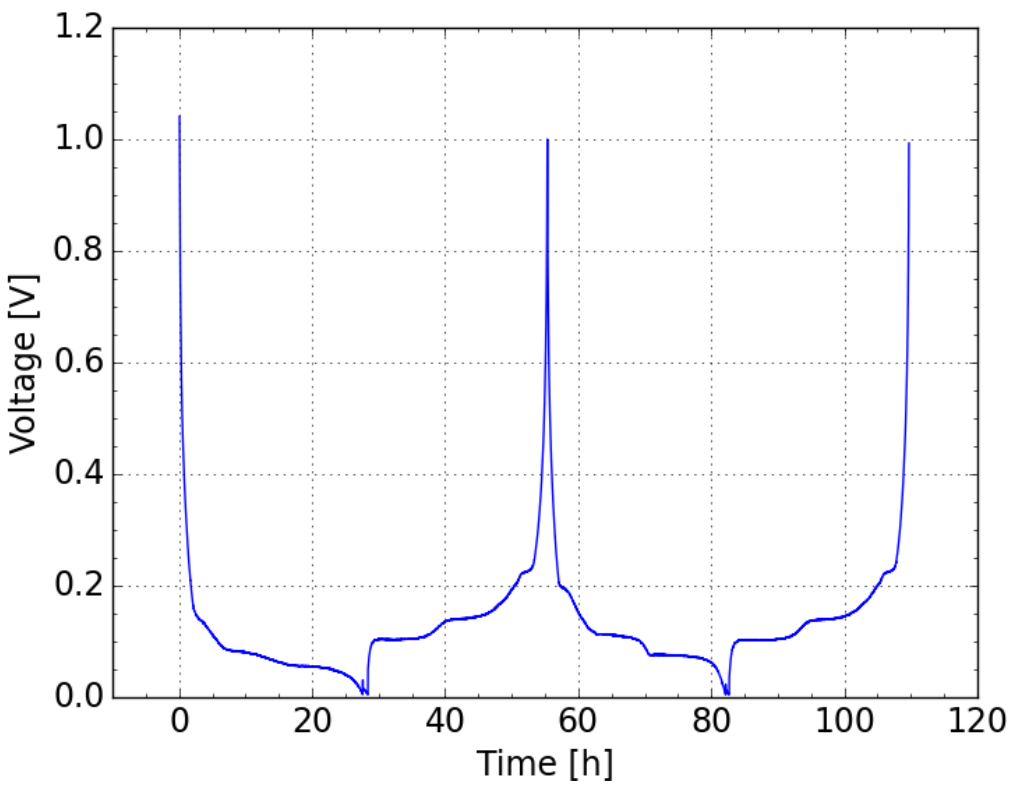


Figure C.1: The cell potential vs.Li/Li$^+$ as a function of time for determination of the specific capacity of the S49- and S93-powder. Coin cells having graphite and lithium metal as working- and counter- electrode respectively were used for the measurements. The cycling currents were based on the graphite electrode with the theoretical capacity equal 372 mAh/g.

Table C.1: Cycle program for the determination of the specific capacity of the S48- and S93-powder. The C-rates were based on the loading of the graphite electrode.

Number of repetitions	Cycling	Potential imitations
	Rest: 24 hours	
2	Lithiation at $\frac{C}{30}$ Constant voltage down to $\frac{C}{50}$ Delithiation at $\frac{C}{30}$	$E_{cell} \leq$ 5mV. $E_{cell} \geq$ 1V.

C.2 Formation of 3-electrode cells

A visual of the formation program for 3-electrode cells is shown in Figure C.2. Here the cell potential, as well as the potential vs.Li/Li$^+$ of the working- and counter-electrode are plotted as a function of time. These data was obtained from the S93-cell.

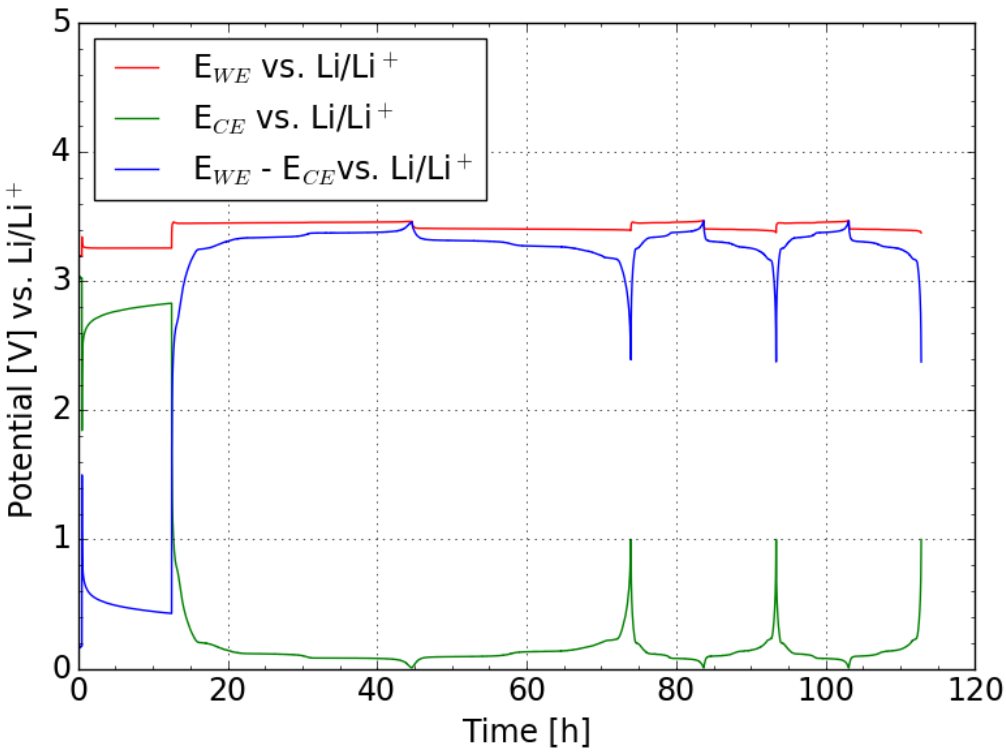


Figure C.2: The cell potential, as well as the potential of the working- and counter- electrode vs.Li/Li$^+$ as a function of time during formation of 3-electrode cell. The cycling current were based on the graphite electrode using the specific capacity of the powder.

Table C.2 presents the program used for formation of 3-electrode cell. Here, the cycling current with corresponding potential limitation is shown as well as number of repetitions.

Table C.2: Cycle program for formation of 3-electrode cells. The C-rates were based on the loading of the graphite electrode.

Number of repetitions	**Cycling**	**Potential limitations**
1	Rest: 30 minutes	
1	Lithiation at C/20	E_{WE}-E_{CE} $>$ 1.500V E_{WE} $>$ 4.000V E_{CE} $<$ 0.005 V
1	Rest: 12 hours	
1	Lithiation at $\frac{C}{30}$ Delithiation at $\frac{C}{30}$	E_{WE}-E_{CE} $>$ 4.000V E_{WE} $>$ 4.200V E_{CE} $<$ 0.005 V E_{WE}-E_{CE} $>$ 2.000V E_{WE} $>$ 3.000V E_{CE} $<$ 1.000V
2	Lithiation at $\frac{C}{10}$ Delithiation at $\frac{C}{30}$	E_{WE}-E_{CE} $>$ 4.000V E_{WE} $>$ 4.200V E_{CE} $<$ 0.005 V E_{WE}-E_{CE} $<$ 2.000V E_{WE} $>$ 3.000V E_{CE} $<$ 1.000V

C.3 Charge acceptance test for 3-electrode cell

The cell potential and the potential of the working-, counter- electrode vs. Li/Li^+ as a function of time during the charge acceptance test are shown in Figure C.3. These data is obtained from the S93-cell.

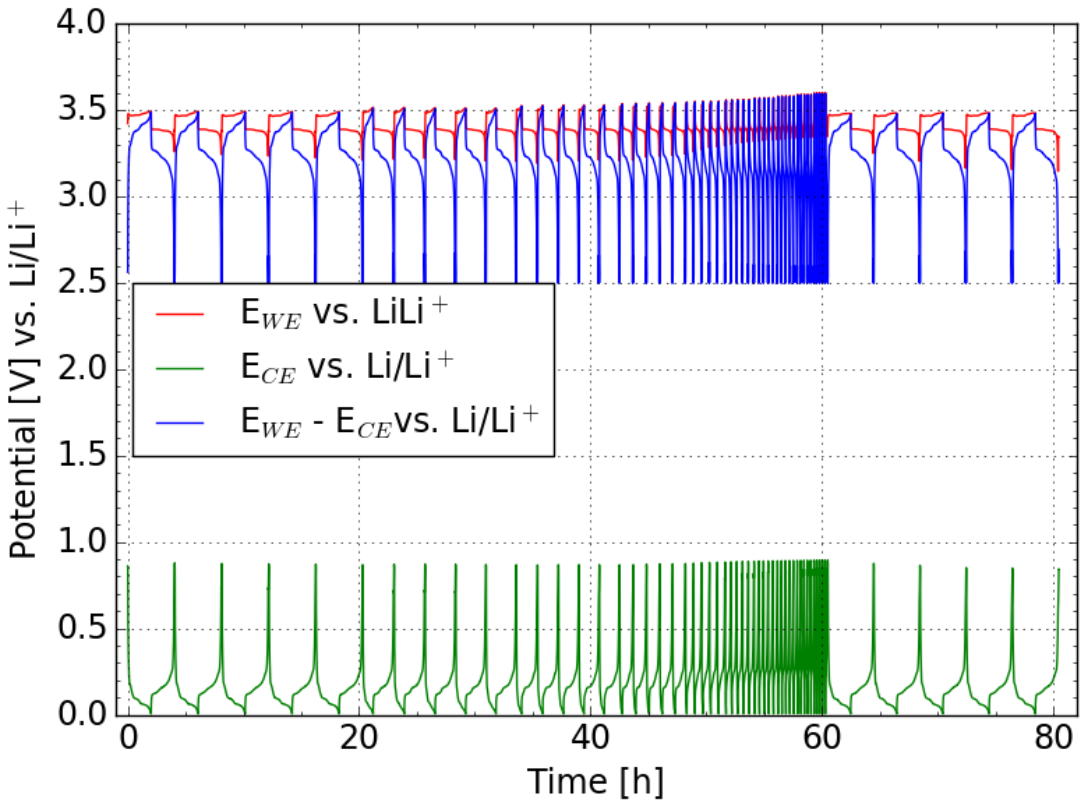


Figure C.3: The cell potential, as well as the potential of the working- and counter- electrode vs.Li/Li^+ as a function of time during the charge acceptance test. The cycling current were based on the graphite electrode using the specific capacity of the powder.

The cycling program used for the charge acceptance test on 3-electrode cells are shown in Table C.3. The table show the charge- and discharge- rats with corresponding potential limitations.

Table C.3: Cycle program for charge acceptance test on 3-electrode cells. The C-rates are based on the specific loading of the graphite electrode. The C-rates were based on the loading of the graphite electrode.

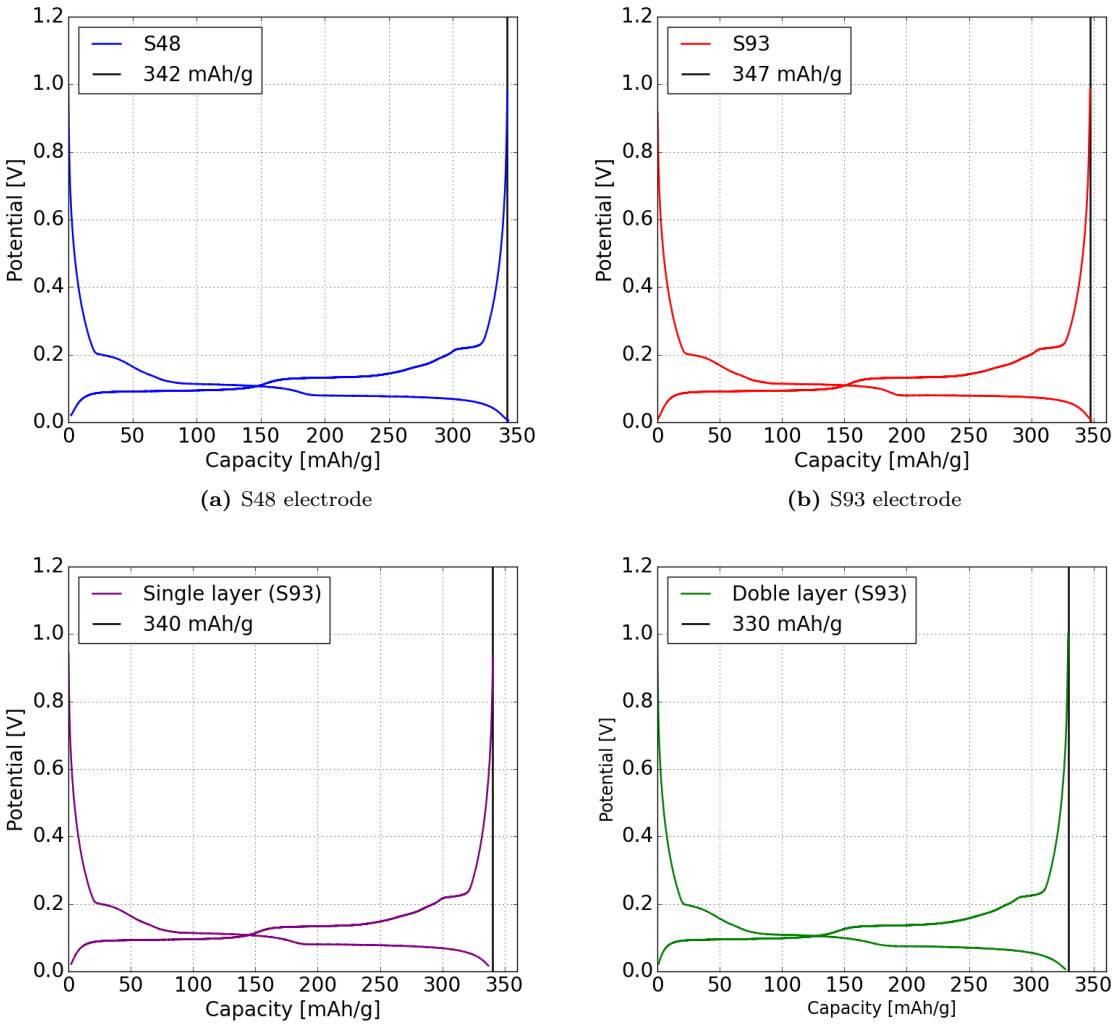
Number of repetitions	Cycling program	Potential limitations
5	Rest: 1 minutes	
	Lithiation at $\frac{C}{2}$	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: 1 minutes	
	Lithiation at 1C	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: 1 minutes	
	Lithiation at $\frac{3C}{2}$.	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: 1 minutes	
	Lithiation at 2C	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: 1 minutes	
	Lithiation at $\frac{C}{2}$	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{5C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: 1 minutes	
	Lithiation at 3C	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: 1 minutes	
	Lithiation at 3.5C	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: 1 minutes	
	Lithiation at $\frac{C}{2}$	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at 4C	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: 1 minutes	
	Lithiation at 4.5C	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
5	Rest: Lithiation at 1 minutes	
	Lithiation at 5C	$E_{CE} < 0.005$V or E_{WE}-$E_{CE} > 4.000$ V
	Delithiation at $\frac{C}{2}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V
	Rest: 1 minute	
	Delithiation at $\frac{C}{10}$	$E_{CE} > 1.000$ V or E_{WE}-$E_{CE} < 2.500$ V

D Results

This section presents the addition result obtained in this work. Here, the obtainable capacity of the 3-electrode cells are presented, as well as the results from the impedance measurements.

D.1 Obtainable capacity from first formation cycle

The obtainable capacity during formation at C/30 are presented in Figure D.1. The figure shows the discharge capacities for the two cells tested for the S48- and S93-cells, and for the cells having double- and single- layer graphite electrode.



(a) S48 electrode

(b) S93 electrode

(c) Single layer electrode (S93)

(d) Double layer electrode (S93)

Figure D.1: Potential of the graphite electrode vs. Li/Li^+ as a function of capacity. The figures show the maximum capacity reached at C/30 for the first formation cycle. Figure a and b represents the S48- and S93- cell, while c and d are the single- and double-layer electrodes respectively. The cycling current were based on the graphite electrode using the specific capacity of the powder.

D.2 Ionic conductivity measurements

D.2.1 Cell constant

The cell constant was found by EIS -measurements of a 0.1M KCl solution. The Nyquist plot from this measurement is shown in Figure D.3.

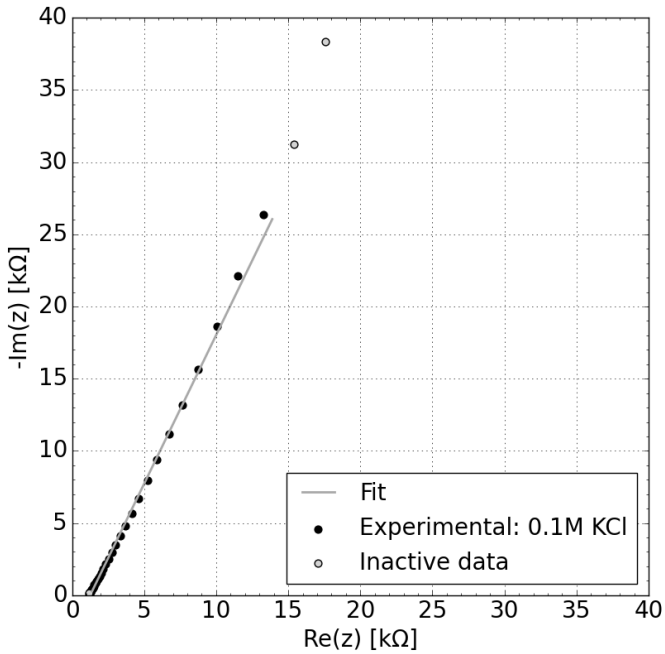


Figure D.3: Nyquist plot for a 0.1M KCL solution.

By using RelaxIS, the experimental parameters were fitted to the circuit shown in Figure 3.4. The parameters with corresponding fitted value are presented in Table D.1.

Table D.1: Parameters for 0.1M KCl-soution. The parameters are fitted to the circuit shown in Figure 3.4. RelaxIS were used to evaluate the impedance data.

Parameters	Values
R	$1260.4 \pm 18.3\ \Omega$
Q	$2.500 \cdot 10^{-7} \pm 3.600 \cdot 10^{-9}\ Fs^{\alpha-1}$
α	0.713 ± 0.002

Based on the resistance (R) and the known conductivity equal 12.87 mS/cm at 25 °C, the cell constant was found to be 16.22 ± 0.24 cm^{-1}. The calculation is shown in Equation

D.1

$$K_{\text{cell}} = \sigma \cdot R = 12.87 \cdot 10^{-3}\text{S/cm} \cdot 1260.4\Omega = 16.22\text{cm}^{-1} \tag{D.1}$$

D.2.2 Conductivity of electrolytes

The experimental data obtained from EIS-measurements for the two electrolytes were fitted to the circuit shown in Figure 3.4 by using RelaxIS. The resulting values are presented in Table D.2.

Table D.2: The parameters for the circuit shown in Figure 3.4 with corresponding fitted value and standard deviation. RelaxIS was used to evaluate the experimental data. The results was obtained from the two electrolytes used in the tortuosity measurements.

Electrolyte concentration	Parameters	Values
0.01 M	R	42013 ± 168 Ω
	Q	$1.162 \cdot 10^{-8} \pm 3.11 \cdot 10^{-10}\ Fs^{\alpha-1}$
	α	0.797 ± 0.003
0.1 M	R	5460.2 ± 13.8 Ω
	Q	$1.656 \cdot 10^{-8} \pm 2.26 \cdot 10^{-10}\ Fs^{\alpha-1}$
	α	0.928 ± 0.001

D.2.3 Ionic resistance

The ionic resistance was found by evaluating the EIS-results from the symmetrical cell using the simplified transmission line model. Biologic was used to evaluate the experimental data. The resulting values are presented in Table D.3.

Table D.3: The parameter for the circuit shown in Figure 2.10 with corresponding fitted values and standard deviations. Biologic was used to evaluate the experimental data. The results were obtained from symmetrical cells.

Powder	$C_{\text{electrolyte}}$ [mol/L]	R_{ion} [Ω]	Q [$Fs^{\alpha-1}$]	α [-]
s48	0.01	113.00 ± 0.98	0.00055 ± 0.00001	0.94 ± 0.02
	0.10	16.18 ± 0.93	0.00052 ± 0.00002	0.95 ± 0.02
s93	0.01	69.54 ± 0.99	0.00053 ± 0.00001	0.95 ± 0.02
	0.10	11.14 ± 0.99	0.00067 ±0.00002	0.94 ± 0.01

D.3 Electrochemical impedance data for S48- and S93- cells

The impedance data for the EIS- measurements performed on the S48- and S93- cell after the charge acceptance test were fitted with RelaxIS. The obtained values for the parameters corresponding to Figure 4.14 are presented in Table D.4. The circuit used for this experiment are shown in Figure 4.7 .

Table D.4: The parameter for the circuit shown in Figure4.7 with corresponding fitted values and standard deviations. RelaxIS was used to evaluate the experimental data. The data is fitted to the experimental values of the S48- and S93- cell.

Powders	Parameters	Impedance
S48	R0	4.52 ± 0.05 Ω
	R1	7.39 ± 0.12 Ω
	Q0	0.0120 ± 0.0050 $Fs^{\alpha-1}$
	α_Q	0.405 ± 0.008
	Z_w	381.04 ± 25.10 $\Omega s^{-1/2}$
	τ_W	1966.6 ± 187 s
	α_W	0.744 ± 0.005
S93	R0	4.48 ± 0.02 Ω
	R1	5.90 ± 0.09 Ω
	Q0	0.0132± 0.0008 $Fs^{\alpha-1}$
	α_Q	0.471 ± 0.009
	Z_w	734.34 ± 82.50 $\Omega s^{-1/2}$
	τ_W	2907.1 ± 378.0 s
	α_W	0.809 ± 0.004

D.4 Electrochemical impedance data for the double- and single-layer electrode cells

The fitted parameters from the impedance measurements before and after the charge acceptance test of the double - and single layered electrodes are presented in Table D.5 and D.6 respectively.

Table D.5: The parameter for the circuit shown in Figure 3.6 with corresponding fitted values and standard deviations. RelaxIS was used to evaluate the experimental data. The data is fitted to the experimental values of the double layer electrode from the impedance results before and after the charge acceptance test.

Double layered	Parameters	Impedance
Before	R0	5.13 ± 0.04 Ω
	R1	6.56 ± 0.10 Ω
	Q0	0.0071 ± 0.0005 $Fs^{\alpha-1}$
	α_Q	0.57 ± 0.01
	Z_w	168.06 ± 3.48 $\Omega s^{-1/2}$
	τ_W	630.0 ± 16.5 s
	α_W	0.726 ± 0.004
After	R0	4.91 ± 0.04 Ω
	R1	6.80 ± 0.17 Ω
	Q0	0.0129 ± 0.0060 $Fs^{\alpha-1}$
	α_Q	0.48 ± 0.02
	Z_w	493.52 ± 25.80 $\Omega s^{-1/2}$
	τ_W	1840.7 ± 99.9 s
	α_W	0.808 ± 0.006

Table D.6: The parameter for the circuit shown in Figure 3.6 with corresponding fitted values and standard deviations. RelaxIS was used to evaluate the experimental data. The data is fitted to the experimental values of the single layer electrode for the impedance results taken before and after thee charge acceptance test.

Single layered	**Parameters**	**Impedance**
Before	R0	4.32 ± 0.03 Ω
	R1	5.93 ± 0.11 Ω
	Q0	0.0131 ± 0.00105 $Fs^{\alpha-1}$
	α_Q	0.45 ± 0.011
	Z_w	622.75 ± 55.40 $\Omega s^{-1/2}$
	τ_W	2649.0 ± 290.0 s
	α_W	0.814 ± 0.005
After	R0	4.06 ± 0.02 Ω
	R1	5.79 ± 0.08 Ω
	Q0	0.0148 ± 0.0008 $Fs^{\alpha-1}$
	α_Q	0.439 ± 0.008
	Z_w	368.59 ± 7.62 $\Omega s^{-1/2}$
	τ_W	1684.0 ± 45.0 s
	α_W	0.801 ± 0.004

Mari Hognestad

The Effect of Tortuosity and Porosity Graded Graphite Electrodes in Lithium-Ion-Batteries During Fast Charging

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