Electrochemical Society
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Sustainable Power and Energy Center

Friday, June 8th, 2018 10:30-11:30 AM
Fung Auditorium at Powell-Focht Bioengineering Hall

Three Electrode Cell and Full Cell Measurements for Better Understanding of Battery Materials

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Abstract

It is widely accepted that materials research in the field of electrochemical energy storage has to follow a system approach. In many cases, the understanding of materials in the cell system is only possible via complex experimental approaches. In the battery community, the tool "electrochemistry" is underrated. In fact, battery research has become to a large extent a branch of materials science.

Here, we show how rather simple, but still uncommon electrochemical measurements can help to understand the behavior of lithium ion battery materials in the full cell system. Among others, we will highlight experiments that elucidate irreversible capacity losses of high voltage cathodes, differentiate between irreversible capacities at anodes, that involve Li consumption (irreversible capacity loss) and not (reversible capacity loss) and discuss the influence of anode overhang.

Related literature:

1. Holtstiege F, Wilken A, Winter M, Placke T, *Running out of lithium? A route to differentiate between capacity losses and active lithium losses in lithium-ion batteries, Phys. Chem. Chem. Phys.*, **2017**, *DOI: 10.1039/C7CP05405J.*
2. Kasnatscheew J, Placke T, Streipert B, Rothermel S, Wagner R, Meister P, Cekic-Laskovic I, Winter M, *A tutorial into practical capacity and mass balancing of lithium ion batteries, J. Electrochem. Soc.*, **2017** *164.* A2479-A2486
3. Kasnatscheew J, Boerner M, Streipert B, Meister P, Wagner R, Cekic-Laskovic I, Winter M *Lithium ion battery cells under abusive discharge conditions: Electrode potential development and interactions between positive and negative electrode, J. Power Sources,* **2017**, *362*, 278-282
4. Kasnatscheew J, Streipert B, Roeser S, Wagner R, Cekic-Laskovic I, Winter M, *Determining oxidative stability of battery electrolytes: Validity of common electrochemical stability window (ESW) data and alternative strategies, Phys. Chem. Chem. Phys.*, ***2017,*** *19*, 16078-16086
5. Kasnatscheew J, Evertz M, Streipert B, Wagner R, Nowak S, Cekic-Laskovic I, Winter M, *Improving cycle life of layered lithium transition metal oxide ($LiMO_2$) based positive electrodes for Li ion batteries by smart selection of the electrochemical charge conditions, J. Power Sources,* ***2017****, 359*, 458-467,
6. Kasnatscheew J, Evertz M, Kloepsch R, Streipert B, Wagner R, Cekic-Laskovic I, Winter M, *Learning from electrochemical data: Evaluation and classification of $LiMO_2$ type based positive electrodes for Li ion batteries by using a novel electrochemical analysis methodology, Energy Technology,* **2017**,*5.9. 1670-1679*
7. Kasnatescheew J, Evertz M, Streipert B, Wagner R, Nowak S, Cekic-Laskovic I, Winter M, *Changing established belief on capacity fade mechanisms: Thorough investigation of $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ (NCM111) under high voltage conditions, J. Phys. Chem. C,* ***2017****, 121*, 1521−1529
8. Kasnatscheew J, Rodehorst U, Streipert B, Wiemers-Meyer S, Jakelski R, Winter M, *Learning from overpotentials in lithium ion batteries: A case study on the $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ (NCM) cathode, J. Electrochem. Soc.*, **2016**, *163*, A2943-A2950
9. Kasnatscheew J, Evertz M, Streipert B, Wagner R, Kloepsch R, Vortmann B, Hahn H, Nowak S, Amereller M, Gentschev A-C, Lamp P, Winter M, *The truth about 1st cycle Coulombic efficiency of $LiNi_{1/3}Co_{1/3}Mn_{1/3}O2$ (NCM) cathodes, Phys.Chem.Chem.Phys.* **2016**, *18*, 3956-3965
10. Krueger S, Kloepsch R, Li J, Nowak S, Passerini S, Winter M, *How do reactions at the anode/electrolyte interface determine the cathode performance in lithium-ion batteries, J. Electrochem. Soc.*, **2013**, *160 (4)*, A542-548.

Biosketch

Martin Winter has been researching in the field of electrochemical energy storage and conversion for more than 25 years with a focus on the development of new materials, components and cell designs for batteries and supercapacitors. Martin Winter currently holds a professorship for "Materials Science, Energy and Electrochemistry" at the Institute of Physical Chemistry at Muenster University, Germany. The full professorship developed from an endowed professorship funded by the companies Volkswagen, Evonik Industries and Rockwood Lithium from 2008 to 2012.

Martin Winter is the scientific director of the MEET Battery Research Center at Muenster University. MEET combines outstanding equipment with an international team of about 150 scientists, engineers and technicians. Since January 2015 he is also director of the Helmholtz-Institute Muenster (HI MS) "Ionics in Energy Storage" with a staff of about 70 scientists.

Martin Winter is the spokesperson of German Battery Research, past spokesperson of the innovation alliance "LIB2015" and current speaker of the National Project Alliance "Batterie2020". Currently, he holds several president and chairmen positions of scientific societies.

Martin Winter is a highly cited author as recognized by ISI (Thomson Reuters), The Shanghai Ranking, and Elsevier Scopus. Among more than 40 awards and recognitions, he holds the Carl Wagner Memorial Award of the Electrochemical Society (ECS) and the "Braunschweig Research Prize". He has been the recipient of the Research and Technology awards of both, the ECS and the International Battery Materials Association (IBA). He is Honorary Professor at Taiwan Tech und at National Cheng Kung University, is a member of the National Academy of Science and Engineering (acatech) and is a Fellow of the ECS and the International Society of Electrochemistry (ISE).

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