



Luca Tendera (Autor)

Parametric influences on thermal characteristics of lithium-ion cells and their effect on thermal simulation

Herausgeber: Prof. Dr. Kai Peter Birke

ENERGIE & NACHHALTIGKEIT
Elektromobilität & Batterietechnologie

Luca Tendera

**Parametric influences on thermal
characteristics of lithium-ion cells
and their effect on thermal simulation**

Elektrische
Energiespeichersysteme



Nachhaltige
 CO_2 -Kreisläufe



Elektromobilität &
Batterietechnologie



Cuvillier Verlag Göttingen
Internationaler wissenschaftlicher Fachverlag

<https://cuvillier.de/de/shop/publications/9018>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentzsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen,
Germany

Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>

Contents

Abstract	1
Zusammenfassung	3
1 Introduction	5
1.1 Motivation	5
1.2 Goals	8
1.3 Outline	9
2 Basics of lithium-ion cells	11
2.1 Charging and discharging of lithium-ion cells	11
2.2 Cell formats of lithium-ion cells	13
2.3 Overview of lithium-ion cell components	14
2.3.1 Cathode chemistries	15
2.3.2 Anode chemistries	17
2.3.3 Separator design	19
2.3.4 Electrolyte configurations	19
2.4 Heat generation in lithium-ion cells	20
2.5 Thermal parameters of lithium-ion cells	21
2.5.1 Thermal conductivity	21
2.5.2 Heat capacity	23
2.5.3 Thermal homogenization of lithium-ion cells	24
2.6 Thermal simulation of lithium-ion cells	25
3 In-plane thermal conductivity	31
3.1 Background	31
3.1.1 Existing measurement approaches	31

3.1.2	Available literature data	32
3.1.3	Recorded parametric effects	34
3.1.4	Preview	35
3.2	Experimental	35
3.2.1	Measurement setup	36
3.2.2	Sample cells	38
3.2.3	Validation and determination of measurement error	39
3.3	Results and discussion	40
3.3.1	Effect of temperature on the in-plane thermal conductivity . .	41
3.3.2	Effect of SOC on the in-plane thermal conductivity	42
3.3.3	Effect of SOH on the in-plane thermal conductivity	42
3.3.4	Analytical prediction of the in-plane thermal conductivity . .	44
3.4	Summary	46
4	Through-plane thermal conductivity	49
4.1	Background	49
4.1.1	Existing measurement approaches	50
4.1.2	Available literature data	51
4.1.3	Recorded parametric effects	51
4.1.4	Preview	53
4.2	Experimental	54
4.2.1	Measurement setup	54
4.2.2	Sample cells	56
4.2.3	Validation and determination of measurement error	57
4.3	Results and discussion	58
4.3.1	Effect of temperature on the through-plane thermal conductivity	58
4.3.2	Effect of SOC on the through-plane thermal conductivity . .	59
4.3.3	Effect of SOH on the through-plane thermal conductivity . .	61
4.3.4	Analytical prediction of the through-plane thermal conductivity	62
4.4	Summary	64
5	Specific heat capacity	67
5.1	Background	67
5.1.1	Existing measurement approaches	68
5.1.2	Available literature data	69
5.1.3	Recorded parametric effects	70

5.1.4	Preview	72
5.2	Experimental	72
5.2.1	Measurement setup	73
5.2.2	Sample cells	74
5.2.3	Validation and determination of measurement error	75
5.3	Results and discussion	76
5.3.1	Effect of temperature on the specific heat capacity	77
5.3.2	Effect of SOC on the specific heat capacity	78
5.3.3	Effect of SOH on the specific heat capacity	79
5.3.4	Analytical prediction of the specific heat capacity	81
5.4	Summary	83
6	Effects on the thermal simulation	85
6.1	Background	85
6.1.1	Existing thermal simulations and parametrization	86
6.1.2	Preview	88
6.2	Thermal-electrical-electrochemical model	89
6.2.1	Modeling framework	89
6.2.2	Operating point-dependent thermal parameters	90
6.2.3	Cooling scenarios	94
6.3	Results and discussion	96
6.3.1	Exemplary charging procedure	96
6.3.2	Effect of variable through-plane thermal conductivity	98
6.3.3	Effect of aged through-plane thermal conductivity	100
6.3.4	Effect of variable specific heat capacity	102
6.3.5	Effect of variable thermal parameters on charging time	104
6.4	Summary	107
7	Conclusion	109
List of abbreviations		113
List of tables		115
List of figures		117
Bibliography		119

Publications	141
Curriculum Vitae	143
Supervised thesis	145